ARKANSAS STATE BROADBAND MANAGER'S REPORT

DECEMBER 2020

Produced by the Arkansas State Broadband Office

Contents

I. INTRODUCTION AND OVERVIEW

It seems clear that the year 2020 will mark a turning point for broadband in Arkansas.

At the time of writing, as for many years previously, large swaths of Arkansas have suffered from inadequate access to the internet. This has long been felt to be increasingly unacceptable, as the proliferation of internet applications over the past generation has led to a situation where to lack internet service is to be left out of much of modern life, culturally and economically. The COVID-19 pandemic turned a smoldering grievance into an acute crisis.

But relief is in sight. An endgame for the digital divide is starting to emerge. It depends, above all, on the FCC's Rural Digital Opportunity Fund program, with secondary roles to be played by the Arkansas State Broadband Office and other state agencies, by the US Department of Agriculture, and possibly by the Starlink satellite internet service that is being spearheaded by SpaceX. If the promises of all these programs are fulfilled, the digital divide will largely disappear over the next decade.

A. The Online Economy and the Digital Divide Before the Pandemic

The phrase "digital divide" is used in different ways, but here it refers to geographic differences in access to high-quality internet service. As society evolves in ways that make the internet increasingly central to its operations and institutions, being on the wrong side of the "digital divide" means deprivation both of new conveniences, entertainments and opportunities enjoyed by others, and of some services once enjoyed that become unsustainable because the digital revolution deprives them of a critical mass of demand. Prior to the pandemic, there was growing recognition that the digital divide was a problem, but the pandemic added greatly to its urgency.

Home movie viewing may serve as an example of the creeping impoverishment that results from the digital divide. Twenty years ago, there were video rental stores where people could rent videos to watch at home. When Netflix started in the 1990s, it shipped DVDs to people's mailboxes, but customers transacted with Netflix through the internet. Later, Netflix began streaming video, which is now its dominant business model, and it competes with several other online video streaming services. At the time of writing, it still provides DVD rentals by mail, as a premium service. Meanwhile, video rental stores have largely disappeared, in the face of competition from Netflix and live streaming services. Those with good internet connections can access far more video content more conveniently and cheaply than they could in the age of video rental stores. But those whose internet connections are poor or lacking have worse options for home video watching than they did before the internet came along. They are victims of the digital divide.

A more urgent example of the digital divide in action is Arkansas's sole statewide daily newspaper, the *Arkansas Democrat-Gazette*, which stopped its weekday print edition in 2020. The newspaper is still publishing, both online and through iPads specially distributed to customers to help them read the paper. But to read the newspaper this way requires some kind of internet access. Nationwide, traditional print newspapers have struggled, as advertising revenues have shifted towards Google, Facebook, and other online media giants, and as a host of novel news sources enabled by the internet compete for readers' attention. Thanks to this abundance of online content, those with internet

connections can stay better informed than ever before, even as those without internet service become more out of touch, victims of the digital divide. As another example, people used to use phone books to find people and businesses to call, but now they use the internet.

The internet has had more impact on some sectors than others, and news and media have so far been more affected than most. Before the COVID-19 pandemic, three sectors where traditional brick-and-mortar routines from the digital age were still dominant were (a) education, (b) health care, and (c) employment. In each case, there were online alternatives to traditional face-to-face practices. There was a rich array of online education options. Some consultations with doctors were conducted by videoconference, and some people worked from home, telecommuting into a virtual office and conducting meetings by phone or videoconference instead of physically commuting to a physical office or other worksite. But such practices represented a small "market share" of education, health care, and employment, respectively. Mainstream practice in education and health care, and mainstream employment, made intermittent use of the internet, e.g., for setting appointments, sharing documents, or looking up information, and a complete lack of internet access could be crippling because it impeded these occasional but vital functions. But the comprehensive substitutes for traditional practices which the internet offered were not widely adopted.

Shopping had been more heavily impacted, prior to the COVID-19 pandemic, than education, health care, and employment, without being thoroughly revolutionized. For years, brick-and-mortar stores have faced formidable competition from e-commerce. Some retail sectors, such as bookselling and electronics, were more affected than others. Some retailers succumbed, and bankruptcies of retailers were often blamed on e-commerce, but plenty of other retailers continued to do well. Before the pandemic, e-commerce only accounted for 11% of retail.[1] For some goods, such as clothing and fresh produce, the in-store experience provides crucial information to inform buyer decisions, while for other goods, such as food products that require delicate handling or must be kept cold, home delivery involves special logistical challenges that had impeded e-commerce solutions. Relative to education, health care, and jobs, shopping tends to be viewed as less of a governmental concern, and policy attitudes are more *laissez-faire*. Nonetheless, lack of access to online shopping is a significant harm resulting from the digital divide. People without internet access enjoy fewer purchasing options and must often satisfy fewer of their needs and/or get less value for their money.

In still other cases, the internet offered new experiences for which no practices before the digital age provide close parallels. Humans have long socialized, but until the rise of MySpace, Facebook and Twitter, the human race had never experienced anything closely resembling participation in modern social media. There is a long tradition of publishing, but the ease and speed with which texts can be disseminated online, with no need for the traditional gatekeepers of the publishing industry, has led to a new and unprecedented experience of fast-paced, many-sided, open-access and globalized conversational engagement for which history really provides no precedent. Humans have long been in the business of collecting and organizing and accessing knowledge, but the ease with which a search engine puts a vast array of human knowledge at the fingertips of anyone with a smartphone is something radically new in the world.

[1] https://econlife.com/2020/02/exaggerated-retail-apocalypse/

In today's America, when cooking, you are more likely to look up a recipe online than to open a cookbook.[2] When singing, you are likely to look up song lyrics. Online research is likely to be the first step to fixing up the house or choosing the weekend's entertainment. The internet has become a leading arena of entrepreneurship and innovation, with certain new apps and websites serving as cultural landmarks in much the way that certain new books or bands had for past generations. The whole quality of modern life has become interwoven with the online world. And yet it is not available everywhere. It depends on a physical infrastructure either of wires and cables, or else of wireless signals traveling through the airwaves, to transmit data to users' devices. In some places, including large parts of Arkansas, no company offers internet services adequate to enable full participation in the online world.

B. What It Takes to Connect to the Online World

Internet connections vary in quality in ways that can be characterized by several network performance metrics. "Speed" or "bandwidth" measures the size of the flow that can be transmitted over a connection. Typically measured in megabits per second (Mbps), it is the most common internet service quality metric. Networks are frequently designed so that download speeds are faster than upload speeds. "Latency," another measure of speed, is the *time* that it takes for a signal to reach its destination, if the amount of data to be transmitted is small. It is typically measured in milliseconds (ms). Other standard network performance metrics include packet loss and jitter. Network connections also differ in their reliability. And monthly data caps force some users to forgo some data-intensive uses of the internet.

To simplify somewhat, the speed with which a file is fully transmitted is a function of bandwidth and latency, with bandwidth mattering more in proportion to the size of the file. If the file is 1 megabyte (MB) in size, it would take 200 ms to begin arriving, and another 8/25 seconds, or 320 milliseconds, to finish arriving. Altogether, the 1 MB file would be downloaded in 520 ms, or roughly one-half of one second. If the file is 1 gigabyte (GB) in size, it would still begin arriving after 200 ms, but now it would take 320 seconds, or a little more than five minutes, to finish. Movie files can be several gigabytes in size, so they can take a long time to download over a slow connection. Latency is generally less important than bandwidth for purposes of downloading files, but can be critical for highly interactive applications such as teleconferencing, online gaming, or editing documents in the cloud.

Not long ago, key stakeholders were arguing that internet connections with a bandwidth of 10 Mbps download and 1 Mbps upload (10 Mbps/1 Mbps or 10/1) were adequate to meet most needs. That position has become unfashionable, and the FCC definition of "broadband" limits the term to connections that provide 25/3 or faster. Yet the bandwidth actually required by popular internet applications is still small enough that it is not easy to explain how a typical user would fully utilize even a 25/3 connection, much less the gigabit speed connections that some Arkansans have access to, and far more will gain access to in the next few years, especially in light of the results of the FCC's RDOF auction. E-mail, search engines, and social media typically require negligible bandwidth. Music streaming requires much less than 1 Mbps. Common data-intensive internet uses include teleconferencing and

[2] https://www.foxnews.com/food-drink/cooking-survey-says-americans-prefer-to-find-recipes-on-social-media-rather-than-cookbooks

video streaming, and might require 5 Mbps or a little more, but it would take multiple devices streaming HD videos to exhaust a 25 Mbps connection on the download side, though slow upload speeds could easily become a pain point for active users of video calling. A person skilled in making efficient use of bandwidth might be very functional with a 10/1 connection.

But the evolution of the internet does not favor efficient use of bandwidth. As the connection speed of the median internet user rises, producers of online content and applications feel less need to be economical with bandwidth. The rise of cloud computing exemplifies the trend. If a user is richly endowed with bandwidth, it makes sense for applications and documents to live in the cloud, where they can be centrally maintained. Software developers have responded by making many programs more cloud-dependent than in the past. The growing dependence of a wide variety of applications on the cloud, in turn, makes offline personal computing less and less viable, in a way that most individual computer users are helpless to prevent. Sometimes bandwidth demands might escalate without improving the user experience. Video advertisements on websites, hardly viable when most connections were slower, are now common. They are innocuous enough for users who have plenty of bandwidth, but can slow down other online applications when bandwidth is limited. The 25/3 standard that has recently become normative in broadband investment is geared towards meeting future as much as present needs. Some commentators expect 25/3, too, to become, in due course, insufficient to enable normal use of the internet, but that is uncertain.

How severe the digital divide is deemed to be depends on what bandwidth, latency and other properties of internet connections are considered necessary. If low latency and 25/3 speeds are required, then much of the state of Arkansas is underserved. But the reach of 10/1 service with low latency is greater, and the whole state is notionally covered by satellite service with high latency, although the Broadband Office has heard anecdotal reports of places where a satellite signal cannot be received. Satellite services are widely regarded as inadequate, but it is not clear whether this perception is driven by latency, by data caps and pricing, or by other factors such as reliability. (Satellite systems tend to underperform in stormy weather.[3]) But rather than settling such edge cases, the policy momentum currently seems to favor raising broadband speeds to 25/3 and beyond for as many users as possible, using low-latency broadband technologies such as fiber, cable, and fixed wireless.

C. Broadband and the COVID-19 Pandemic

Starting in March 2020, face-to-face contact suddenly became dangerous. Anywhere that people from different households mingled indoors was an opportunity for the respiratory transmission of the COVID-19 virus. State and local governments issued directives and guidelines closing restaurants, schools, barber shops, gyms, and many other establishments in a desperate effort to stop the spread, leaving only “essential” businesses physically open. Unemployment surged, and the economy became bleak and discombobulating, with a prolonged toilet paper shortage grimly symbolizing the panic. But the internet didn’t break, and it suddenly took on new importance as the backbone of the economy and society, and the key to resilience in the face of the pandemic.

During the COVID-19 pandemic, it became clearer than ever that broadband has become more of a necessity than a luxury. Broadband’s role in people’s lives became more central and indispensable as K-

[3] https://www.satelliteinternet.com/resources/does-weather-affect-internet/

12 students relied on broadband to study and many people relied on broadband to work or shop safely. For people in high-risk demographics, such as the elderly, grocery shopping through e-commerce and delivery instead of a physical visit to the store might plausibly make the difference between life and death. Telework was critical in preserving livelihoods and keeping organizations running while on-site collaboration was unsafe. And telemedicine was a safer alternative to visiting doctor's offices and hospitals where patients might breathe the same air as knowing or unknowing COVID-19 sufferers and get sick. Because of its role in facilitating distance education, telemedicine and telework, broadband was approved as an allowable expenditure of the $1.25 billion CARES Act allocation that the state received, and over $82 million in CARES Act funds were allocated to Arkansas Rural Connect broadband grant projects, which are expected, by the beginning of 2021, to have brought broadband access to over 70,000 Arkansans who previously lacked it. The pandemic seems to have spurred a nationwide push for broadband deployment, and this investment will outlast the pandemic itself and leave a legacy of greater connectivity in many communities in Arkansas and across the nation.

At the time of writing, vaccines have begun to be distributed, so there is good reason to hope that by the end of 2021, the pandemic will be eliminated or at least greatly mitigated, and face-to-face commerce and social interaction will be enjoying a recovery. If so, the great societal experiment in virtualizing everything will lose its urgency. But it will surely leave behind some habits, some innovations, and some lessons learned, all tending to favor online ways of doing things. Policymakers should expect there to be more telework, more telemedicine, more distance education and/or more e-commerce in 2022 or 2025 than there would have been without the COVID-19 pandemic. Widespread broadband will be critical for enabling citizens to take advantage of it.

D. The Big Push for Broadband

Broadband deployment would probably have accelerated in response to rising demand, even if government had done nothing to encourage it. But government at all levels has responded.

The FCC's Rural Digital Opportunity Fund program will have the largest impact. It committed $9.23 billion nationally to serve over 5.2 million homes, including $424 million for over 200,000 locations in Arkansas. Of these, 97% will, if—a big *if*—ISPs fulfill their commitments, gain access to speeds of 1 Gbps download/500 Mbps upload. Of course, such speeds are not available to most Arkansans today. An ironic future appears to be in store, whereby many thousands of rural RDOF beneficiaries, after suffering for years from inadequate internet service, will find themselves better connected than many of their urban neighbors.

The Arkansas Rural Connect program, which at the time of writing has spent $86,883,834 on broadband grants since the launch of the first round in April 2020, mostly using federal coronavirus relief funds, should deliver broadband access to over 70,000 Arkansans who previously lacked it, starting from the beginning of 2021. The USDA ReConnect program also awarded $11.8 million for broadband projects in parts of Arkansas. And SpaceX's Starlink service will soon begin taking customers for its new low-latency low-Earth-orbit (LEO) satellite service.

Arkansas Rural Connect complements the FCC's RDOF program in some ways. First, it deployed faster. While initially developed for a deployment timeline of two years or more, the ARC program was repurposed by rule changes early in 2020 to be responsive to the COVID-19 emergency, and the conditions placed on the use of federal CARES Act money required most ISPs receiving ARC awards to

complete deployment by December 2020. RDOF winners, by contrast, are allowed to take three years before any deployment is completed, and only need to serve all targeted locations by year six of the program. Second, while the RDOF program generally excluded towns from participation, Arkansas Rural Connect awarded grants for towns as well as rural areas, and so was able to bring broadband to many Arkansans living in areas that also had poor internet access but were not eligible for RDOF support.

These multiple, simultaneous efforts to solve the digital divide overlap in ways that will soon give some Arkansans multiple broadband options where they recently had none. In parts of Conway County, for example, fiber service from the rural electric coop, subsidized by the FCC, will compete with fixed wireless service subsidized by Arkansas Rural Connect, and hopefully—since it's good for consumers to have options—also with LEO satellite service from Starlink. At the same time, some Arkansans may continue to suffer from a deficiency of internet service for years to come. Starlink may, in the best case, solve the digital divide quickly, but it is a technologically novel venture that may underperform or suffer setbacks. Arkansas Rural Connect projects, though fast and impactful, are reaching only a minority of unserved and underserved Arkansans. And not only will some RDOF beneficiaries wait years before RDOF winning ISPs are required to fulfill their promises, but some critics doubt whether all the winners will be able to deliver on their promises at all.[4]

Still, thanks to RDOF, Starlink, and Arkansas Rural Connect, there is a plausible endgame to the digital divide in Arkansas.

E. An Endgame in Sight for the Digital Divide in Arkansas

At the time of writing, it looks as if plans and commitments by ISPs are currently, or soon will be, in place that will nearly eliminate the digital divide in Arkansas over the course of the next few years. This will depend on most of the following happening:

1. Winners of the 2018 CAF II auction will continue to carry out their deployments as promised to the FCC.
2. Winners of USDA ReConnect grants and loans will complete their deployments as promised.
3. Arkansas Rural Connect project footprints will get internet service from grant awardees, and will continue to be served until at least 2030.
4. Fixed wireless companies that won ARC grants will offer broadband service not only to residents of their project footprints, as promised, but also to residents of surrounding areas, where the companies have no obligations, because it makes business sense to offer service throughout the areas reached by their towers.
5. Lots of new fiber-to-the-home broadband will be deployed by RDOF winners that are identifiable as known, reputable companies doing business in Arkansas, such as rural electric cooperatives, Windstream, Cox, and Southern Arkansas Telephone Company, using RDOF funds and fulfilling RDOF obligations.
6. More new fiber-to-the-home will be deployed by RDOF winners that are new to the state and/or cannot be identified at the time of writing, because they are consortia with non-transparent names, and the FCC is still enforcing a "quiet period" that prevents their identities from being

[4] https://potsandpansbyccg.com/2020/12/11/im-still-confused-by-the-rdof-grants/

known. These include Resound Networks, LLC; the NexTier Consortium; the Prospero Broadband Consortium; and the Segnem Egere Consortium.

7. SpaceX will launch a large fleet of low-Earth orbit (LEO) satellites that should provide broadband service at 100/10 speeds, with low latency, everywhere in the state.

Not all of this has to happen to solve Arkansas's digital divide. For example, if the Starlink service is highly effective and popular, it could solve the digital divide all by itself. But confidence that the digital divide will be solved depends on most of the above being achieved. Most doubtful are (6) and (7).

It is a good thing that companies will soon, if everything proceeds as planned, make commitments to the FCC to bring gigabit speed internet service to the vast majority of Arkansas's Mississippi Delta region. But currently, little if anything is known about the companies' plans or even their identities. Resound Network LLC appears to be a fixed wireless provider based in the Texas Panhandle. The NexTier Consortium may have something to do with the Georgia-based company NexTier Infrastructure Solutions,[5] though NexTier does not seem to be a provider of retail internet service anywhere in the United States, to judge from broadband maps provided by the FCC and BroadbandNow.com. And there seems to be no information available online about who the members of the Prospero Broadband Consortium or the Segnem Egere Consortium are. Out of respect for the FCC's "quiet period" rules, the Broadband Office has not attempted to make inquiries at this time. But after the quiet period ends on [check this] January 31, 2021, it will be critically important to find out who these providers are, and what their plans are. The future digital divide in rural Arkansas depends heavily on them, as well as on the rural electric coops and historic telcos that have stepped up to the RDOF challenge.

If Plan A for closing Arkansas's digital divide depends principally on RDOF winners building out to meet their obligations, two Plan Bs also emerge from the RDOF auction.

First, while SpaceX's $886 million RDOF award has been criticized as an inappropriate expenditure of universal service funds on an unproven technology, the award presumably makes it more likely that SpaceX will succeed. And it's the nature of LEO satellite technology that its success will benefit not only residents of the limited territories that it won, but the whole country and even the whole world. LEO satellites are not geostationary, so providing consistent service depends on having a whole fleet of LEO satellites orbiting the Earth, so that one of them is always within line of sight of ground-based receivers. Once this system is established, it must cover not just a single target geography on the ground, but a large swath, at minimum, of the Earth's surface. So while relatively few of Arkansas's RDOF dollars were diverted to SpaceX, Arkansans benefit from the increased probability of Starlink internet service succeeding.

Second, because the RDOF Phase I spend of $9.23 billion was much less than the $16 billion that had been planned, the FCC has $6.23 billion more money to spend on RDOF Phase II. RDOF Phase II has not been scheduled, and little is known about the FCC's plans for it, but it was vaguely intended to serve "underserved" Census blocks, which were partly but not fully covered by 25/3 broadband, as opposed to the "unserved" Census blocks, with no 25/3 broadband, meant to be reached by Phase I. For this seemingly easier task there was a correspondingly smaller budget of $4.4 billion. Now, if, as expected, leftover Phase I money is allocated to Phase II, its budget should be almost $11.2 billion, which, if anything, seems like more money than is needed if RDOF Phase I is entirely successful in realizing the

[5] https://nextieris.com/

deployment commitments to emerge from the auction. But if, as seems likely, RDOF Phase I does not meet all its objectives, then RDOF Phase II should be well positioned to remedy the deficiencies of Phase I, if the FCC uses its resources skillfully, possibly including learning from any mistakes that time may reveal it has made in Phase I. One advantage that RDOF Phase II will likely enjoy, relative to Phase I, is better data. The widely criticized Form 477 data, which relies on Census blocks as the geographical atoms of maps, is expected to be replaced by new data sources that builds from the address level and represents coverage as polygons.

The state of Arkansas should be prepared to monitor RDOF winners closely and, if it appears that a solution to the digital divide is not on track, to advocate strongly and intelligently at the FCC for the interests of any rural communities in the state that still do not seem to be able to count on getting high speed internet service in the coming years.

II. THE COMPETITIVE LANDSCAPE OF BROADBAND IN ARKANSAS

The competitive landscape for broadband in Arkansas is complex, with many providers competing yet, at the same time, relatively little consumer choice for many to most of the Arkansans fortunate enough to have access to broadband at all, even as a substantial minority of Arkansans have very inadequate access to internet service. Most broadband provision still depends on legacy infrastructure that was installed for other purposes, especially cable TV and telephony. However, ongoing investment is increasing the role of fiber optic and fixed wireless internet. Cable, DSL, and fiber internet are all naturally monopolistic technologies, in which competition at the address by address level tends to be inefficiently duplicative and competitively unsustainable. Where competition exists, it is generally *among* technologies, e.g., fiber vs. cable or fixed wireless vs. DSL, rather than between providers using the same technology. The most general and persistent pattern in broadband supply is that more options and/or higher speeds are available in areas of higher population density, but the pattern applies very imperfectly, in large part because the broadband competitive landscape has been heavily affected by government programs, regulations and subsidies. A lot of investment has occurred, and it accelerated in 2020, but great inequities remain.

A. Coverage and Competition

Some Arkansans have access to very fast internet. In much of Northwest Arkansas, the Little Rock metro area, Jonesboro and Fort Smith, as well as in some quite rural parts of northern, western, and southwestern Arkansas, internet connections are available at speeds of one gigabit per second, which is so fast that hardly any applications exist capable of fully utilizing them. Of course, not all who have access to gigabit speed broadband choose to subscribe. In other good news, most of the state by area—and a much larger share by population—has at least some sort of internet connectivity available in addition to satellite, which is omitted because it's reportedly available everywhere. But of course, many Arkansans lack access to speeds that are satisfactory for modern internet use. Figure 1 shows the top download speeds available statewide, including two speed tiers, 1-4 Mbps and 5-9 Mbps, which are omitted because they fall so far short of adequacy.

Figure 1: Maximum internet speed available, by Census block (Source: FCC Form 477, December 2019)

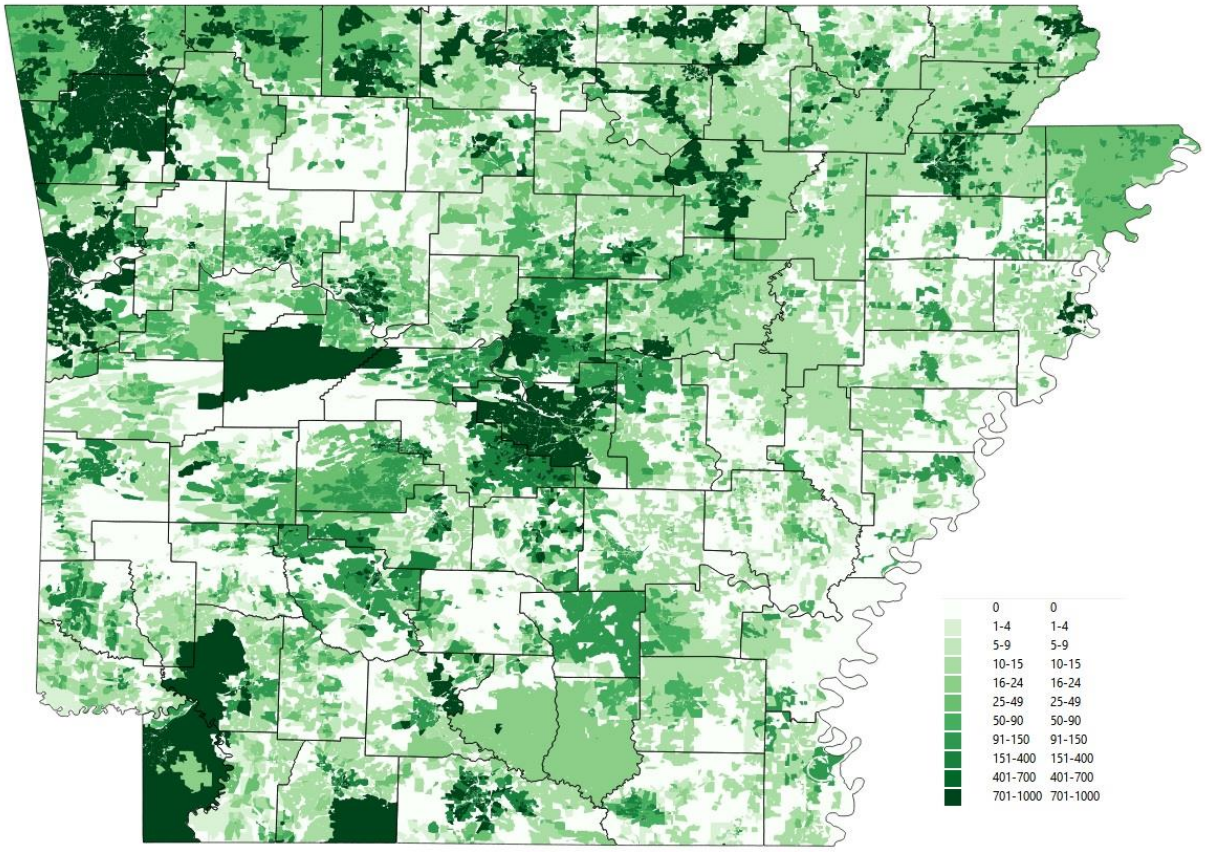
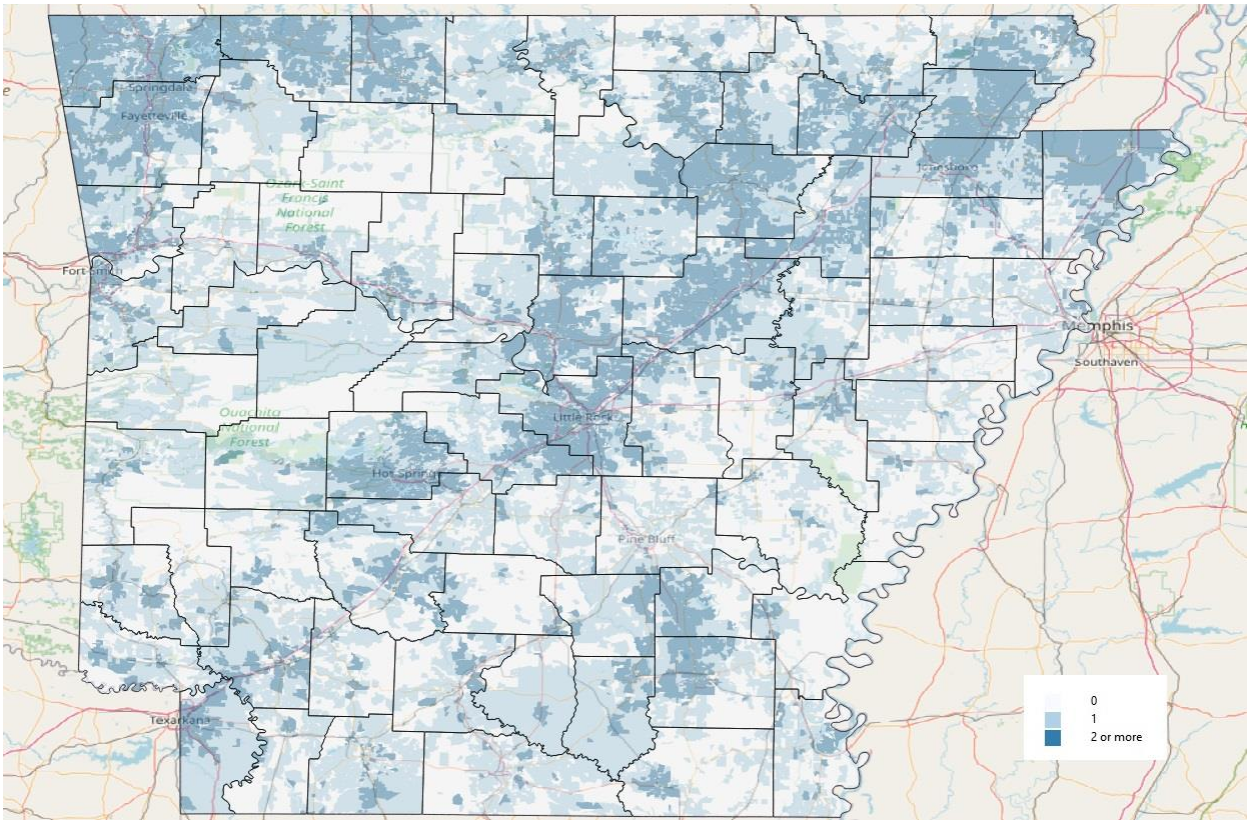


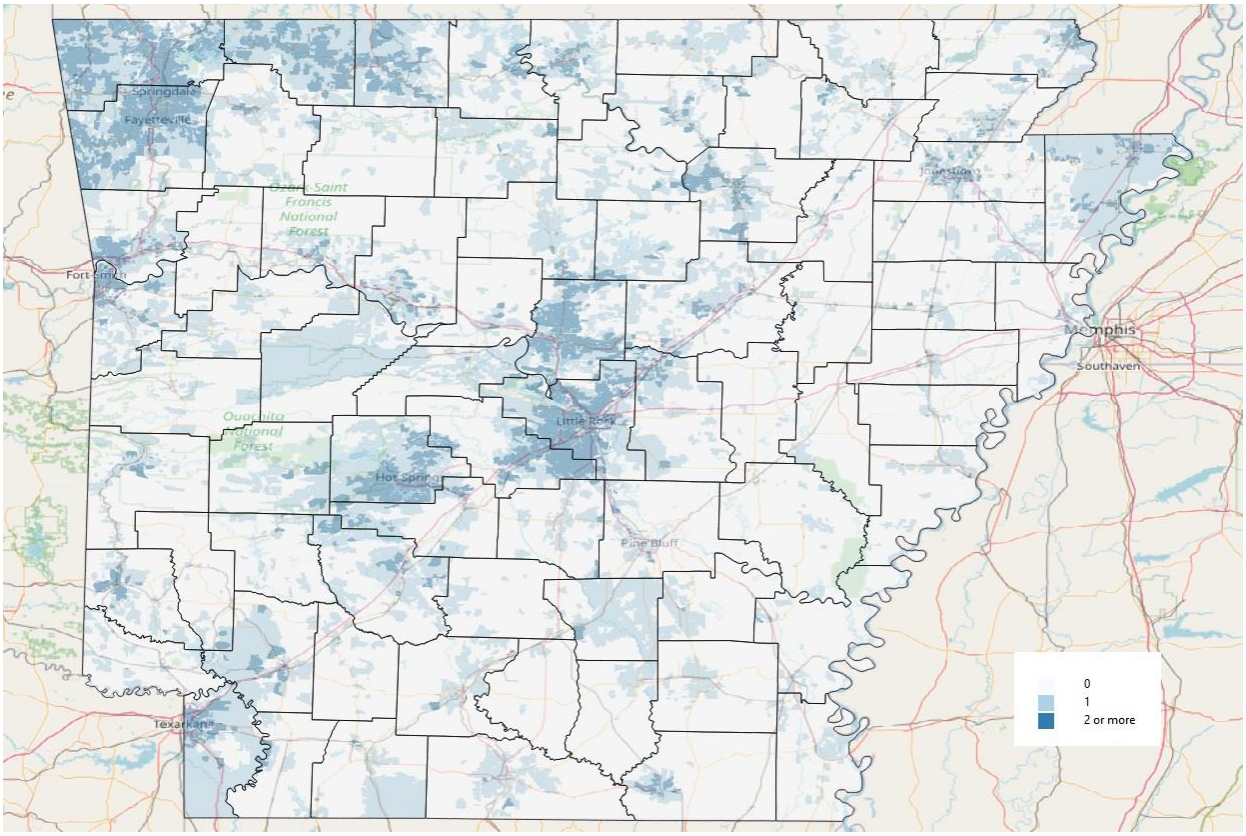
Figure 2 focuses on the 10/1 speed tier and shows both availability and competition, with white indicating no 10/1 service available, light blue indicating availability but only one provider, and a darker shade of blue indicating competition, that is, two or more providers offering 10/1 service. Relative to the map of maximum speeds, it shows a clearer urban advantage, although Pine Bluff is at a disadvantage, and substantial parts of rural northeast Arkansas do well by this measure.

Figure 2: Availability and competition at the 10/1 speed tier (Source: FCC Form 477, December 2019)



The urban advantage shows up more clearly in Figure 3, which displays availability and competition at the 25/3 speed tier, or "broadband" as defined by the FCC. White in Figure 3 signifies that no 25/3 service was available, while light blue, again, signifies availability, and darker blue, competition. Figure 3 suggests that many to most residents of the Little Rock area, urban Northwest Arkansas, Fort Smith, Hot Springs, Jonesboro, and Texarkana, though not Pine Bluff, enjoy multiple broadband providers, while very few Arkansas living outside these cities do.

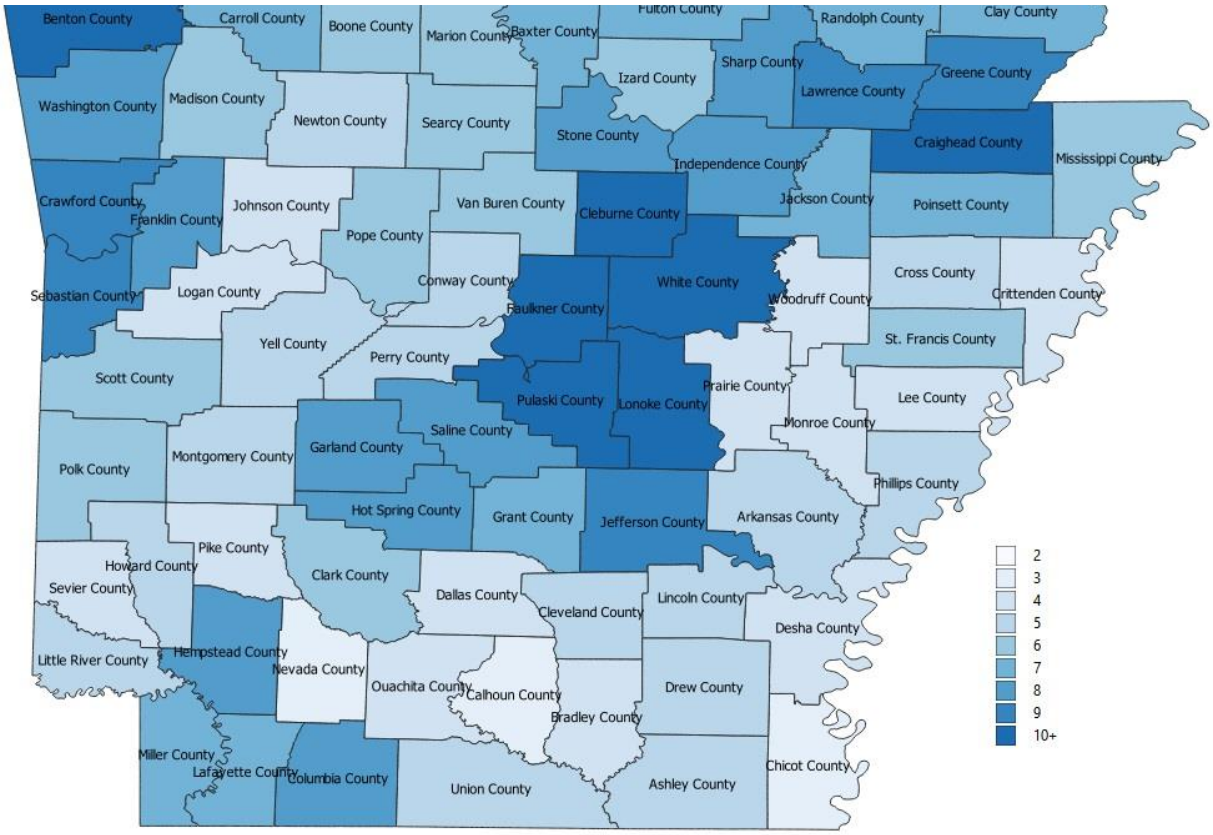
Figure 3: Availability and competition at the 25/3 speed tier (Source: FCC Form 477, December 2019)



In general, the advantage of urban over rural areas with respect to broadband access is one of the major, long-standing patterns in broadband, driven by fundamental cost structures that make broadband far cheaper to deploy per home in areas of high population density. Yet the picture has been complicated by some community-oriented companies and a lot of government subsidies, which have delivered ultra-fast broadband to some rural areas while leaving others behind.

Figure 4 shows the number of ISPs offering 10/1 internet or faster, by county. This is less directly relevant to households, since any given household isn't directly an ISP that offers service *somewhere else* in the county but not at its specific address. However, ISPs that operate nearby pose a competitive threat because they might expand, so they might provide a form of competitive discipline nonetheless. Broadband competition is most intense in central Arkansas, Benton County and Craighead County, while mountainous areas and the Delta enjoy less competition.

Figure 4: Number of ISPs offering 10/1 service or faster, by county (Source: FCC Form 477, December 2019)



Again, the urban advantage is more striking at the 25/3 speed tier, with much more broadband competition in the Little Rock area and Benton County, even relative to smaller cities like Jonesboro and Fort Smith. Yet it should also be noted that all counties in Arkansas have at least two broadband providers claiming to offer 25/3 service somewhere in the county. So a solution to the broadband coverage gap may not require new ISPs to enter these counties, but could involve incumbent ISPs upgrading and building out.

Figure 5: Number of ISPs offering 25/3 service or faster, by county (Source: FCC Form 477, December 2019)

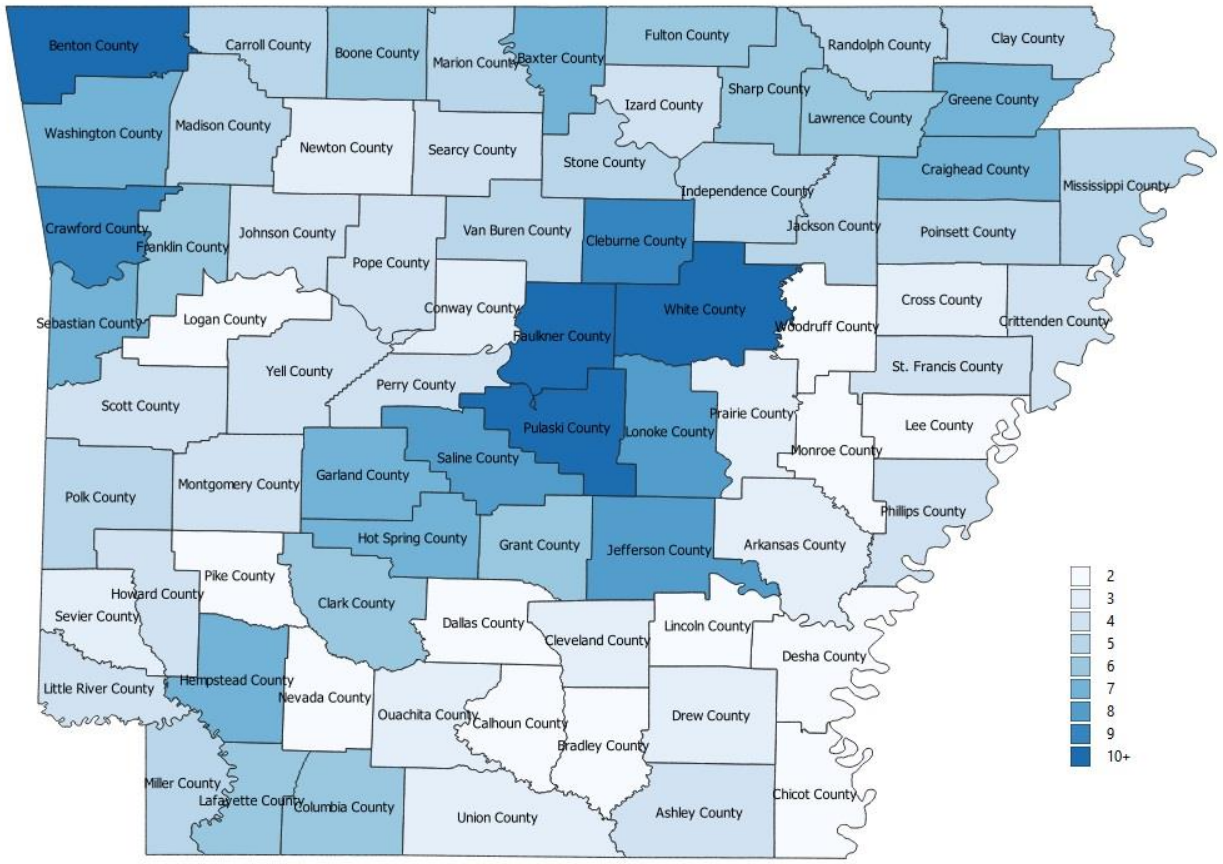
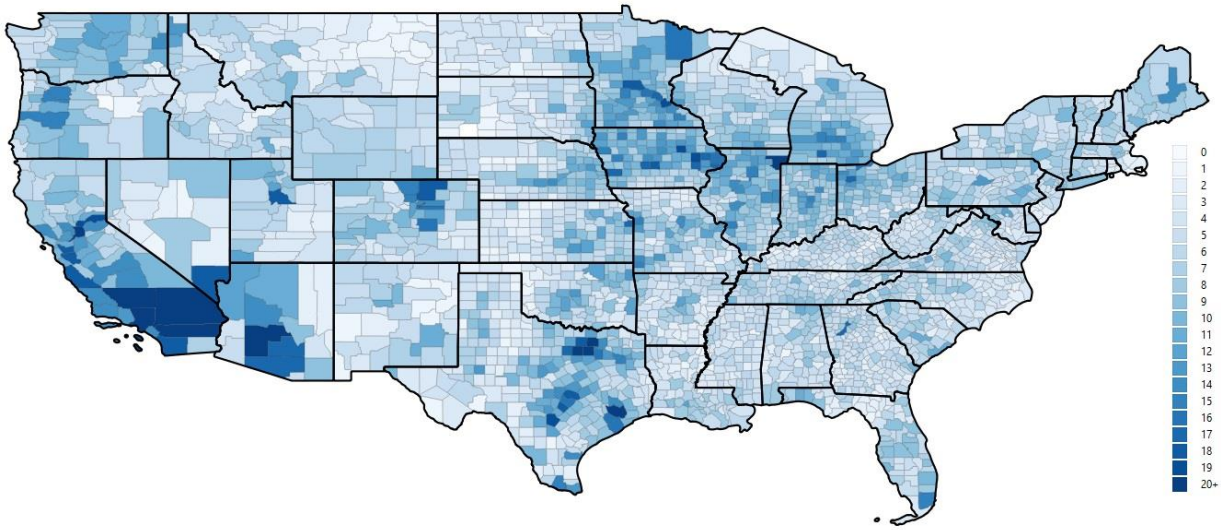


Figure 6 shows the same metric as Figure 5, number of broadband providers by county, but nationally, rather than for just Arkansas. Note that the scale is different: the statewide maps top code at 10 (in fact the metric ranges up to 13), whereas the national map top codes at 20. Arkansas is not severely disadvantaged by this metric, comparing favorably not only to some other southern rural states like Kentucky and Mississippi, but also to some eastern seaboard states. But the Midwest is a hotspot for broadband competition, as is Texas, and Arkansas tends to have fewer broadband providers per county than many neighboring and nearby states to its north and west.

Figure 6: Number of competitors offering 25/3, by county (Source: FCC Form 477, December 2019)



The June 2020 State Broadband Manager's Report emphasized that Arkansas rates very poorly for most measures of overall broadband coverage, and dead last for some, including the share with access to 25/3 broadband, the share with access to 25/3 broadband from two or more providers, and the share with access to broadband at 100 Mbps or faster. But Arkansas does enjoy a reasonably large number of ISPs operating in the state, which may be an asset in getting the population served.

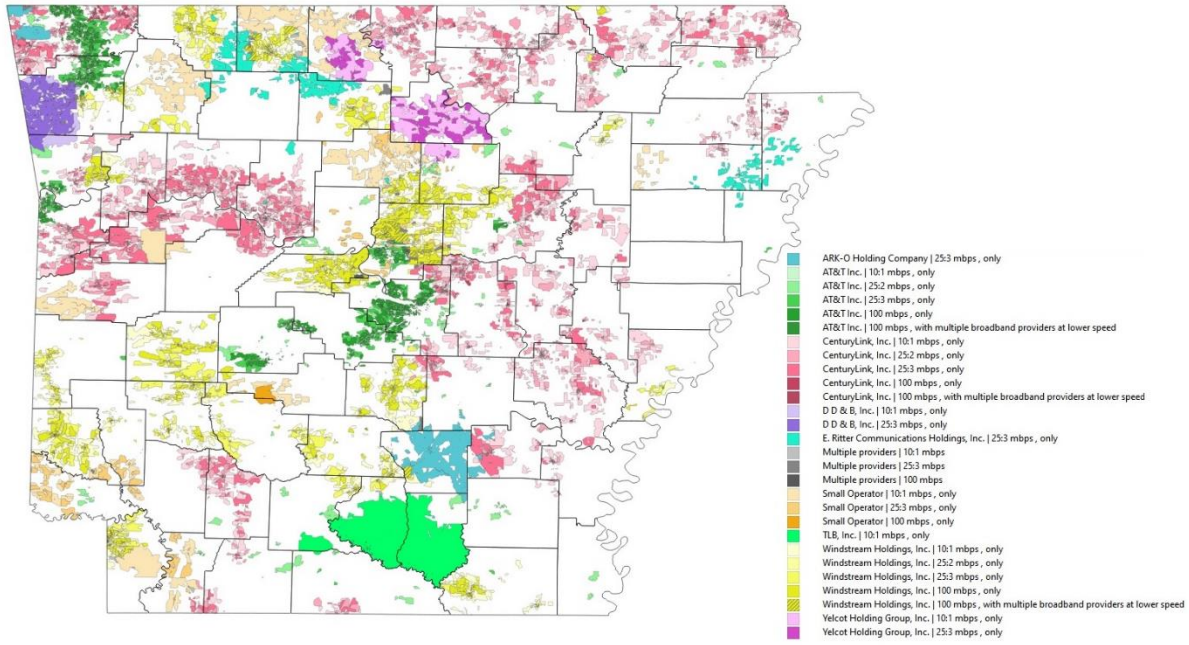
B. ISPs and Maximum Speeds by Technology

There are six major technologies by which people access the internet: fiber optic, cable, DSL, fixed wireless, satellite, and mobile wireless/mobile data. This section focuses on the first four technologies in turn. In general, *natural monopoly* is an important concept in the broadband industry, because some of the technologies by which broadband is provided have naturally monopolistic tendencies. Natural monopoly occurs when high fixed costs make it inefficient and competitively unsustainable for there to be more than one provider. Public utilities like telephony and electricity have long been recognized as naturally monopolistic, and long-standing public policies are adapted to this reality, tolerating an unusual degree of market dominance while requiring in return some combination of universal service and consumer-friendly pricing. Broadband *per se* is not well described as a natural monopoly and is not heavily regulated. But telephony, cable TV, and electricity are naturally monopolistic and governed by corresponding regulations appropriate to these tangent business spaces. Most internet service is provided by companies whose origins are in these sectors. And the naturally monopolistic character of internet service *for each technology* will be evident in the maps that follow.

First, DSL, short for "digital subscriber line," internet service transmits data using "twisted pair" copper telephone wires. Its statewide availability by ISP and maximum offered speed is shown in Figure 7. It was

developed in the 1980s, and it improved on dial-up internet connections by adding Digital Subscriber Line Access Multiplexers (DSLAMs) that split voice from data traffic so that people can use the same phone lines for voice calls and internet access simultaneously. In general, DSL inherently offers less bandwidth than the other major copper technology, cable. But the legacy network used by DSL, the landline telephone system, has a larger reach than the legacy network that cable relies on, the cable TV system, so DSL is available in many areas where cable is not.

Figure 7: DSL availability, by ISP and maximum offered speed (Source: FCC Form 477 data, December 2019)



DSL service is available in much of rural Arkansas, though by no means everywhere. It often falls short of the 25/3 speeds that meet the FCC's definition of "broadband." In many areas, DSL is available at a slower 10/1 speed tier, while in other places, it satisfies the 25 Mbps desideratum but falls slightly short on upload speeds, thus achieving only 25/2. It has become unavailable in some urban areas, such as west Little Rock, because it struggles to compete with alternatives such as cable and fiber.

Notably absent from Figure 7 are any substantial grey, black, or striped areas. Such areas would represent competitive supply of DSL, not necessarily at the address level but at least within the same Census blocks. That this hardly ever occurs is powerfully illustrative of the natural monopoly character of DSL internet service.

Cable internet service transmits data using the same copper wires used by cable TV networks. It is sometimes called "hybrid fiber-cable" because while copper cable is used for the "last mile," backhaul is provided by fiber optic backbone and/or middle mile connections with greater speed and capacity. Nationally, and in most Arkansas urban areas, it has for some time enjoyed a dominant market position,

and the top speeds offered by cable broadband providers satisfy most users, although it cannot match the performance of fiber. The DOCSIS technology that is used to provide broadband over cable TV networks was developed in the late 1990s. Figure 8 shows the availability of cable broadband, by ISP and maximum offered speed.

Figure 8: Cable broadband availability, by ISP and maximum offered speed (Source: FCC Form 477 data, December 2019)

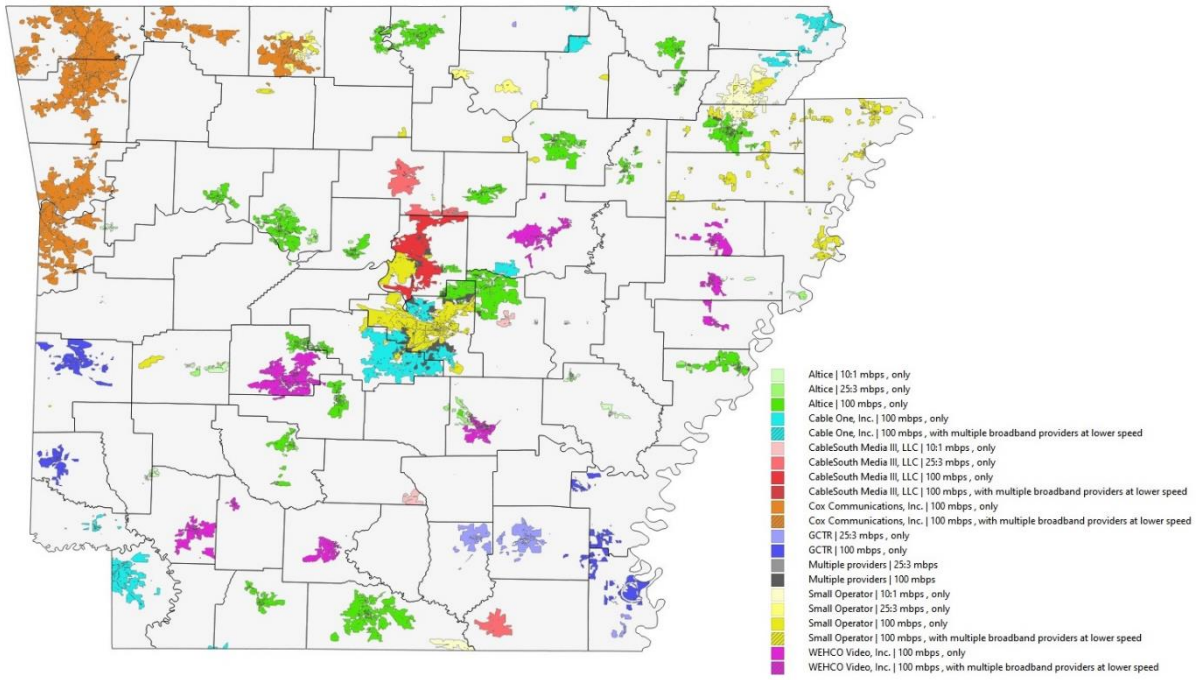


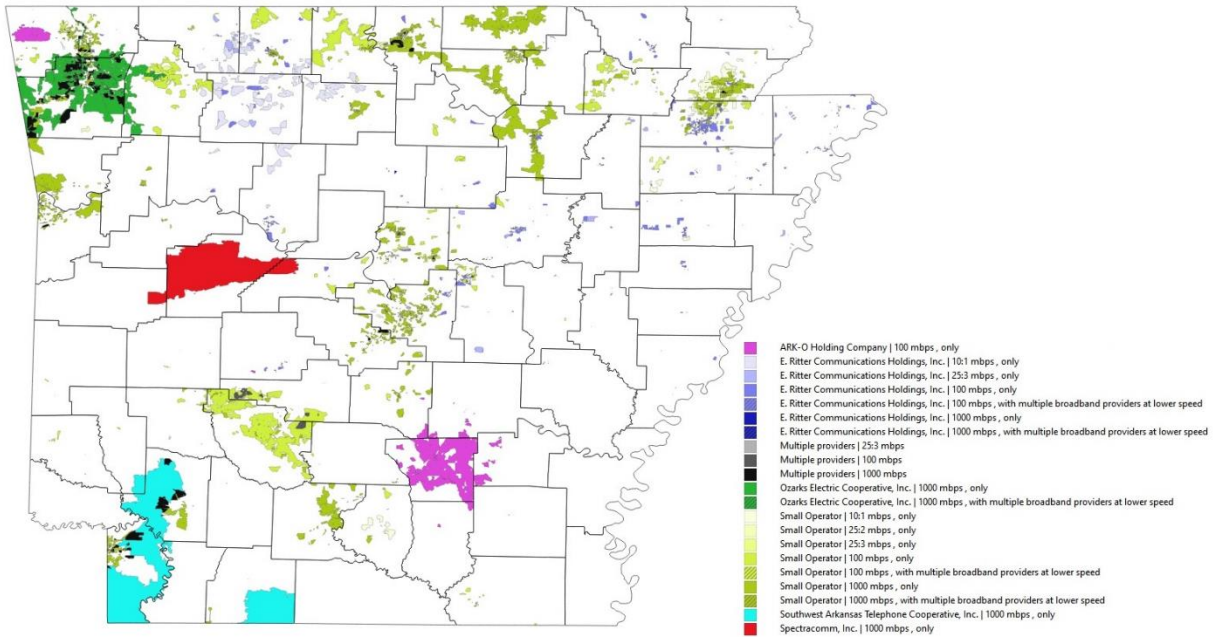
Figure 8 shows no gigabit speed service by cable, because we are here reserving the gigabit speed designation for connections with higher *upload* speeds than any cable ISP in Arkansas offers, though some cable ISPs do claim to offer gigabit download speeds in places. While gigabit download speeds can arguably be achieved with the latest DOCSIS technology, that stretches the limits of what can be achieved given the physical limitations of electrons flowing through copper wires as compared with light flowing through glass, and it's not clear that offering the same speeds on the upload side is practically feasible in the face of usage patterns and inherent capacity constraints. As the map shows, it is typical for cable to be available only in sizeable population centers, and again, to be local natural monopoly for cable TV and internet. Only very small parts of the map have multiple cable providers, and even that may represent data issues[6] rather than real competition at particular addresses. Altice (holding company name) does business as Suddenlink, GCTR as Vyve Broadband, CableSouth as SwyftConnect, and WEHCO

[6666] The FCC Form 477 questionnaire asks ISPs what is the "maximum advertised speed" in each Census block. If two cable ISPs offered service in different parts of a Census block, that will show up in the FCC maps as two cable ISPs serving the same areas, even if in fact there is no overlap at the address level.

Video under multiple names such as Resort TV and East Arkansas Video. Together, cable ISPs cover most of Arkansas's population, but only a small minority of its territory.

Fiber optic cable was invented in 1970, yet it is in a sense a late comer to the internet service business, because by the time it could be produced and used at scale, the legacy last mile networks for landline telephones and cable TV were already in place, so DSL and DOCSIS/cable technologies had a head start. Fiber optic cable has vastly superior performance relative to cable or DSL, though not in ways that matter to all users. The data carrying capacity of a fiber optic cable is inherently far greater, due to the laws of physics, than that of a coaxial copper cable, and light also moves about 100 times faster than electricity, reducing latency slightly. But relatively few users seem to have been willing to pay much for the extra performance of fiber up to now, which makes sense since there are few internet applications whose bandwidth demands would max out the capacity of most cable internet connections. Consequently, fiber has had only a limited tendency to overbuild cable networks in cities, and deployments have often taken place in rural areas instead, where cable internet never reached. Figure 9 shows fiber optic internet availability across the state, by ISP and maximum offered speed.

Figure 9: Fiber broadband availability, by ISP and maximum offered speed (Source: FCC Form 477, December 2019)



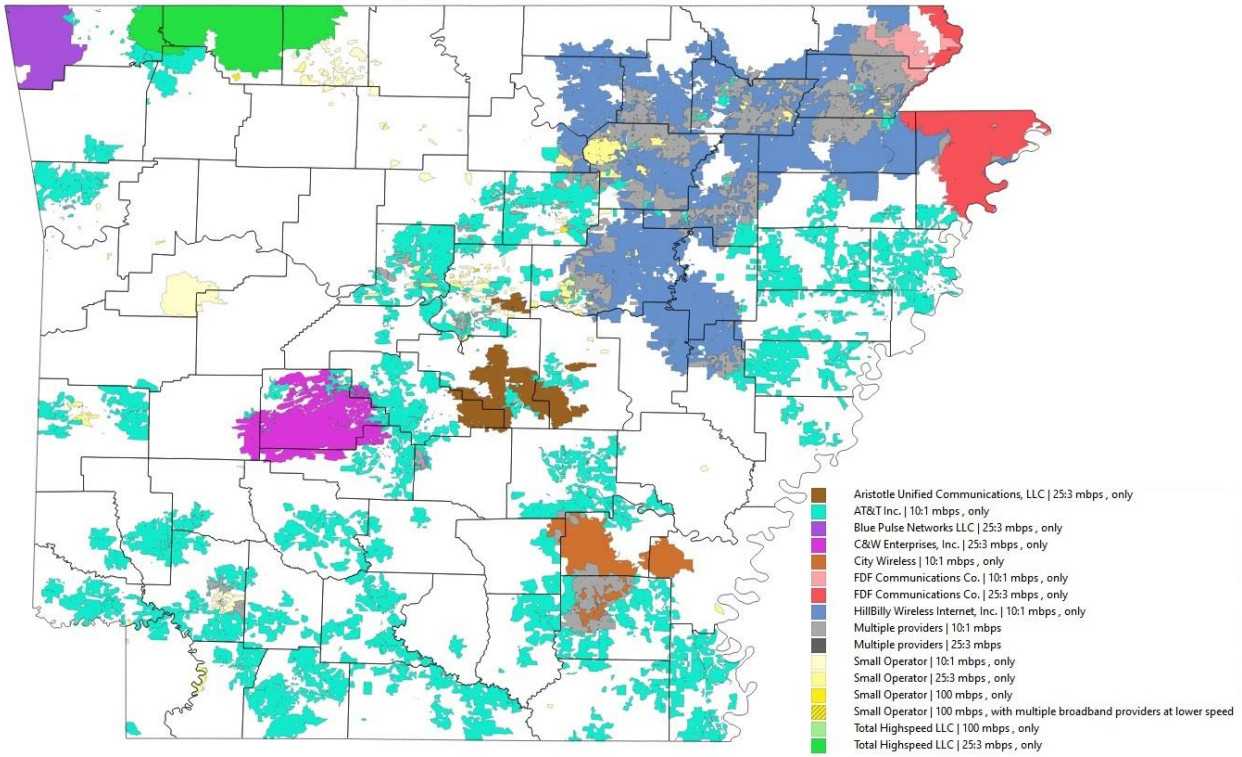
As Figure 9 shows, fiber coverage is patchy in the Little Rock metro area, and largely absent in Pine Bluff and Hot Springs, yet there is abundant fiber coverage in rural Cleveland County, Yell County, Clark County, Miller County, Hempstead County, and Columbia County. In northern Arkansas, Jonesboro and Fayetteville have pretty good fiber coverage, as does a stretch of territory in the rural Ozarks, while prosperous Benton County has relatively little fiber coverage, and West Memphis has none. Not all fiber ISPs offer gigabit speeds, and some areas appear to get only 10/1 service, even though fiber has been installed. This somewhat accidental-looking map has been shaped by the idiosyncratic decisions of

specific federal agencies and ISPs over the past 10 to 20 years, but to the extent that there is a principle at work, it is that fiber broadband investment tends to be worthwhile *either* in areas with the highest population and economic density, where demand is so abundant that it is worthwhile to overbuild cable networks, *or* in areas where cable TV's legacy infrastructure was never installed, which tend to be rural. Suburbs well served by cable internet are less likely to get fiber, but it depends on what bets ISPs and federal agencies decide to take, and it may conform to no plan or pattern.

As in the DSL and cable maps, the grey-black color family represents multiple providers offering fiber internet service at the same speed tier. Striped regions would represent multiple fiber providers at different speed tiers, if this situation existed anywhere in the state. There are a few areas with multiple fiber providers, mostly in northwest Arkansas, but it is rare. Fiber optic internet service is not governed by legacy regulations and territories to the same extent as DSL and cable, but it is clearly a natural monopoly, for basic reasons of technology and cost structure—multiple networks of fiber optic cables serving the same addresses are inefficiently duplicative and competitively unsustainable except possibly in areas of very high economic density—and this is quite evident from the map in Figure 9.

Fixed wireless internet is not really a new technology—the key technological ingredient in fixed wireless internet service, the dish antenna, has been common since the 1960s—but it has seen accelerating adoption in recent years as unserved demand for rural internet has increased, and as electronics have gotten cheaper while copper or fiber cable networks have expanded slowly and remain expensive to install. There are ongoing debates about how seriously fixed wireless internet can be impaired by foliage and/or rainy weather. The market structure of the fixed wireless broadband industry is quite different from other broadband technologies, with more small players and startups and less legacy infrastructure and regulations. However, well-established telecom firms have also embraced the technology, and the largest fixed wireless provider in the US is AT&T. Figure 4 shows a statewide coverage map for fixed wireless, by ISP and maximum offered speed, as of December 2019.

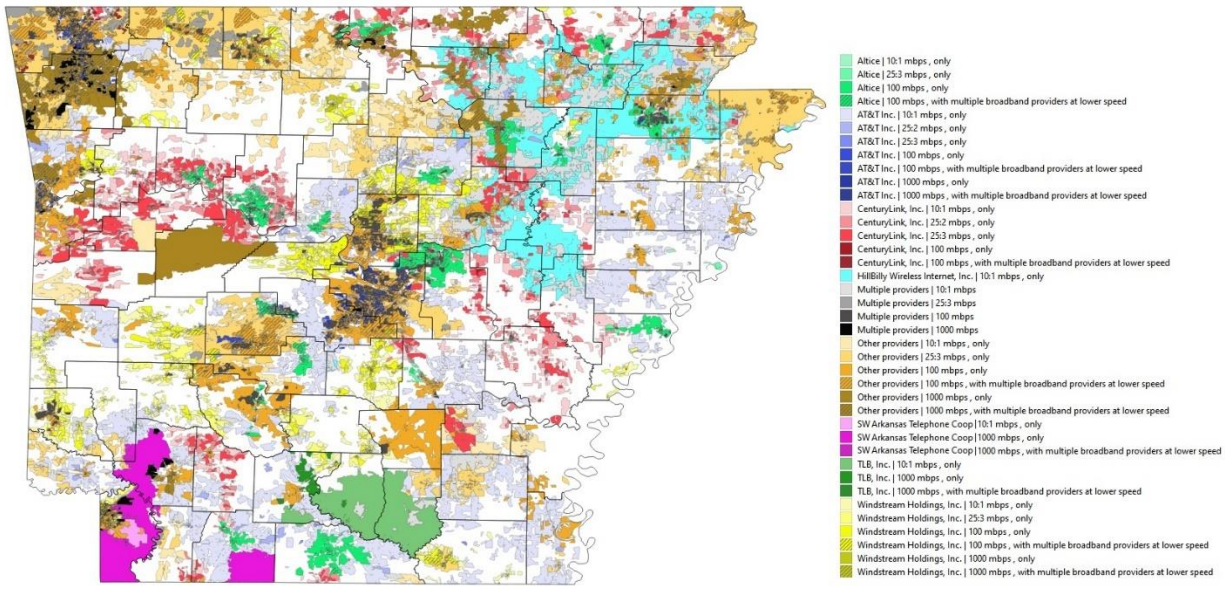
Figure 10: Fixed wireless internet availability, by ISP and maximum offered speed (Source: FCC Form 477, December 2019)



While the reach of fixed wireless is impressive, speeds tend to be slow. Most of the fixed wireless coverage in the state satisfies only the 10/1 speed tier, and does not qualify as "broadband" by the FCC definition. In contrast with ISPs using other technologies, which are more territorial and locally monopolistic, fixed wireless ISPs often find themselves competing with each other in the same areas, e.g., Hillbilly Wireless vs. AT&T in parts of Northeast Arkansas, and AT&T vs. City Wireless in northwestern Drew County. We can expect to see more of this as deployments funded by Arkansas Rural Connect take effect.

Figure 11 combines all technologies to provide some impression of the broadband competitive landscape across Arkansas, albeit the information starts to become too complex to display effectively in a map. The three historic price cap carriers, Windstream, AT&T, CenturyLink, continue to be critically important to meeting internet service needs across large regions of the state. Altice/Suddenlink is also important in serving several of Arkansas's smaller cities. Some smaller telcos, such as SWATCO, are important in regions of the state, and TLB, Inc., doing business as Airecast, is important in the vicinity of Camden, Arkansas. Hillbilly Wireless is a major player mitigating the broadband coverage gap in northeastern Arkansas. There are not enough color families for all major providers, so some ISPs that are regionally important, such as Comcast, Cox, and Ozarks Electric are grouped as "other providers" here and called out in maps that focus on those regions.

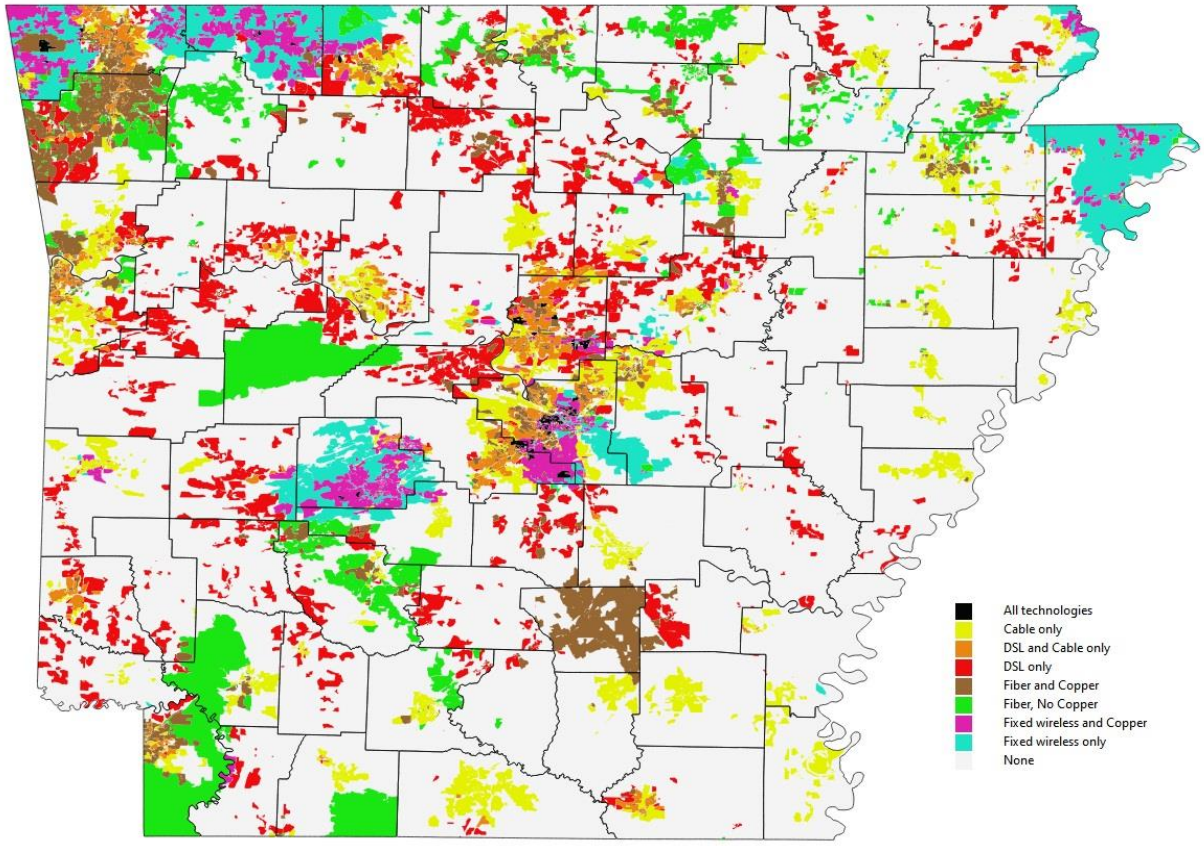
Figure 11: Statewide broadband coverage, all technologies, by ISP and maximum offered speed (Source: FCC Form 477, December 2019)



The biggest takeaways from Figure 11 relate to competition. With all technologies in play, the grey-black color family indicating multiple providers at the same speed tier, and the striped areas where a single provider at the fastest speed tier faces competition from other broadband providers at slower speed tiers, become important. It is common for consumers to enjoy multiple, competing broadband providers using different technologies. But there are far larger areas of the state where, if any broadband provider is available, there is only one. Competitive discipline in the broadband business is scarce relative to most other industries.

Figure 12 maps the competitive landscape for broadband in Arkansas by the combination of technologies offering 25/3 service. The map still suggests a good deal of natural monopoly inasmuch as pretty large parts of the state have only one broadband technology offering 25/3.

Figure 12: Technologies offering 25/3 internet service (Source: FCC Form 477, December 2019)



Until recently, a typical urban situation was to have two broadband providers available, DSL and cable, both using legacy infrastructures. This pattern is still seen in large parts of the Little Rock metro area, Northwest Arkansas, and a few other places such as Fort Smith and Crossett. But it has been eroded both by fiber investments and by the decline of DSL in some areas. Sometimes DSL networks cease to be maintained in areas where cable is available, because the DSL provider cannot offer service that is competitive with cable, and while some discount-seeking customers might still opt for DSL at the right price, the resulting revenues don't suffice to maintain the networks in an appealingly profitable way. And presumably the availability of cable has long deterred investment in DSL. In large parts of the state *either* DSL *or* cable *or* fiber is the only fixed broadband technology offered (excluding satellite). Fixed wireless is sometimes the only technology offered, but it often overlaps cable or DSL, resulting in competition. Fiber vs. copper competition is commonest in urban areas, especially Northwest Arkansas.

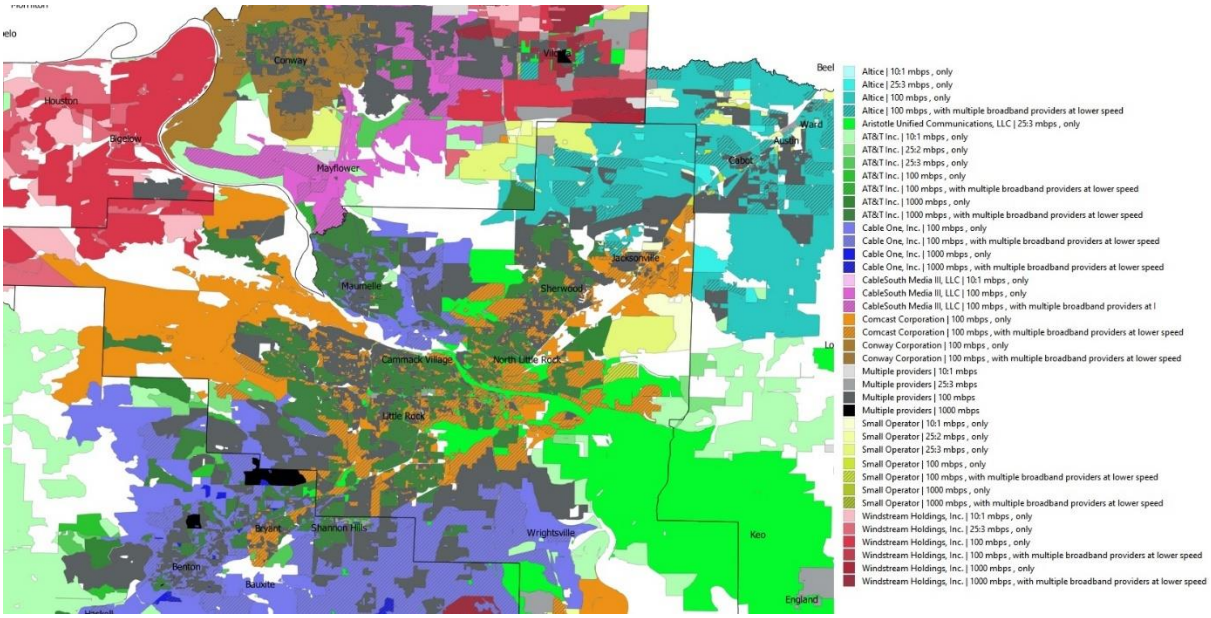
C. Cities and Metro Areas

Statewide maps inevitably exaggerate the importance of large lightly populated or unpopulated areas relative to densely populated cities. To offset that, we zoom in on a few of Arkansas's larger urban areas to look at the broadband coverage landscapes there. Together, these urban areas account for most of

Arkansas's population. They are mostly well served with broadband relative to rural areas and small towns, but there are pockets of poor broadband coverage, and lack of competition is often a problem.

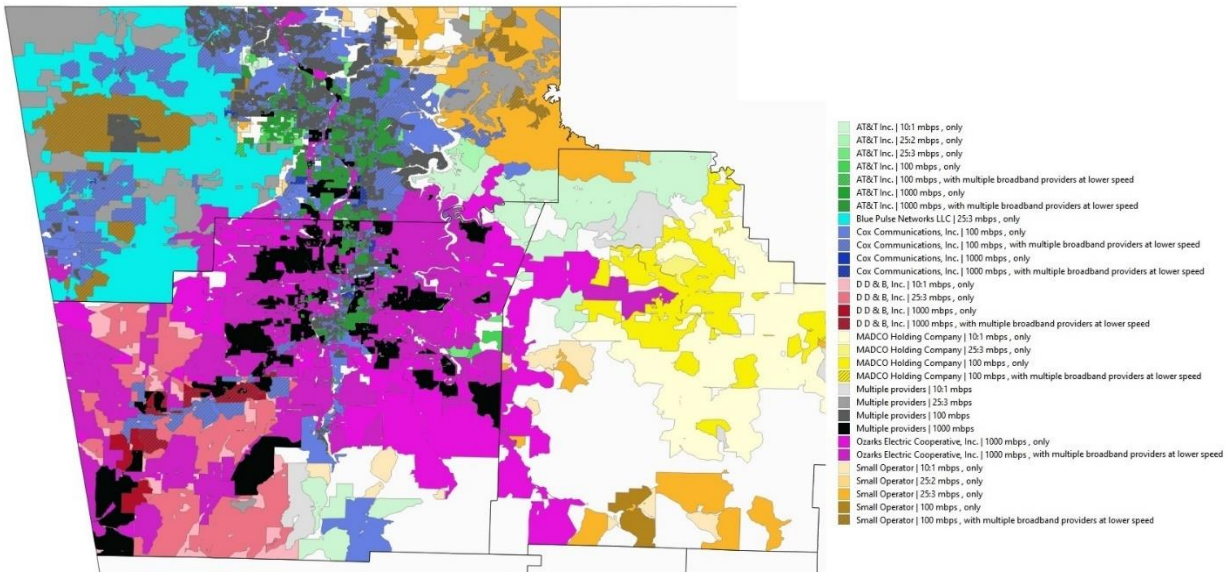
The Little Rock area is served by several largely non-overlapping cable providers, with Comcast serving west and central Little Rock, Cable One serving further south, and Suddenlink serving towards the northeast in the Cabot area, while the Conway Corporation serves Conway. The Little Rock area has some gigabit service from Windstream and AT&T. Large areas to the east of the city center lack wireline options, though they have recently come to enjoy 25/3 fixed wireless coverage by Aristotle.

Figure 13: Broadband coverage in the Little Rock MSA, by ISP and maximum offered speed (FCC Form 477, December 2019)



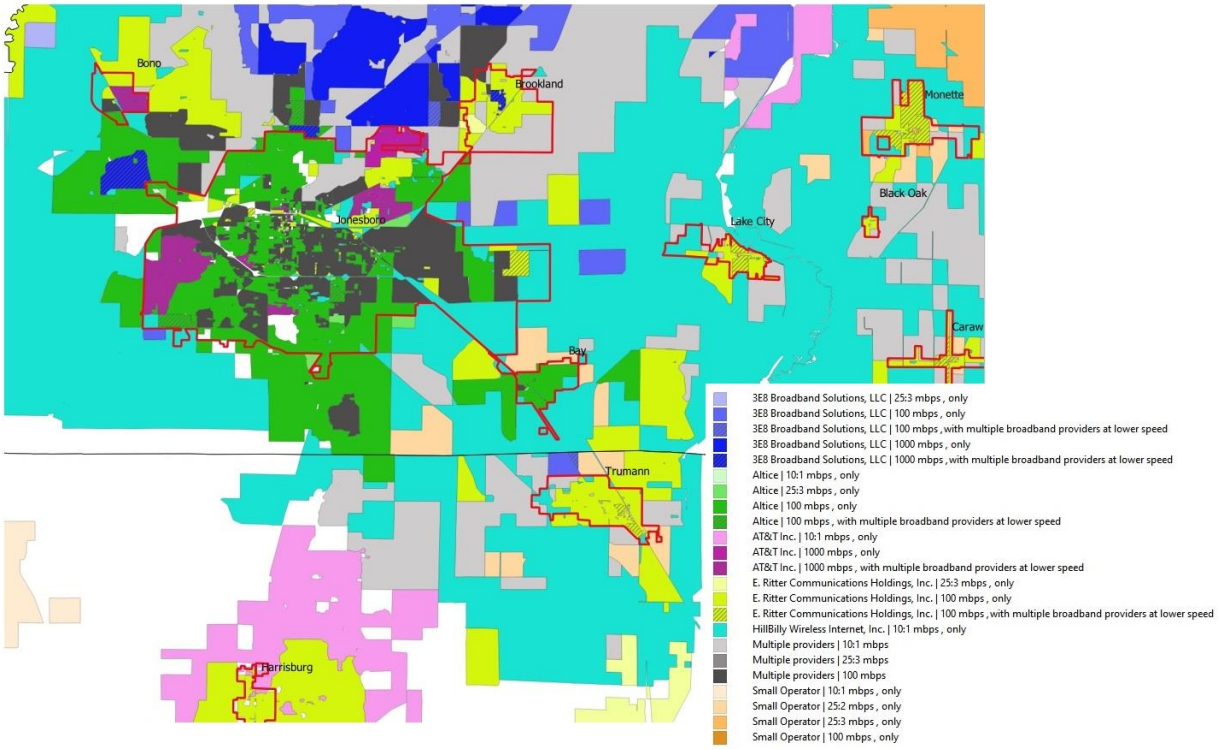
Northwest Arkansas is the most advantaged regions for broadband coverage, with extensive gigabit coverage in the populous heart of the region, and even *competitive* gigabit coverage in sizeable areas. Ozarks Electric Cooperative has proved to be a pioneer, and as major RDOF awards to electric cooperatives get finalized, a future is taking shape wherein the broadband competitive landscape across much of Arkansas will look a bit like Northwest Arkansas does today, reshaped by gigabit fiber provided by electric utilities. An irony is that Ozarks Electric Cooperative fiber extends deep into rural areas but does not blanket the central population corridor of Northwest Arkansas, resulting in a situation where some of the region's most urban areas enjoy less coverage than neighboring rural areas. But AT&T fiber coverage is also extensive, while Cox's service, also high speed though generally not gigabit, blankets the most populated parts of the region. Meanwhile, large rural areas, especially in Madison County, have 10/1 or less.

Figure 14: Broadband coverage in Northwest Arkansas, by ISP and maximum offered speed (FCC Form 477, December 2019)



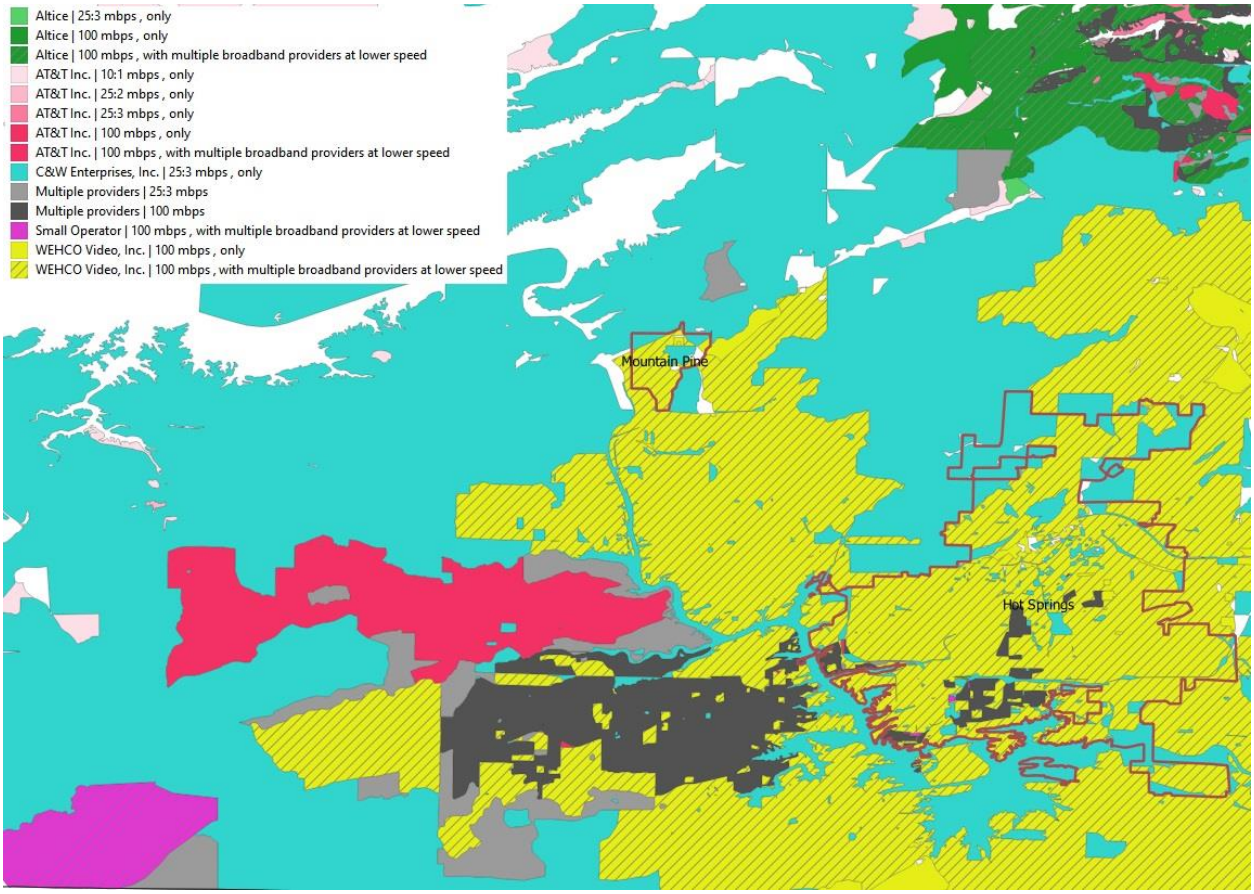
Jonesboro has some gigabit coverage from AT&T, and there are pockets of gigabit coverage from 3E8 Broadband north and west of the city, but most residents have a lower speed tier than that. More widespread is the high-speed, though not gigabit, coverage by Suddenlink. Many Jonesboro residents have competitive broadband options at the 100 Mbps speed tier. Ritter serves parts of Jonesboro and most of the surrounding towns, while the rural areas around these towns have access to fixed wireless service from Hillbilly Wireless at 10/1.

Figure 15: Broadband coverage in Jonesboro, by ISP and maximum offered speed (Source: FCC Form 477, December 2019)



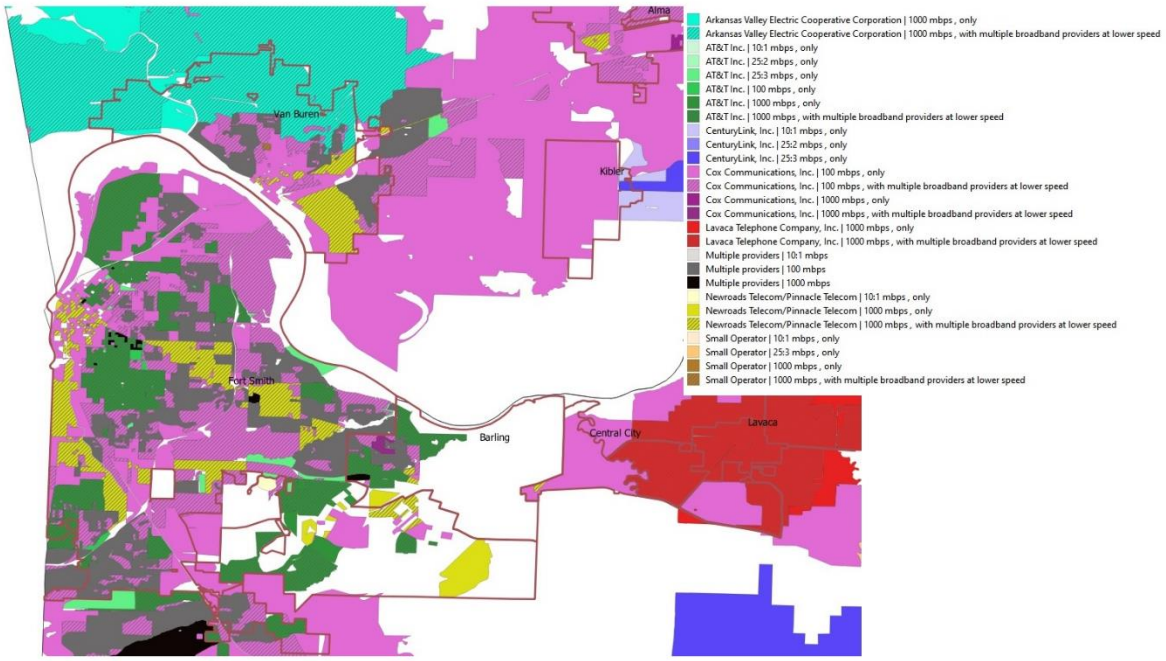
In Hot Springs, broadband is a duopoly, with cable internet from WEHCO Video/Resort TV competing with fixed wireless from C&W Wireless/Wireless Etc., as shown in Figure 16. Wireless Etc. coverage extends to the surrounding areas. There is also a pocket of AT&T coverage to the west, and a pocket of Suddenlink coverage to the north.

Figure 16: Broadband coverage in Hot Springs, by ISP and maximum offered speed (Source: FCC Form 477, December 2019)



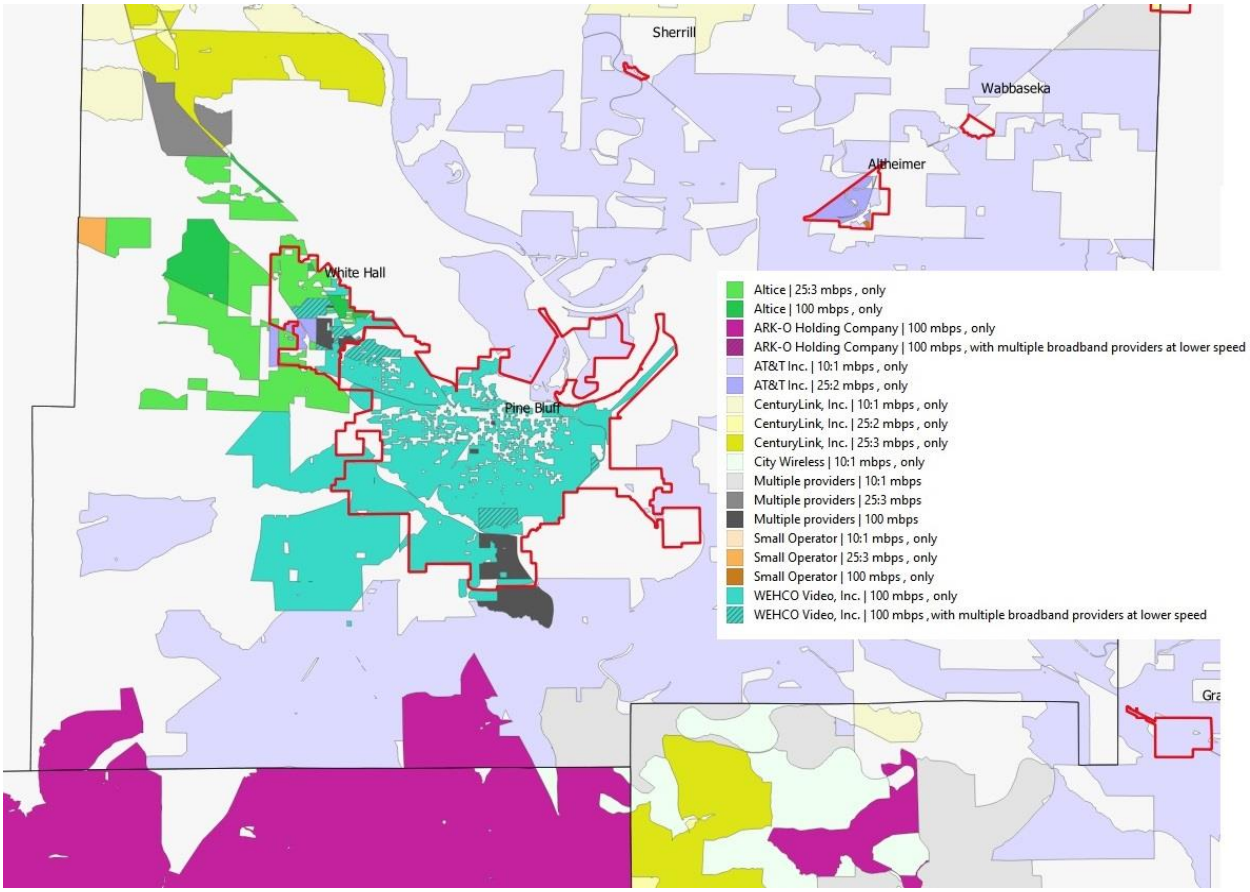
In the Fort Smith area, Cox is the market leader except where AT&T, Pinnacle Communications, or Lavaca Telephone Company have installed fiber. In addition to being overbuilt by fiber providers in some areas, Cox faces substantial competition from slower broadband providers. Cox itself appears to have small pockets of fiber coverage in the Fort Smith area.

Figure 17: Broadband coverage in Fort Smith, by ISP and maximum offered speed (Source: FCC Form 477, December 2019)



Of Arkansas's major urban areas, Pine Bluff is by far the most disadvantaged with respect to broadband coverage. There is no fiber gigabit coverage in Pine Bluff, as there is in other large Arkansas cities. There is very little broadband competition. Most of Pine Bluff does have access to internet service at the 100 Mbps speed tier from WEHCO Video/Pine Bluff Cable, but there appear to be a lot of gaps in coverage even in the heart of the city. Neighboring White Hall has some coverage from Altice/Suddenlink, but mostly only at the 25/3 speed tier. The rural areas immediately surrounding Pine Bluff mostly have nothing but 10/1 coverage by AT&T, and some places lack even that. Further south, ARK-O covers northern Cleveland County at 100 Mbps download speeds, but this stops at the border of Jefferson County.

Figure 18: Broadband coverage in Pine Bluff, by ISP and maximum offered speed (Source: FCC Form 477, December 2019)

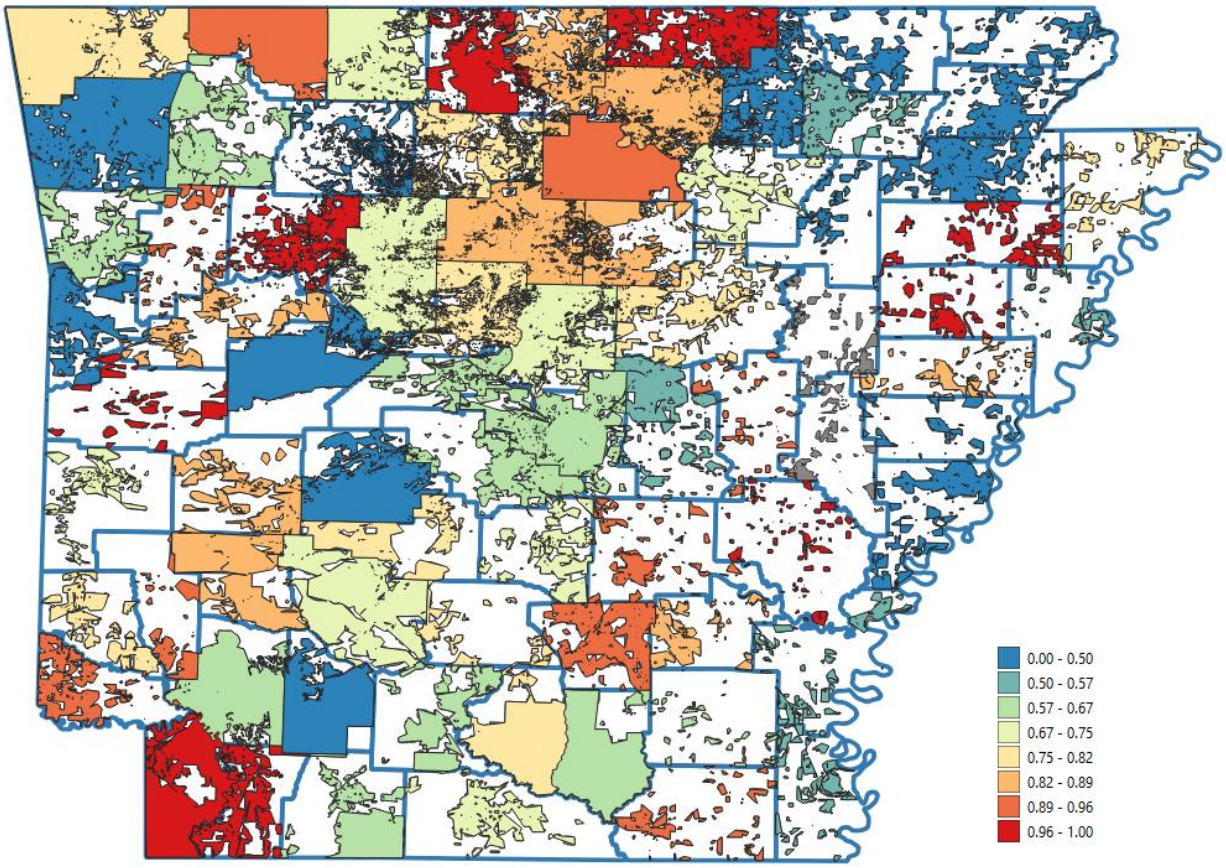


D. Reality Check: The Broadband Office Speed Test Survey

The limitations of the FCC Form 477 data, upon which all the above maps are based, are well known, so while they were used, with other data sources, to define areas of need for purposes of administering the Arkansas Rural Connect program, the Broadband Office also set up an online speed test survey to help communities that felt their internet coverage was misrepresented by the maps to provide data in support of a challenge to the maps that would render them eligible for grants. These speed test results provide a glimpse of the gap between broadband coverage as represented by FCC maps and the actual experiences of many Arkansans in trying to access the internet.

At the time of writing, 4,780 speed tests had been conducted using the speed test survey tool. Figure 19 is based on the results of these speed tests. It focuses on areas that were deemed by the Broadband Office to be covered, and which on that basis were made candidates for broadband grants. The areas deemed covered are partitioned by county in Figure 19 and given a map color that indicates the share of speed tests that showed a download speed below 25 Mbps.

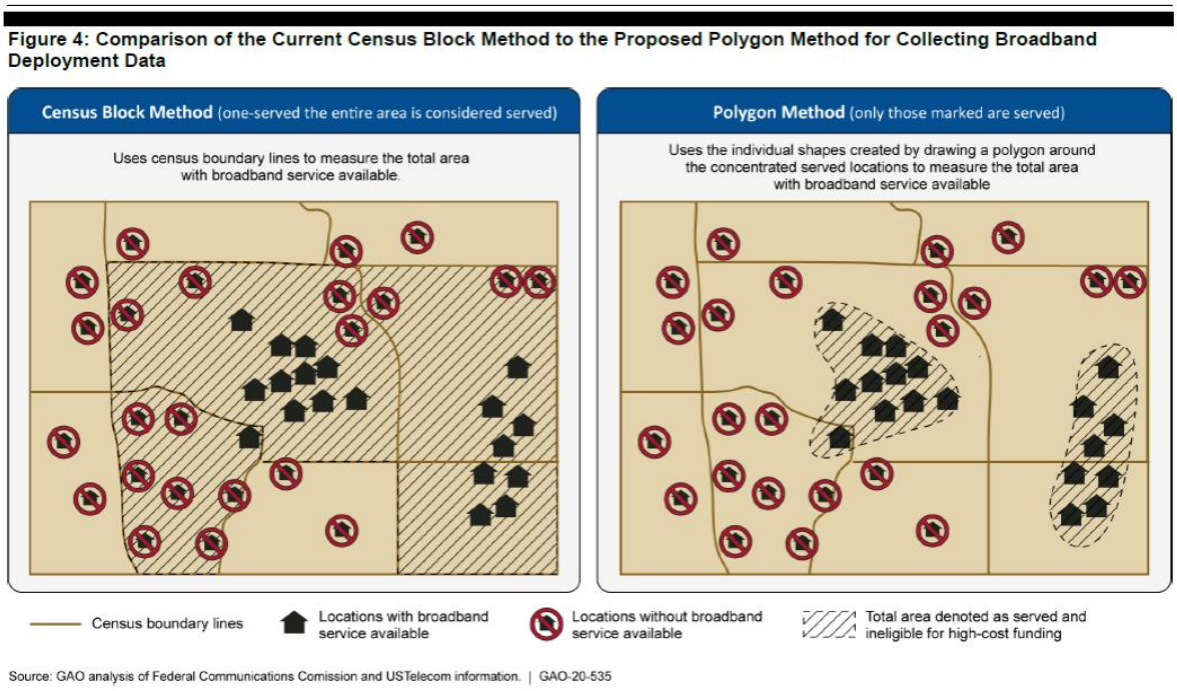
Figure 19: Share of speed test results indicating speeds less than 25 Mbps in areas where broadband coverage claims exist



Most covered areas had substantial numbers of speed test survey respondents with results below the 25/3 standard. The dark blue areas in Figure 19 indicate that fewer than half of speed test results were below 25/3. A moderate frequency of slow speed test results is not necessarily problematic. They may occur because respondents choose to subscribe to a slower provider than the one that offers 25/3; because the user subscribes to a slower speed than the maximum available; or because something about the user's hardware setup is impeding its efficient exploitation of the connection. Also, speed tests are sometimes conducted because a user is experiencing problems, and are therefore unrepresentative of the general experience of internet users, though this may be less true of the Broadband Office speed test survey results than for speed tests generally, since the typical motivation for the speed test in this case was that a community was mobilizing to get a broadband grant, and not that a user was troubleshooting. With this in mind, the fact that in most counties a majority, and in many counties a huge majority, of speed test results originating from notionally served areas were below 25/3, strongly suggests that Form 477 and other data sources used to compile the ARC Coverage Map substantially overstated the quality of coverage available in many areas.

Fortunately, the FCC is working on improving broadband coverage maps. This report[7] explains the benefits of switching from the Form 477 approach of asking about "maximum advertised speed" by Census block, to a new approach based on polygons, visually represented in Figure 20 (Figure 4 in the linked report). In future, better data should help the FCC and the State of Arkansas better target grants and subsidies to meet the most acute needs.

Figure 20: Visual explanation of the benefits of the FCC's proposed new "polygon" method of mapping broadband coverage



III. BROADBAND AND THE COVID-19 PANDEMIC

As the news breaks of multiple effective COVID-19 vaccines being developed, there is a new basis for hope that 2021 will see the COVID-19 pandemic taper off. Some of society's adaptations to the pandemic will end with the pandemic itself. A lot of masks, gloves and hand sanitizer will go unused. Some sneeze guards will be uninstalled, while others, not worth the trouble of uninstalling, will remain as a mild inconvenience. Other changes may prove more lasting, for good or ill. In sharp contrast, the transition to a more broadband-enabled society stands out as a change caused by the pandemic that is likely to prove both lasting and positive.

For a brief period in the spring of 2020, popular fears and government public health directives forced society to make urgent, drastic adaptations in the direction of doing as much as possible online. Schools

[7] https://www.gao.gov/products/GAO-20-535

and universities closed their physical campuses, and attempted to continue educating students through the internet. All sorts of public-facing businesses closed, causing a surge in unemployment. Offices closed too, but this led to much less unemployment, since many office workers continued working from home. Almost all churches closed their doors to the public, but many continued to conduct services, live streaming them as a substitute for physical church attendance. There was a surge in online shopping and delivery. All of these adaptations were enabled by the internet.

In the latter part of 2020, some public-facing businesses, offices, and schools reopened, while others did not. At the time of writing, the need to do more things online for the sake of public health is perceived to be mitigated, but far from eliminated. If the pandemic is ended by mass vaccination, as will hopefully occur in 2021, a major reason to do more things online will disappear, yet in many cases, there may not be much reason to go back to the status quo before the pandemic. In some cases, the pandemic may even have helped to solve a "coordination problem" and reach a better equilibrium. That is, in some cases, online interaction might have been a better solution even before the pandemic, but only if simultaneously adopted by various interacting parties, making it too difficult to coordinate, and norms favoring face-to-face contact suboptimal but stable. Many adaptations to online living, discovered under the pressure of the pandemic, may have sufficiently proven their worth, or simply become sufficiently habitual, to persist after public health conditions get back to normal. As explained below, distance education, telemedicine, telework, and e-commerce provide possible examples of this.

Even before the pandemic, broadband was increasingly recognized as "a necessity rather than a luxury." During the pandemic, broadband access must sometimes, though to what extent may never be possible to quantify, have been a matter of life and death. People who practiced "social distancing" by shopping online instead of going to crowded grocery stores, or by learning to telework instead of coming into the office, must sometimes saving their own lives or those of others, and the broadband networks that made it possible for them to do this were indispensable for reducing the death toll and/or the economic damage from the COVID-19 pandemic. The emerging consensus that broadband is a necessity will probably not be reconsidered as the pandemic recedes. Even the shift to online practices that took place during the pandemic might not be set back much when crowds cease to be a danger to public health. Elite economic thinker Tyler Cowen has argued that the relatively slow progress in technology (other than IT and communications) and living standards that has characterized recent decades will occur when society makes the internet central to its institutions.[8] The pandemic has brought that vision closer.

The online shift induced by the pandemic makes broadband access more important than ever. We don't know what post-pandemic US society will look like, but one thing that already seems certain is that the internet will be among the winners. There will be at least somewhat, and maybe a lot, more telework, telemedicine, distance education, online shopping, and online socializing than there was before the pandemic. All that will be at least somewhat, and maybe a lot, more normal, more pervasive, more trusted, more influential and more important than it was before. And that makes the digital divide a more urgent problem. Where good internet service is available, a more internet-intensive society will provide many compensations for a certain amount of lasting damage that the COVID-19 pandemic inflicted. Where good internet service is lacking, a more internet-intensive society will leave people still more left behind and excluded.

[8] https://marginalrevolution.com/marginalrevolution/2020/12/why-did-the-great-stagnation-end.html

A. Broadband and Data Demand Growth During the Pandemic

Broadband usage surged during the COVID-19 pandemic. According to the OpenVault Broadband Insights (OVBI) Report, data usage nationwide surged 40% in 2020 Q2, then stabilized in 2020 Q3, with monthly weighted average data consumption by households at just over 380 gigabytes. Median usage rose less than average, implying that the increase in data usage is somewhat concentrated. The number of "power users" who used more than 1 TB of data more than doubled in the year to 2020 Q3. The share of subscribers provisioned for gigabit speed service rose to 5.6% in 2020 Q3, having more than doubled from 2.5% a year before. Average data usage in the United States is 71% higher than in Europe. The top 10% of subscribers by data usage consume more than half of total upstream traffic on the network.

The surge in data usage during the COVID-19 pandemic confirms widespread commentary about heightened need for broadband during the pandemic. One expert has suggested that the sharp rise in gigabit speed subscribership may create a "critical mass" of potential users to support the emergence of new online applications, such as "telepresence," which will require gigabit connections to be used.[9]

Generally, broadband networks proved able to cope with the surge in data usage. A report from Thousand Eyes, a Cisco-affiliated consultancy,[10] found that there was a precipitous rise in network disruptions beginning in March 2020, yet "the system… held up surprisingly well overall, with no systemic performance degradation." North American ISPs experienced 65% more disruptions in March 2020 compared to January 2020. But in general, performance metrics remained in tolerable ranges. After March, outages declined steadily, though remaining somewhat elevated compared to pre-pandemic levels. At a time of great societal disruption, symbolized by toilet paper shortages, the stability of the internet sustained confidence and supported societal adjustment. Fortunately, enormous spare capacity is typical of the internet backbone, and it is typical for fiber optic cables to have orders of magnitude more data carrying capacity than is normally utilized. Challenges are more common at the "last mile."

B. Telework, Broadband, and the Future of Economic Competitiveness

One impact of the COVID-19 pandemic that is likely to prove lasting is the advent of mass telework. Widely adopted starting in spring 2020, telework practices have been critical to weathering the COVID-19 pandemic, have been welcomed by some telecommuters, and have proved surprisingly effective for some employers. But if the shift to telework proves at least somewhat permanent, it will have lasting effects on the nature of economic competitiveness that policymakers should take into account.

The possibility that many jobs could be done remotely, thanks to the internet, has been recognized for many years. Nonetheless, there has been only halting progress in the direction of more people working from home.[11] Telework tends to be popular with workers, can save money on office space for

[9] https://potsandpansbyccg.com/tag/openvault/

[10] https://marketo-web.thousandeyes.com/rs/thousandeyes/images/ThousandEyes-Internet-Performance-2020-Final.pdf

[11] https://www.shrm.org/resourcesandtools/hr-topics/technology/pages/why-are-some-companies-moving-away-from-telework.aspx

employers, and has other social benefits such as reducing carbon emissions from commuting. But it proved to be a management challenge for some employers,[12] and in many cases was simply never tried.

Then, suddenly, social distancing directives in spring 2020 compelled most corporate and government offices either to close or to curtail on-site staff, ordering all or most office employees to work from home. Meetings shifted to Microsoft Teams, Google Meet, or Zoom. Of course, this was only possible when (a) the nature of a worker's job allowed for teleworking, and (b) the worker had home internet service adequate to support teleworking. Telework was clearly an advantage, early in the pandemic, for workers who could do it. Teleworkers were uniquely fortunate in being spared both (a) unemployment and (b) the COVID-19 contagion risk associated with working on business premises. And society benefited from the ability of teleworkers to keep major organizations and institutions running even as so much economic activity had to shut down. The news media kept reporting, the stock market kept trading, the IRS kept collecting taxes and mailing refunds, banks kept lending, insurance companies kept processing claims, and in general, organizations kept processing information and making decisions, powered by telecommuting professionals, from the safety of their home offices.

A University of Chicago working paper on "Why Working From Home Will Stick" (Barrero, Bloom and Davis, 2020) is an early contribution to the academic literature of telework and the pandemic. Based on a survey of 15,000 respondents during May to October 2020, they estimate that:

- Telework surged to 62% of paid work days in May 2020, up from 5.3% before COVID-19.
- By October 2020, telework was down to 42% of paid work days in October 2020.
- The plans of some employers to continue telework practices post-pandemic will cause 21.5% of paid work days to be done at home in 2022 (or whenever the pandemic ends).
- Most plans for telework involve working from home some days rather than all the time.
- Workers would *like* to work from home 44% of the time, which is fairly uniform across all demographics.
- Post-pandemic opportunities for telework are expected to be higher for men (25%) than women (19%), for the better educated, and for higher earners.
- Telework will lastingly reduce demand for goods and services in central business districts by 5-10%.
- Telework was more prevalent in 2020 in "blue" states (high Biden vote share) than in "red" states (low Biden vote share).
- Over 40% of those working from home due to the pandemic believe they are more efficient than they were before the pandemic.

Since workers' desires for telework amount to roughly double the amount of telework that employers plan to offer, the option to telework can be regarded as privileged, and like many other privileged, it is disproportionately enjoyed by the educated and well-paid. Workers with earnings over $150,000 expect to telework about 40% of the time, compared to just over 15% for workers earning between $20,000 and $50,000. Workers with graduate degrees expect to telework about 30% of the time, compared to under 15% for workers with only a high school diploma. Men also expect to be able to telework more than women do.

[12] https://www.nbcnews.com/think/opinion/i-let-my-staff-work-home-then-realized-it-wasn-ncna814751

Surprisingly, Barrero, Bloom and Davis (2020) do *not* find that the quality of a person's home internet connection affected telework rates.

Barrero, Bloom and Davis (2020) identify five reasons why telework rates will probably persist at levels four times higher than before the pandemic:

1. *Reduced stigma*. Perceptions of telework have overwhelmingly improved since the beginning of the pandemic.
2. *Experience*. The vast majority of workers found that they were more productive working from home than they expected to be.
3. *Investment in telework capabilities.* Workers and employers have spent time and money equipping themselves and learning how to telework. These costs are estimated at 1.2% of GDP.
4. Residual preferences for social distancing due to fear.
5. Technological innovation that facilitates working from home.

Preferences for telework have been widespread for some time,[13] and many benefited when tens of millions of Americans stopped commuting during the pandemic,[14] saving time, gas money, and wear and tear on vehicles, prompting auto insurance companies to refund money to customers[15] because people were driving so much less. But telework could also create domestic conflicts[16] over scarcities of space suited to serve home office functions. On employers' side, well-known companies that have announced plans to let employees do more work from home permanently[17] include Dropbox,[18] Facebook,[19] Ford,[20] and Twitter,[21] but the extent of the shift towards telework by corporate America and government agencies is not clear. The rise of telework is one reason why 2020 was a bad year for commercial real estate.[22]

A lasting shift to telework will doubtless shift the nature of economic competitiveness and alter the comparative advantage of places. For example, it is likely that telework will enable workers to move further from city centers and telecommute to urban jobs, leading to a boost in competitiveness for suburbs' at city centers' expense. Though city centers can also offer lifestyles attractive to some, polls show[23] that Americans' preferences for where to live, compared to where they actually live, favor rural areas (where 12% live but 27% would like to live) over big cities (where 20% live but 12% would like to live). It is not clear how much geographic mobility telework will allow, since a worker might telework

[13] https://www.entrepreneur.com/article/347781
[14] https://www.prnewswire.com/news-releases/61-million-americans-have-stopped-commuting-due-to-covid-19-301118993.html
[15] https://www.propertycasualty360.com/2020/10/06/a-look-at-auto-insurers-responses-to-the-first-covid-19-wave/?slreturn=20201030110833
[16] https://www.arkansasonline.com/news/2020/aug/30/home-offices-separate-unequal/
[17] https://www.fastcompany.com/90508784/heres-an-ever-growing-list-of-companies-that-will-let-people-work-from-home-forever
[18] https://www.dropbox.com/jobs/all-jobs
[19] https://www.theverge.com/facebook/2020/5/21/21265699/facebook-remote-work-shift-workforce-permanent-covid-19-mark-zuckerberg-interview
[20] https://www.wsj.com/articles/ford-gears-up-for-the-post-pandemic-office-11598445075
[21] https://www.theverge.com/2020/5/12/21256060/twitter-employees-work-from-home-covid-19-pandemic
[22] https://www.cnn.com/2020/09/22/investing/commercial-real-estate-recession/index.html
[23] https://www.economicmodeling.com/attract-and-retain-remote-workers/

90% of the time but still need to be ready to attend an occasional face-to-face meeting on short notice. Part-time telework, which is expected to be more common than full-time telework, would tend to reduce the importance of a short commute time in choosing where to live, thereby encouraging more geographic diffusion, but might not increase the scope for interstate migration.

It does seem clear that the rise of telework makes internet service quality a more important factor in the economic competitiveness of areas. Without any internet service, businesses and workers would miss out on the benefits of telework. But the fact that Barrero, Bloom and Davis (20202) find internet service quality statistically insignificant in explaining telework propensities during the pandemic is a reminder that we do not really know how good the internet service quality has to be in order to facilitate the bulk of telework functions. Very little bandwidth is needed for many tasks, such as e-mail, the transfer of text and most PDF documents, and voice conversations. Videoconferencing is more data-intensive, but whether the value-added of a Zoom meeting relative to a phone call is critical for many business functions is not clear.

Full-time teleworkers, though a minority even of teleworkers, are likely to become more numerous in the 2020s as a result of the COVID-19 pandemic and the shift to telework. They have a distinctive geographic freedom about where to live, provided they can get a good internet connection, and they are worth attracting since they bring consumer dollars to the communities where they settle. In the past, top cities for teleworkers[24] have featured places with pleasant climates and natural beauty, with appealing community features, often near large cities. Some parts of Arkansas have such advantages, and may be competitive for attracting teleworkers if high-quality broadband connections are or become available.

C. Whither Distance Education?

For some time before the COVID-19 pandemic, a commonly cited grievance related to the digital divide was the "homework gap." Teachers would assign homework involving some kind of online research or online engagement. Most students, having home internet access, could comply. But some, lacking it, would either miss homework assignments and fall behind in grades and/or learning, or else be forced to resort to troublesome workarounds such as doing their homework at a local McDonalds for the sake of the wi-fi. Fortunately, K-12 schools themselves have had good internet access for years thanks to a previous investment push. But many students go home to households that are digitally deprived.

The COVID-19 pandemic made this problem much more acute when it forced K-12 schools nationwide to launch a sudden, unplanned experiment with remote learning. Widespread commentary that deems the experiment disastrous[25] masks the reality that for some students, remote learning worked out just fine. Comments from actual students about their remote learning experience are often neutral or favorable.[26] For other students, self-discipline was harder at home than in the classroom, and many families suffered because having a child at home instead of at school got in the way of parents holding jobs. But the harms from school closures affected some students more than others, and they especially

[24] https://havenlife.com/blog/cities-with-the-most-remote-workers/
[25] https://www.mckinsey.com/industries/public-and-social-sector/our-insights/covid-19-and-student-learning-in-the-united-states-the-hurt-could-last-a-lifetime
[26] https://www.nytimes.com/2020/04/09/learning/what-students-are-saying-about-remote-learning.html

affected those lacking internet access at home. Before, they had trouble doing homework. Now, they sometimes couldn't participate at all. Governor Hutchinson's hot spot initiative sought to address the digital divide in education by providing internet-enabled devices to needy students, and many communities applying for Arkansas Rural Connect broadband grants cited school closures and the need to help students study as a key motive for seeking better broadband in their communities.

Dissatisfaction with remote learning drove state policymakers to reopen most schools even in the face of a continuing pandemic, probably at some risk to public health, and education stakeholders are clearly not contemplating mass distance education after the end of the pandemic. On the other hand, full-time distance education through institutions like the Arkansas Virtual Academy,[27] at the K-12 level, or the University of Arkansas Online,[28] at the college level, was already part of the educational landscape. Since 2012, major online education providers such as Khan Academy, Coursera, Udemy, Udacity, edX, Pluralsight, and LinkedIn Learning have sought to spearhead a vision of change for education, arguing that the internet's economies of scale and ease of access can lower costs, improve selection, and make learning more flexible and adaptive. They have attracted millions of users, but faced severe retention challenges,[29] and their user bases have turned out to be disappointing elite for those who hoped that massive open online courses (MOOCs) would democratize education, though most MOOC completers saw professional benefits from their studies.[30] But business has been booming for online educators since the beginning of the COVID-19 pandemic.[31] Online education providers may succeed in leveraging the temporary boost to their competitive position to become more mainstream. And the exposure that so many students had to remote learning during the COVID-19 pandemic may make the rising generation more receptive to what online educators have to offer.

Education is an important reason for policymakers to try hard to close the digital divide, even though the internet is not yet, and may not become, central to most educational processes in normal times. Online degrees are a minority pursuit, but benefit some. Online courses are used by many professionals to broaden their skill sets or keep their skills up to date. Classroom education is usually supplemented by some degree of online engagement. Online skills are themselves an increasingly important component of many jobs. Remote schooling will be a less acute need after the pandemic, but the long-term trend is for online education to grow in importance. The pandemic has almost surely accelerated that trend, perhaps dramatically.

IV. THE BIG PUSH FOR BROADBAND: GOVERNMENT EFFORTS TO CLOSE THE DIGITAL DIVIDE

In light of the greatly heightened need for broadband during the COVID-19 pandemic, it makes sense that 2020 should turn out to be a year when a big push for broadband began. Yet at both the state and federal levels, the big push for broadband in 2020 was planned before the pandemic. The FCC's Rural

[27] https://arva.k12.com/who-we-are.html
[28] https://online.uark.edu/
[29] https://www.insidehighered.com/digital-learning/article/2019/01/16/study-offers-data-show-moocs-didnt-achieve-their-goals
[30] https://hbr.org/2015/09/whos-benefiting-from-moocs-and-why
[31] https://observatory.tec.mx/edu-news/boom-of-online-courses-covid-era

Digital Opportunity Fund (RDOF) auction was announced in considerable detail well before COVID-19 hit, with only minor modifications occurring in the early months of 2020 to a design that was largely foreshadowed by the CAF II Auction, or Auction 903, conducted in the summer of 2018. Arkansas Rural Connect was planned in 2019 and was on the verge of launching its first round when the COVID-19 pandemic hit, although its rules were modified and its funding increased in response to the pandemic. While the pandemic did not create Arkansas Rural Connect (ARC) or RDOF, it probably affected participation by boosting broadband demand and thereby improving the business case for rural broadband deployment. Local public officials regularly cited COVID-19 as a principal motive for the applications of their cities and counties for Arkansas Rural Connect broadband grants. ARC and RDOF are somewhat complementary in terms of the areas they target, and more so in their timing. ARC helped to meet urgent needs for broadband during the pandemic, and funded grants to many towns, which were generally not eligible for the more rural-focused RDOF program. RDOF, if it fulfills its promises, will meet the broadband needs of deeper rural areas over the course of the next few years. The big push for broadband by the state and federal governments that gained decisive momentum during 2020 is the biggest reason for hope that we are seeing the beginning of the end of the digital divide.

A. ARKANSAS BROADBAND PROGRAMS

The most important state programs that affect broadband in Arkansas are the Arkansas Rural Connect broadband grant initiative and the Rural Broadband I.D. Expenses Trust Fund, both launched in 2020, as well as the Arkansas High Cost Fund, which administers a state universal service policy focused on landline telephony but also affecting broadband that has been in place since the late 1990s. In addition, Governor Hutchinson's Hotspots for Education Initiative was important in meeting the acute needs of school kids for internet connectivity during the pandemic.

1. Arkansas Rural Connect

The Arkansas Rural Connect broadband grant initiative, with planned funding of $25 million, was advocated by Governor Asa Hutchinson starting in August of 2019. After some back-and-forth, the Arkansas Rural Connect Rules were approved by the Arkansas Legislative Council on February 19, 2020. By that time, $4.7 million had already been allocated for broadband from the Restricted Reserve Fund. Just as the first round of Arkansas Rural Connect was about to launch, the COVID-19 pandemic hit. But while this raised administrative challenges and cast doubt on the program's fiscal affordability, it also gave it new urgency, since broadband played a critical role in society's efforts to carry on basic functions in the face of the new need for social distancing. So the first round of Arkansas Rural Connect was launched on April 28, 2020, with an initial budget of $4.7 million.

Subsequently, the budget for Round 1 of Arkansas Rural Connect became much larger because of an influx of federal coronavirus relief funds. The CARES Act, passed on March 27, 2020, allocated $1.25 billion to Arkansas for general coronavirus relief purposes. Subsequent guidance clarified that broadband infrastructure investment qualified as coronavirus relief, since it enables telework, telemedicine, and distance education. The CARES Act Steering Committee then allocated $19.3 million to Arkansas Rural Connect on June 15, 2020. Then, on August 5, after the first Arkansas Rural Connect grants had been awarded, the Arkansas Legislature requested that the CARES Act Steering Committee

allocate another $100 million to the Arkansas Rural Connect program. While this gave the Arkansas Rural Connect program $125 million in total spending power, it also faced a very short timeline of five months in which it had to be spent, before the CARES Act deadline of December 31, 2020.

As of the time of writing, $86,882,984.40 in broadband grants have been awarded through the Arkansas Rural Connect program, leaving nearly $40 million of CARES Act money that was allocated to Arkansas Rural Connect by the legislature unspent. Tens of millions of dollars' worth of additional broadband grant projects were applied for, which were not funded for various reasons, but most often, because they did not claim to be able to complete deployment before the end of 2020, as required by the CARES Act. Early in the first round, three grants were awarded using state funds, but with these funds largely exhausted, the Broadband Office focused on reviewing, approving, and funding projects by ISPs that committed to complete deployment within 2020, and were therefore fundable with CARES Act money. Many ISPs did not feel able to commit to such rapid deployment, but submitted grant applications anyway, in the hope that a CARES Act extension would enable them to be funded. These projects remain on file with the Broadband Office and might be funded later if applicable funds become available.

Grant Awards and Funded Activities

Meanwhile, physical broadband infrastructure investment has been taking place. Boring crews have been laying conduit for underground fiber. Aerial crews have been making poles ready and attaching fiber. Towers have been erected in some areas, and wireless access points installed on new or previously existing towers. Thanks to these activities, **over 70,000 Arkansans**, in over 30,000 households, who previously lacked access to any 25/3 broadband service, are expected to get access to it, in most cases by the beginning of 2021. A list of ARC grantees, with technology, funding amounts, and households served, is shown in Table 1.

Table 1: Grant funding and households served by Arkansas Rural Connect projects

ISP	Technology	Total Grants	% of Total ARC Spend	Total Households in Project Footprints	Newly Served Households in Project Footprints
Aristotle Unified Communications	Fixed Wireless	$30,894,835	35.6%	14,606	11,097
CableSouth	Fiber	$12,000,000	13.8%	7,681	5,212
Clay County Connect	Fiber	$8,854,033	10.2%	1,033	1,017
The Computer Works	Fixed Wireless & Fiber Projects	$5,182,327	6.0%	6,555	2,777
Windstream	Fiber	$4,938,325	5.7%	1,080	396
SkyFiNet, LLC	Fiber	$4,490,909	5.2%	1,734	1,569
Premier	Fixed Wireless	$2,841,235	3.3%	3,160	2,352

Hillbilly Wireless	Fixed Wireless	$2,294,672	2.6%	1,272	955
Natural State Wireless	Fixed Wireless	$2,073,358	2.4%	1,806	874
Pinnacle	Fiber	$1,909,264	2.2%	799	495
Comcast	Fiber-Coax	$1,807,002	2.1%	873	846
ArkTelCo	Fiber	$1,568,750	1.8%	409	166
CATC	Fiber	$1,191,000	1.4%	338	183
TechStream	Fixed Wireless	$1,133,519	1.3%	675	459
World of Wireless	Fixed Wireless	$1,064,241	1.2%	437	321
MagazineTelCo	Fiber	$1,025,692	1.2%	330	330
East Arkansas Video	Fiber	$927,000	1.1%	374	374
Yelcot	Fiber w/ Other Tech	$922,948	1.1%	701	0[32]
Resort TV	Fiber	$601,000	0.7%	486	486
SkyFi Wispernet	Fixed Wireless	$486,896	0.6%	43	43
City Wireless	Fixed Wireless	$483,838	0.6%	275	263
Hope Community TV	Cable	$193,000	0.2%	207	170
All Fixed Wireless		$43,552,076	50.1%	27,533	18,912
All Fiber Only		$40,408,818	46.5%	15,560	10,457
Total		$86,883,844	100.0%	44,874	30,385

In some ways, these totals even understate the numbers who will get service. Over 100,000 Arkansans live in Arkansas Rural Connect project footprints, with the difference representing those who are believed to have access to some 25/3 broadband service already. The ARC program allows communities that have some broadband coverage to apply, as long as at least 20% lack service, and many did, resulting in new broadband coverage commitments for some people already enjoying access to some kind of 25/3 service. In other cases, communities compiled evidence which, while not sufficiently detailed to allow for a precise redefinition of coverage maps, persuasively indicated that the community had a significant deficiency of broadband coverage.

Another reason why the totals understate coverage is that most of the fixed wireless companies that won grants co-applied with towns and limited their ARC obligations to the municipal boundaries of applicant communities, when in fact the fixed wireless signals will carry farther and serve surrounding areas. While it made sense under the ARC rules for ISPs to define limited project footprints, once the towers are built and the fixed wireless access points installed, it will be in the business interest of ISPs to offer service wherever their signals can reach. So thousands more Arkansans will get service from ARC broadband projects even though they don't live in ARC project footprints.

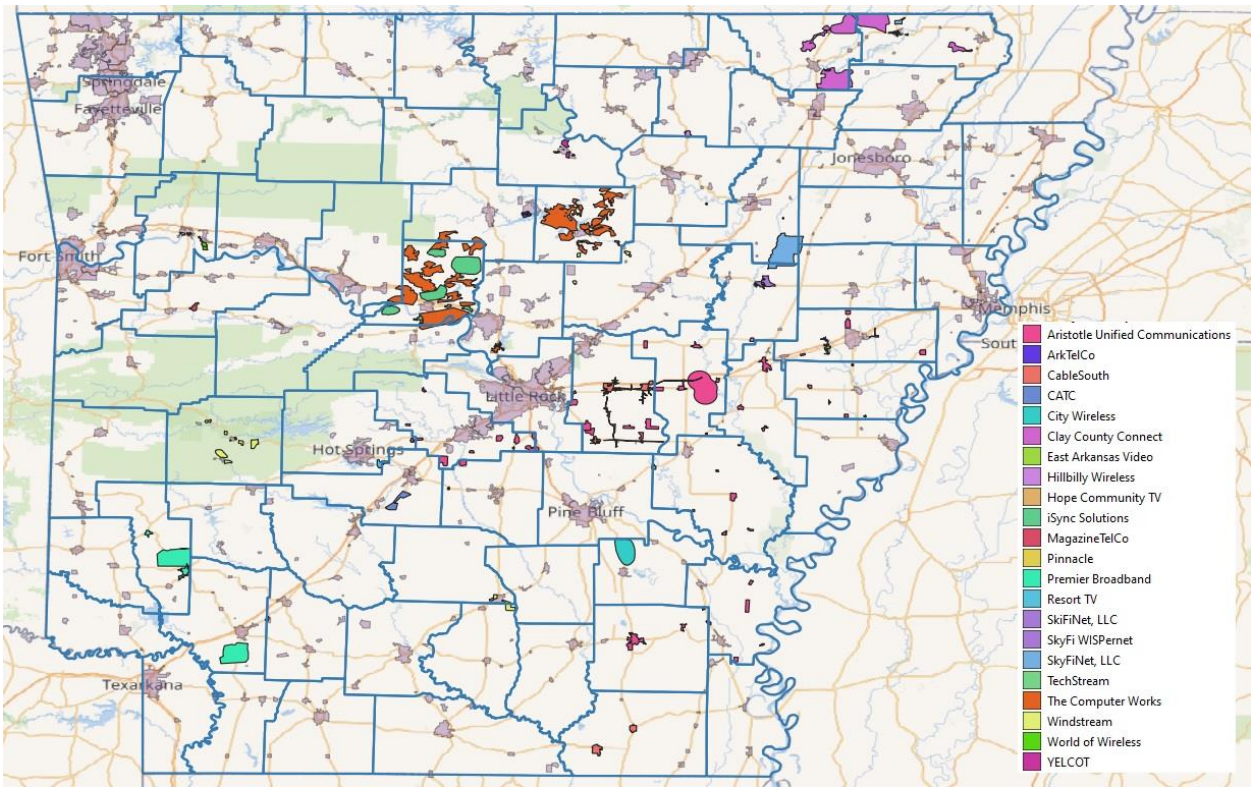
By far the largest awardee of ARC grants was fixed wireless ISP Aristotle Unified Communications, which was awarded 15 grants, one-quarter of the total, worth $30.9 million, over one-third of the total, distributed across eastern and southern Arkansas. Over 14,000 Arkansan households live in the project

[32] While the ARC Coverage Map indicated that no one in the area affected by this project lacked broadband coverage, the provider established through the challenge process that there was a significant coverage gap, though the number of households affected can't be precisely quantified.

footprints that Aristotle has committed to serve, and many more are likely to be reached by Aristotle's towers. CableSouth, the next biggest awardee, was awarded six grants worth $12 million to serve the cities of Lonoke, Carlisle, Hamburg, Crossett, England, and Humnoke, along with some rural locations along the fiber routes that CableSouth will build. Other awardees with multiple awards included Clay County Connect, the electric coop, with a project in rural Randolph and Clay counties; The Computer Works, which will serve the town of Mayflower with fiber and large areas of Cleburne and Conway counties with fixed wireless; Windstream; SkyFiNet; and Premier Broadband.

Figure 1 shows the project footprints of all the Arkansas Rural Connect grant projects in a single map. Most of them are in the southern and eastern parts of the state, reflecting the easier terrain and the greater deficiency of broadband there.

Figure 21: Arkansas Rural Connect project footprints



Did the state get value for money on these grant projects? Table 2 shows the awardee ISPs sorted by technology, and adds information on the per household costs of the projects. Windstream, which won fiber projects in rural Dallas County, Montgomery County, and White County, had the highest per household costs. This partly reflects the relatively low share, 37%, of households in the project footprint that were classified as unserved before Windstream's grant-funded buildout, although this may be misleading, since the estimate of unserved households was based on FCC Form 477 data that tends to overstate coverage in certain known ways. Clay County Connect's projects were the most expensive per

household served if all households living in the project footprint are considered. Grant requests by fixed wireless ISPs tended to have lower per household costs, with the exception of SkyFi Wispernet.

Table 2: ARC awardees by technology and per household cost

ISP	Total Grants	% of Total ARC Spend	Total House-holds in Project Footprints	Newly Served House-holds in Project Footprints	$ / Hh	$ / Newly Served Hh
Technology: Cable						
Hope Community TV	$193,000	0.2%	207	170	$933.87	$1,137.52
Technology: Fiber						
Windstream	$4,938,325	5.7%	1,080	396	$4,571.93	$12,472.02
ArkTelCo	$1,568,750	1.8%	409	166	$3,835.40	$9,423.03
Clay County Connect	$8,854,033	10.2%	1,033	1,017	$8,573.30	$8,708.21
CATC	$1,191,000	1.4%	338	183	$3,524.07	$6,524.10
Pinnacle	$1,909,264	2.2%	799	495	$2,390.91	$3,855.46
MagazineTelCo	$1,025,692	1.2%	330	330	$3,109.24	$3,109.24
SkyFiNet, LLC	$4,490,909	5.2%	1,734	1,569	$2,589.24	$2,861.45
East Arkansas Video	$927,000	1.1%	374	374	$2,476.69	$2,476.69
CableSouth	$12,000,000	13.8%	7,681	5,212	$1,562.39	$2,302.37
Resort TV	$601,000	0.7%	486	486	$1,236.89	$1,236.89
Technology: Fiber w/ Other Tech						
Yelcot	$922,948	1.1%	701	0	$1,315.81	-
Technology: Fiber-Coax						
Comcast	$1,807,002	2.1%	873	846	$2,071.06	$2,137.20
Technology: Fixed Wireless						
SkyFi Wispernet	$486,896	0.6%	43	43	$11,205.89	$11,205.89
World of Wireless	$1,064,241	1.2%	437	321	$2,434.42	$3,316.63
Aristotle Unified Communications	$30,894,835	35.6%	14,606	11,097	$2,115.20	$2,784.06
TechStream	$1,133,519	1.3%	675	459	$1,679.03	$2,470.89
Hillbilly Wireless	$2,294,672	2.6%	1,272	955	$1,803.99	$2,403.14
Natural State Wireless	$2,073,358	2.4%	1,806	874	$1,148.14	$2,371.76
City Wireless	$483,838	0.6%	275	263	$1,757.58	$1,837.69
Premier	$2,841,235	3.3%	3,160	2,352	$899.22	$1,208.23
Both Fixed Wireless and Fiber Projects						
The Computer Works	$5,182,327	6.0%	6,555	2,777	$790.54	$1,866.00
Totals						
All Fiber Only	**$40,408,818**	**46.5%**	**15,560**	**10,457**	**$2,596.95**	**$3,864.14**
All Fixed Wireless	**$43,552,076**	**50.1%**	**27,533**	**18,912**	**$1,581.79**	**$2,302.83**

Total	**$86,883,844**	**100.0%**	**44,874**	**30,385**	**$1,936.17**	**$2,859.44**

Many projects cost more than the $3,000 per household cap defined in the original ARC Rules, and could not have been funded without the flexibility provided by the ARC Coronavirus Rules. Yet the overall cost per household newly served for all ARC projects, estimated at $2,859, was not dramatically misaligned with the original budgetary projections. In general, fiber projects were somewhat more expensive, at $3,864 per newly served household, than fixed wireless projects, which averaged $2,303 per newly served household. Half of all Arkansas Rural Connect Round 1 funding went to fixed wireless projects, mostly those of Aristotle, while slightly less than half went to fiber projects, mostly those of CableSouth, Clay County Connect, Windstream, and SkyFiNet, with the balance going to other technologies. In many cases, awardees reported that costs were elevated because of the required rapidity of the deployments.

The Complementarity Between ARC and RDOF

At the same time as Arkansas Rural Connect was making grants, the FCC's Rural Digital Opportunity Fund auction (RDOF) was underway, and it published the auction results shortly after ARC stopped funding new 2020 deployable projects. RDOF bidding was highly secretive, and the State Broadband Office did not know who the RDOF participants in Arkansas were. It did know at the time that Round 1 of Arkansas Rural Connect was launched, though not at the time the ARC rules were being developed, which areas were being targeted by the RDOF program, since that information was published in a map well in advance of the auction. Given the design of the RDOF auction, it was presumed that most RDOF territories would get funded, and in the end, virtually all of them did. At an early stage in the ARC process, the Broadband Office focused grantmaking on non-RDOF areas, to save money and to avoid possibly rendering areas ineligible for RDOF. But as ARC's funding was increased, and after clarifying with the FCC that broadband grants made in RDOF areas would not trigger the removal of those areas from RDOF eligibility, the Broadband Office began to make grants without regard to whether those areas were targeted by RDOF or not.

In the end, most Arkansas Rural Connect project footprints have at least some overlap with RDOF, and a few have a large overlap. There are six projects where more than 80% of the ARC project footprint is now due to get service from a provider funded by the RDOF Phase I auction. But almost four-fifths of the population living in ARC project footprints was not covered by the RDOF auction. Many areas, especially towns, were omitted from the RDOF auction because they were claimed as covered or because, in theory, broadband deployment there should have been cheap and should not have needed a subsidy, though in spite of that, it had in fact failed to occur for years. Arkansas Rural Connect allowed applications from towns, and from communities that challenged the broadband coverage maps. This is one way that the ARC and RDOF programs complemented each other. In most cases, they targeted different geographies.

When ARC and RDOF territories do overlap, they may have funded the same ISP or different ISPs to serve the areas. We cannot quantify the extent to which ARC and RDOF picked the same winners at the present time, because in spite of having announced key information about the results, the RDOF is still in a "quiet period" where participants are limited in what information they can disclose to the public, and some aspects of the outcome remain hidden. Specifically, we don't always know which companies

comprise the named "consortia" that won RDOF territories. It seems clear that there are cases where ARC and RDOF funded the same companies to serve a community, and other cases where ARC and RDOF funded competitors, but we don't know how many of each type of case occurred. Where ARC and RDOF both funded the same ISP, this may boost the ISP's profit margin, but some ISPs may also have planned on, and needed, both funding sources in order to make a business case work. Where ARC and RDOF funded competitors, residents should get the benefit of multiple broadband options. In still other cases, ARC projects may have funded "middle mile" infrastructure that was necessary to enable ISPs to compete aggressively for RDOF money to fund "last mile" buildouts. Arkansas's results in the RDOF auction were generally favorable, suggesting that, far from crowding out federal RDOF dollars, ARC may have helped to leverage them.

Job Creation

In addition to expanding broadband coverage, Arkansas Rural Connect created some jobs at a time of high unemployment. Not all the awardees responded to the Broadband Office's inquiries, and some of those that did respond didn't have hiring numbers handy. Still, almost 400 jobs created in connection with Arkansas Rural Connect grants were reported to the Broadband Office by the awardee ISPs. Fiber projects accounted for a large majority of the hiring, and in general, fiber installations seemed to be considerably more labor-intensive, while the cost structure of fixed wireless projects was heavier on the equipment side. Much of the job creation was explicitly temporary, lasting for the duration of the buildout activities, and often through contractors rather than with the ISPs themselves. Pay seems to have been good, for the most part, based on the hourly rates quoted in grant application budgets, and there was an abundance of overtime for the workers as awardees raced to complete projects before the end of the year. Some awardees mentioned training workers, and many are likely to find the skills and experience useful as the FCC's RDOF program finances more broadband deployment activities in the coming years.

In addition to direct job creation, the grant projects stimulated local economies through ISPs' purchases of trucks, cabling, and other equipment in the state, sometimes from local Arkansas manufacturers, as well as workers' spending for food and gas as they worked. More importantly in the long run, awardees are hopeful that better broadband will help retain jobs in local communities by enabling people to exploit remote opportunities. One ISP mentioned that an online educator had been able to move to the area from out of state thanks to the faster internet provided.

2. The Rural Broadband I.D. Expenses Trust Fund

The Rural Broadband I.D. Trust Fund is designed to help cover the exorbitant costs of applying for broadband deployment funds in rural areas. Due diligence business studies are the first step toward applying for federal grants and loans for broadband deployment; however, the cost of these studies can be a barrier for local applicants. The Rural Broadband I.D. Trust Fund has an overall budget of $2 million, and an applicant can be awarded up to $75,000.

A total of $680,000 has been awarded to ten local entities. See Table_____ below for the awards:

Name	**Amount Requested**

Polk County	75,000.00
Howard County	75,000.00
Arkansas County	75,000.00
City of Benton	40,000.00
City of Cabot	75,000.00
City of Sherwood	75,000.00
Eagle Ridge POA	75,000.00
Little River County	75,000.00
City of Ward	75,000.00
City of Tull	40,000.00
Total	**680,000.00**

3. Governor Hutchinson's Hotspots for Education Initiative

Governor Hutchinson's $10 million GEER Fund allocation was intended to supplement student connectivity with the purchase of approximately 20,000 CIPA compliant internet hotspots. The DESE leveraged state-negotiated rates to provide 260 districts with 20,923 hotspots (24 months of data) at a cost of $9,419,063.76. Districts were able to choose from any of the approved vendors according to available coverage, and devices were intended to be prioritized for students with the greatest connectivity needs. Feedback has been positive from across the state, with hotspots being utilized in a variety of ways to help meet the unique challenges of this school year. Each vendor also agreed to extend the state rate to districts wishing to purchase additional hotspots, and over 5,500 devices have been obtained under this agreement.

Vendor Invoices:

AT&T: $2,951,508.00

T-Mobile: $1,548,720.00

Verizon: $4,918,835.76

Total: $9,419,063.76

Initial Hotspot Order Count

AT&T: 5,999

T-Mobile: 4,302

Verizon: 10,622

Total: 20,923

4. Arkansas High Cost Fund

The Arkansas High Cost Fund (AHCF) is the successor of the Arkansas Universal Service Fund, which was established in 1997, shortly after the passage of the federal Telecommunications Act of 1996, and renamed as part of a slight reform in 2007. Funded by charges on phone bills, it reallocates almost $40 million annually, by a complex formula, among historic telephone companies, to support the maintenance of rural telecommunications. Participating companies are sorted into four categories based on the number of subscribers. Table 3 is taken from the 2019 Annual Support Determination document, accessible via the website of the Arkansas Public Service Commission.[33]

Table 3: Annual support determination for the Arkansas High Cost Fund, 2019

ETC Company	Stipulation (Revenue Base)	Uncapped Annual Support	Capped ARHCF with ARUSF	201 New Determination Monthly Support
Category I				
Arkansas Tel	$0	$1,244,123	$918,432	$76,535.97
ArkWest	$493,416	$S,731,545	$4,231,119	$352,593.25
Central Arkansas	$223,092	$1,724,798	$1,273,274	$106,106.15
Cleveland County	$563,832	$496,132	$366,253	$30,521.08
Decatur Telephone	S247,032	$275,238	$203,185	$16,932.07
E. Ritter Telephone	$573,900	$1,178,194	$869,761	$72,480.12
Madison County	$487,728	$2,305,584	$1,702,020	$141,834.96
Magazine Tele Co	$106,584	$387,651	$286,171	$23,847.54
Mt. View Tele Co	$304,752	$2,356,991	$1,739,969	$144,997.38
Northern Arkansas	$2,392,896	$3,955,493	$2,920,009	$243.334.06
Pinnacle/Lavaca	$530,244	S902,183	$666,006	$55,500.50
Prairie Grove Tel	$1,770,180	$3,624,403	$2,675,593	$222,966.05
Rice Belt	$66,624	$829,950	$612,683	$51,056.89
Scott County	$63,504	$95,555	$70,540	$5,878.33
South Arkansas	$645,528	$2,460,990	$1,816,742	$151,39520
Southwest Arkansas	$1,190,832	$5,103,054	$3,767,156	$313,929.69
Tri-County	$1,303,284	$3,181,958	$2,348,972	S195,747.70
Walnut Hill	$1,276,764	$1,934.842	$1,428,331	$119,027.60
Yelcot	$412,128	$1,471,902	$1,086.581	$90.548.46
Subtotal	$12,652,320	$39,260,586	$28,982,796	$2,415,233.00
Category II				
CenturyTel of Arkansas	$0	$3,185,245	S2,187,834	$182,319.49
CenturyTel of Mountain Home	S692,868	$2,524,266	$1,733,830	$144,485.86

[33] http://www.arrural.com/ahcf/2019%20Support%20determination%20-%20APSC%20Notice.pdf

CenturyTel of Redfield	$819,364	$1,081,906	$743,123	$61,926.94
CenturyTel of South Arkansas	$747,642	$433,884	$298,020	$24,835.00
Category III				
Windstream (Alltel Arkansas)	$0	$14,252,764	$794,049	$66.170.77
Category IV				
AT&T	$0	$7,599,490	$4,962,808	$413,567.29

While broadband is mentioned as a goal in the statutes governing the AHCF, there are no specific requirements for broadband deployment in connection with receiving AHCF support. Nonetheless, informed industry stakeholders report that AHCF funds often do support broadband investment, because the historic telephone companies that receive AHCF support understand that broadband is their future as landline telephony becomes obsolete.

B. BROADBAND POLICY IN OTHER STATES

Many other states face broadband challenges similar to Arkansas, and the legislation these states have used to address them is instructive. At the same time, most other states are at least somewhat ahead of Arkansas, and some are far ahead, in making broadband available to their entire populations. As Arkansas makes progress in closing the digital divide, it will come to resemble these better-connected states, and may find examples to follow in their laws and programs.

Other states that award broadband grants include Alabama, California, Colorado, Georgia, Idaho, Illinois, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Mexico, New York, North Carolina, Pennsylvania, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. Broadband grant programs are usually administered by one of three types of agencies: (a) a public utility commission, (b) a department of information technology, and (c) an economic development or commerce agency.

It makes some sense to regard broadband as a utility service, comparable to electricity, running water, sewage, and especially telephony. Reflecting this, some states support or regulate broadband through state universal service funds and/or public utility commissions. Often, notably in Idaho, Illinois, and Florida, Maryland, Minnesota, Rhode Island, and Tennessee, a priority has been to supplement the E-rate program to bring broadband to schools and libraries. In other cases, for example in Oregon, public service commissions are explicitly tasked in statute with seeking to promote expansion of broadband to the broad citizenry.

In general, state laws governing public utility commissions affect broadband, because state public utility commissions designate the “eligible telecommunications carriers” able to participate in federal universal service programs. One of these programs is Lifeline, which provides $9.25 per month of broadband (or voice) discounts to qualifying households, with eligibility depending on participation in other welfare programs or having an income less than 135% of the poverty line. Some states add state funding to federal Lifeline support.

Some state laws try to use the tax code to promote broadband deployment. One way to do this is to provide favorable tax treatment to broadband providers themselves. Colorado, Minnesota and Mississippi, among other states, exempt broadband providers' equipment purchases from sales taxes; Colorado also allows municipalities to create further sales tax exemptions. Oregon, Indiana, Iowa and Maine provide various kinds of property tax exemptions to broadband investors, in different ways, e.g., Indiana targets "infrastructure development zones," while Maine targets "tax increment financing districts." Wisconsin offers a personal income tax credit for internet equipment.[34]

Many states, including Alabama, Florida, Georgia, Indiana, Maryland, Michigan, Mississippi, Missouri, Nevada, North Carolina, Ohio, Oklahoma, South Carolina, and Tennessee explicitly exclude public utility commissions from regulating broadband. North Carolina's statute remarks that "broadband service… is sufficiently competitive" as the ground for not regulating it. Mississippi's code has language excluding broadband from laws governing other public utilities. Relatedly, the FCC adopted "net neutrality" rules in 2015 and began to treat internet service as a publicly regulated telecommunications service, then reversed itself in 2017 under a new Chairman, renouncing broadband regulation and letting the Federal Trade Commission handle residual problems with deceptive practices or anticompetitive behavior. Even when explicit broadband regulation is lacking at both the federal and state levels, broadband supply is affected by regulations in tangent spaces, such as carrier of last resort obligations in telephony, or rules governing pole attachment fees.

Against this, there was a wave of state laws in 2018-2019 favoring net neutrality, seemingly in reaction to the FCC's reversal of its previous net neutrality stance. The term "net neutrality" refers to the avoidance or prohibition of practices such as paid prioritization, selective throttling, and content blocking by ISPs. Such practices can make business sense, but do not seem to be common, partly because of adverse public opinion and regulatory stances at the state and federal level, although they are not currently illegal in general. Colorado, Hawaii, and Maine, Montana, New Jersey, New York, Oregon, Rhode Island and Vermont passed laws in 2017-2019 requiring ISPs *that do business with state government* to practice net neutrality. Colorado also requires ISPs that receive support from the state's high cost fund to be net neutral. Most aggressive are California and Washington, which mandate net neutrality practices for ISPs generally. AT&T and Comcast are seeking to overturn California's net neutrality law in federal court.[35] Net neutrality polls well, though it is doubtful whether most poll respondents understand what it means, but FCC Chairman Ajit Pai has strongly argued that net neutrality interferes with broadband deployment and innovation. However this struggle turns out, it is not clear whether or not small states can do much to affect whether paid prioritization and selective throttling become part of the future internet economy.

In the broadband industry, many peculiar property rights issues arise that are critical to ISPs' ability to do business and expand. For wireless companies, spectrum is a critical resource. That is, wireless companies often need to establish a right to transmit signals at particular frequencies, and ensure that no other signals are transmitted at those frequencies in the same areas, since those would create interference and prevent the signal from being transmitted. For fiber companies, rights to attach equipment to utility poles and/or to dig and lay fiber conduit in the public right-of-way, are critical.

[34] https://www.revenue.wi.gov/DORforms/2011ic-061f.pdf
[35] http://cyberlaw.stanford.edu/blog/2020/09/california-defends-its-net-neutrality-law

Utility poles are privately owned, but treated as a regulated natural monopoly, and pole owners are generally required to accommodate broadband providers who want to attach to their poles, though they can charge a fee. Depending on the state, pole attachment regulation is provided by the state public utility commission or the FCC. As of 2020, the states that regulate pole attachments are Alaska, Arkansas, California, Connecticut, Delaware, the District of Columbia, Idaho, Illinois, Kentucky, Louisiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Utah, Vermont, Washington, and West Virginia. Elsewhere, FCC rules apply. State laws generally try to ensure "reasonable and nondiscriminatory" access and pricing, sometimes explicitly delegating the details to a public service commission, while in other cases are more prescriptive, e.g., a law in Tennessee sets maximum pole attachment fees at half of the highest fee charged in 2008.

Broadband deployment sometimes requires easements to dig on private land. Colorado, Texas, Mississippi, Alabama, Georgia, Virginia, and Maryland have laws permitting the use of existing electric easements for deployment of broadband. Permits are often need to dig or to install equipment on utility poles or towers, which can be a cause of unpredictable delays. To prevent such delays, Colorado, Hawaii, North Carolina, and Iowa have laws that require timely responses to applications for permits. Iowa's is notably permissive, requiring local jurisdictions to respond to applications within six business days, and deeming a non-response to be an approval. Laws in Colorado allow broadband providers to place facilities along highways or across public land, though another law makes this dependent on local government consent.

Some broadband advocates support "dig once" policies that ensure fiber conduit installation will occur whenever major trenching operation occurs, e.g., in connection with new road construction. California requires the Department of Transportation to notify broadband providers of construction projects suitable for broadband conduit installation. Colorado requires state and local entities to give broadband providers notice of utility trenching operations so that they can choose whether to take advantage of the opportunity to install fiber conduit. Similar laws exist in North Carolina, Utah, Arizona, Minnesota, Nevada, Maryland, Georgia, West Virginia, Maine, and Illinois.[36] Advocates argue that dig-once policies could cut the cost of broadband deployment by up to 90% by eliminating the need for separate trenching work specially for broadband.[37]

One issue about which state laws differ sharply involves municipal broadband. Some cities operate their own broadband networks. In Arkansas, Clarksville, Conway, and Paragould do so. Nationally, an estimated 750 cities did so as of 2018.[38] There are plenty of success stories[39] and plenty of boondoggles.[40] All in all, municipal broadband systems' national market share is minuscule, far below 1%, although these systems often achieve high market share in municipalities where they are established.

State laws about municipal broadband range from firmly prohibiting it, to allowing and encouraging it, but most often they limit it. According to BroadbandNow, there are state laws in some way adverse to municipal broadband in Michigan, North Carolina, South Carolina, Tennessee, Virginia, Utah, Wisconsin,

[36] https://broadbandnow.com/report/dig-once-digital-divide/#state-list
[37] https://broadbandnow.com/report/dig-once-digital-divide/
[38] https://www.vice.com/en/article/a3np4a/new-municipal-broadband-map
[39] https://ilsr.org/report-wilson-broadband-puts-community-first/
[40] https://www.washingtonexaminer.com/opinion/op-eds/stay-away-from-municipal-broadband-boondoggles

Montana, Alabama, Colorado, Connecticut, Oregon, Virginia, Pennsylvania, Minnesota, Wyoming, Missouri, Nebraska, Texas, Washington, Alabama, Louisiana, Nevada, and Florida.[41] Arkansas was removed from this list after the passage of Act 198 of 2017, which allows municipalities to apply for broadband in connection with applications for funding from grant and loan programs. But there are also state laws allowing or encouraging municipal broadband, sometimes in these same states. Alabama, for example, allows municipalities that provide utility service to provide internet access as well. Colorado prohibits local governments from providing broadband *unless* no provider currently provides service or agrees to do so, in which case a referendum must be held before a plan to provide municipal broadband can proceed. Iowa prohibits municipal broadband to be cross-subsidized from general revenues. Nebraska is unusual in firmly prohibiting all municipal broadband. Meanwhile, at the other end of the spectrum, Maine explicitly allows municipal broadband without qualification, and adds tax exemptions.

In recent years, it has become increasingly clear that electric utilities will be crucial protagonists in closing the digital divide throughout large parts of the country, including much of western and northern Arkansas. Arkansas's Broadband Over Power Lines Enabling Act of 2007 helped lead the way to this outcome. Other states with legislation allowing electric utilities to provide broadband include Virginia,[42] Georgia,[43] Maryland, Mississippi, North Carolina, Texas, and Indiana.

State Grant Programs

Many states participate or have participated in broadband funding programs. Some states, such as Maine and Minnesota have been funding broadband since the early 2010's, where other states such as Arkansas have recently created broadband grant programs. Even though state grant programs are typically focused on expanding infrastructure, state programs often differ in scope, size, and funding mechanism.

For example, some states use universal service funds to fund their grant programs. Others use general revenue to fund their programs. Tennessee and other states require a match by the ISP, and practically all states have a cap on the maximum amount that can be requested. There are more differences in how states score and award grant funds. Some states use a rubric to award projects, where others use engineers to determine what projects should be awarded.

Arkansas was a national leader with the ARC program in terms of overall budget (over $100 million). The majority of states have programs that range in budget from $3 to $30 million. It should be noted though that Arkansas used the CARES Act Funds to fund the ARC program, which greatly increased the overall budget. Arkansas was not alone in utilizing CARES Act funds for broadband, though.

Table 4 below compares grant programs nationally. Note – there could be programs in other states that were not included in the list below.

[41] https://broadbandnow.com/report/municipal-broadband-roadblocks/
[42] https://www.fauquier.com/news/state-lawmakers-allow-utilities-to-wire-rural-areas-for-broadband/article_01f78572-49f8-11e9-ae53-835c731e9af7.html
[43] https://www.electric.coop/new-georgia-law-makes-clear-that-electric-co-ops-can-enter-the-broadband-space/#:~:text=Georgia%20electric%20cooperatives%20now%20have,access%20in%20their%20service%20territories.

Table 4: Broadband grant funding by state

State	Awarded Amount	Number of Projects	Connected Premises
Alabama (State Funds)	$9,451,023.16	20	13,101
Arizona (State Funds)	$3,000,000	3	1,776+
California (USF Funds)	$8,738,007.87	9	1833
Colorado (State Funds)	$14,151,620	13	NA
Illinois (State Funds)	$50,000,000	22	NA
Iowa (CARES Funds)	$50,000,000	71	NA
Maine (USF Funds, since 2007)	$2,995,217	27	3726
Michigan (State Funds)	$11,914,185	10	NA
Minnesota (State Funds)	$23,270,933	30	10,938
Missouri (State Funds)	$3,049,075	16	4416
Nebraska (CARES Funds) – also use USF	$29,528,620	60	17,600
North Carolina (State Funds)	$10,244,195	11	6860
Oregon (CARES Funds)	$9,994,507.28	28	NA
Tennessee (State Funds)	$19,735,131.13	17	12,600
Virginia	$18,300,000	12	36,000
Washington (State Funds CERB)	$11,794,000	13	$13,972
Washington (State Funds Public Works Board)	$17,828,760 (grants & loans combined)	7	4,503
Wisconsin (State Funds)	$24,000,000	72	NA
Wisconsin (CARES Act)	$5,378,477	12	NA
Wyoming (CARES Act)	$86,133,228.63	37	NA

National Governors Association Recommendations

A recent report from the National Governor's Association[44] lists nine recommendations for states seeking to overcome the digital divide:

1. Establish robust, cross-cutting governance structures
2. Initiate partnerships with other state agencies, local and county governments, and other entities to kickstart broadband investments
3. Leverage anchor institutions to provide rapid community internet service
4. Leverage existing infrastructure projects with dig-once coordination
5. Leverage electric utilities' infrastructure and services to facilitate deployments of broadband networks

[44] https://www.nga.org/center/publications/expand-affordable-broadband/

6. Coordinate and expand broadband affordability programs
7. Deploy innovative procurement strategies
8. Improve broadband coverage maps
9. Identify funding and financing sources for broadband deployment

Arkansas is a pioneer in some of these areas, e.g., in partnering with cities and counties for its grant program (related to recommendation 2 above), in implementing an online speed test survey to help with grant program decision-making (related to recommendation 8), in channeling CARES Act funds to broadband investment (related to recommendations 7 and 9), and especially in having a relatively permissive regulatory environment that has allowed electric coops to spearhead major fiber investments (related to recommendation 5). Areas for improvement include (1), (3), (4), (6).

C. FEDERAL BROADBAND PROGRAMS

In general, the federal government has far more financial resources than do state governments, and federal agencies are more important than state governments in funding the maintenance and expansion of broadband networks. The main agencies that do this are the Federal Communications Commission (FCC) and the US Department of Agriculture (USDA). While the FCC has many programs that impact the broadband industry, the most important program for funding broadband expansion is the Rural Digital Opportunity Fund (RDOF), successor to the Connect America Fund which has financed broadband expansion for the past decade, though with a different funding model than the new RDOF program. The USDA also has many programs, of which the largest, USDA ReConnect, is also the newest.

1. FCC Rural Digital Opportunity Fund

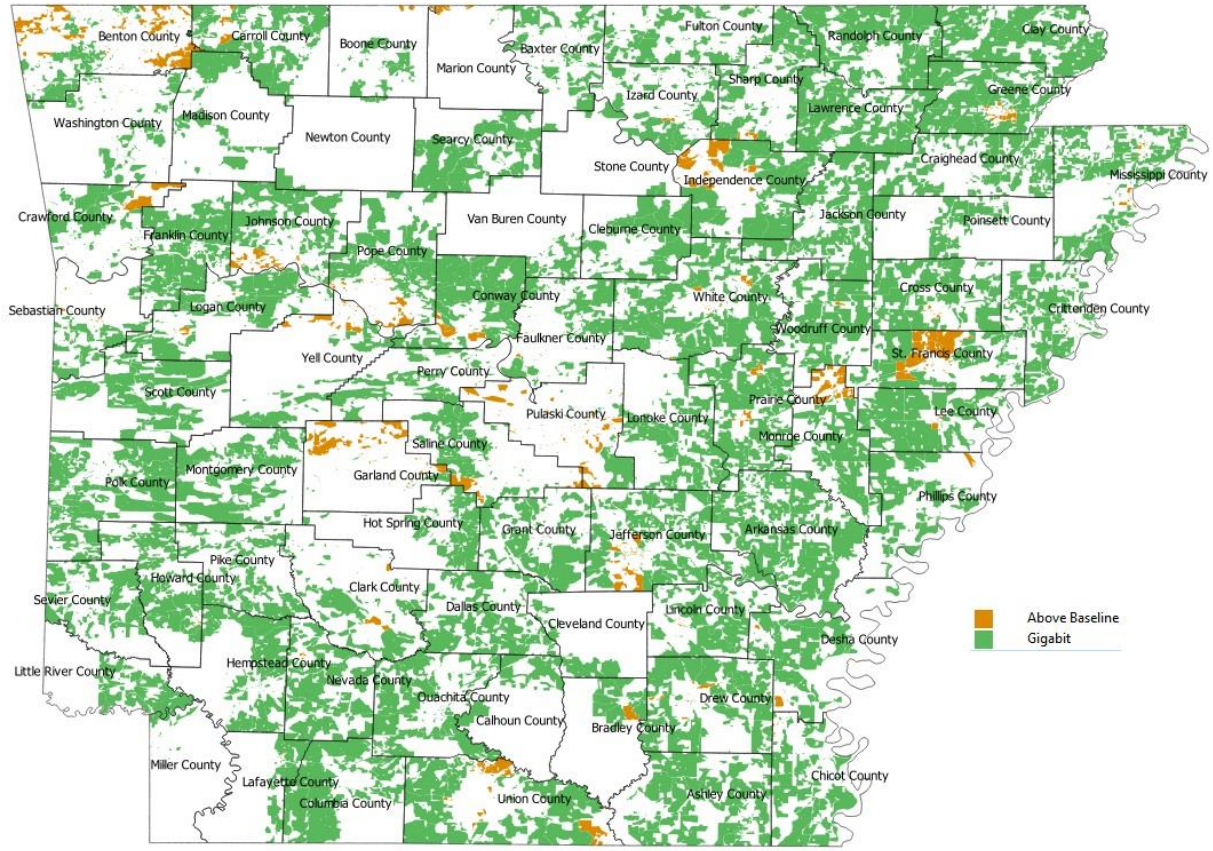
The FCC announced the results of the Rural Digital Opportunity Fund Phase I auction (Auction 904) today. At first glance, it looks as if the RDOF auction, with a little help from Arkansas Rural Connect, will solve most of Arkansas's digital divide problems. If all the service commitments made to the FCC through the auction are fulfilled by RDOF winner ISPs, RDOF will bring broadband to over 200,000 locations in Arkansas, comprising a large majority of the locations in Arkansas currently lacking broadband service. And the FCC achieved this while spending only $9.23 billion of its $16 billion budget. The rest of the money will presumably go towards the Phase II auction, more than doubling its budget to $11.63 billion. It looks increasingly likely that broadband deficiency will become vanishingly rare in the United States over the next decade.

RDOF winners have an obligation to deploy to the territories they won within six years of when the award is finalized. They should reach 40% of the locations awarded by year three, 60% by year four, 80% by year five, and 100% by year six. If there turn out to be more locations in the awarded territories than the FCC anticipated—this might occur due to miscounting or new development—the awardee has an additional two years to get all the remaining locations served. There are a few steps subsequent to the auction before support is finalized. One requirement that might be a barrier to some ISPs claiming their awards is a "letter of credit" that must be provided by the ISP to the FCC, committing a bank to

reimburse the FCC on the ISP's behalf if the ISP should fail to meet its milestones. This is an unusual requirement, the request for which banks sometimes find surprising, and ISPs often lack the kind of collateral that banks find it easy to recognize and value.

Arkansas did well. The overwhelming majority of areas that were targeted by RDOF got an auction winner, promising in all cases to provide low latency internet service at speeds of at least 100 Mbps download/20 Mbps upload, and in most cases, promising gigabit service. Of $9.23 billion in 10-year funding that was allocated, Arkansas got $424.2 million, or 4.6%, which may be compared to Arkansas's roughly 3% of the population lacking access to broadband nationwide. Figure 22 maps RDOF winners by service tier. Perhaps surprisingly, the slower service tier—which at 100/20 is still pretty fast—occurs both in remote rural areas and near urban centers in Pulaski and Benton counties.

Figure 22: Service tier offered by RDOF winners



Overwhelmingly, in Arkansas and nationwide, money for less than gigabit service went to SpaceX, which will get $88.6 million annually nationwide, including $1.24 million for Arkansas, in return for a commitment to provide broadband service at 100 Mbps download/20 Mbps upload speeds. In Arkansas, SpaceX won 17,725 locations, spread across 54 counties, with the most in Benton (2,896 locations), St. Francis (2,024 locations), Jefferson (1,609 locations), Pulaski (1,261 locations), Union (947 locations) and

Saline (866 locations) counties. While SpaceX, which plans to provide internet service through a fleet of low-earth orbit satellites, is an exciting technological venture, its RDOF victories must be regarded as somewhat disappointing for residents of the areas where it won, since they could expect to get SpaceX service anyway. Fortunately for Arkansas, SpaceX won only 2.9% of the RDOF funds for Arkansas, compared to 9.6% nationwide.

Meanwhile, over 180,000 locations that largely lacked even 25/3 service as of June 2019 can look forward to gigabit speed internet service becoming available over the next few years, from the ISPs shown in Table 4. Note that Table 4 shows the *annual* awards to each bidder, but since these awards will continue for ten years, total support is ten times more. The Rural Electric Cooperative Consortium, for example, can look forward to $179.4 million in FCC support over the next decade to bring gigabit speed fiber broadband to much of northern and western Arkansas.

Table 5: RDOF winner ISPs, by service tier, with total annual awards

	Tier				
RDOF Winner	Above Baseline	% of Above Baseline	Gigabit	% of Gigabit	Total
Rural Electric Cooperative Consortium			$17,943,759	43.74%	$17,943,759
Resound Networks, LLC			$6,011,177	14.65%	$6,011,177
Windstream Services LLC, Debtor-In-Posse	$6	0.00%	$5,693,442	13.88%	$5,693,448
Prospero Broadband Consortium			$5,092,158	12.41%	$5,092,158
NexTier Consortium			$3,225,579	7.86%	$3,225,579
Space Exploration Technologies Corp.	$1,238,331	88.66%			$1,238,331
South Arkansas Telephone Company			$1,138,725	2.78%	$1,138,725
CenturyLink, Inc.			$937,874	2.29%	$937,874
Segnem Egere Consortium			$648,597	1.58%	$648,597
Central Arkansas Telephone Cooperative,			$162,993	0.40%	$162,993
Cox Communications, Inc.			$143,066	0.35%	$143,066
HomeTown Broadband, Inc.	$142,423	10.20%			$142,423
Mountain View Telephone Company			$29,857	0.07%	$29,857
Wisper-CABO 904 Consortium	$10,086	0.72%	$407	0.00%	$10,493
Altice USA, Inc.	$5,842	0.42%			$5,842
Total	$1,396,687	100%	$41,027,635	100%	$42,424,322

The dominance of gigabit providers among RDOF winners applied in most but not all states. Table 5 shows, for all states, the share of RDOF funds that went to providers promising gigabit service. At 97%, Arkansas was in the top 20. A few states, such as Montana, Idaho, Utah, and Maine, will get relatively little gigabit speed internet from RDOF. Other Mississippi Delta states like Louisiana, Mississippi and

Tennessee got a lower share of gigabit speed commitments than Arkansas, but all RDOF funds in Oklahoma, Texas, and Missouri went to gigabit speed providers.

Table 6: Share of RDOF funding awarded to gigabit tier providers

State	% Gigabit
AZ	100%
IA	100%
MO	100%
ND	100%
NE	100%
OK	100%
SD	100%
WI	100%
KS	100%
DE	100%
OH	100%
TX	100%
IN	100%
CA	99%
HI	98%
MN	98%
IL	98%
AR	97%
WV	96%
MI	95%
SC	95%
KY	94%
NV	94%
LA	92%
TN	92%
MD	92%
GA	91%
MS	91%
NC	89%
VT	88%
NM	84%
AL	83%
CO	83%
FL	82%
PA	81%

NY	78%
OR	73%
VA	71%
MA	66%
NH	65%
WY	64%
WA	60%
ME	51%
ID	49%
MT	37%
UT	33%
CT	8%
MP	0%
NJ	0%
RI	0%

Table 6 shows the RDOF winners by the number of locations that they will be serving, with the support awarded per location won. On average, the support per location, at $2,114.57, is similar to though a little bit less than the grants awarded per household served for Arkansas Rural Connect, even though the speeds mandated by the FCC are much faster. On the other hand, the FCC's deployment timeline is much less hurried than what was required during Round 1 of Arkansas Rural Connect. SpaceX and other less than gigabit providers got much smaller awards per location than the gigabit speed providers.

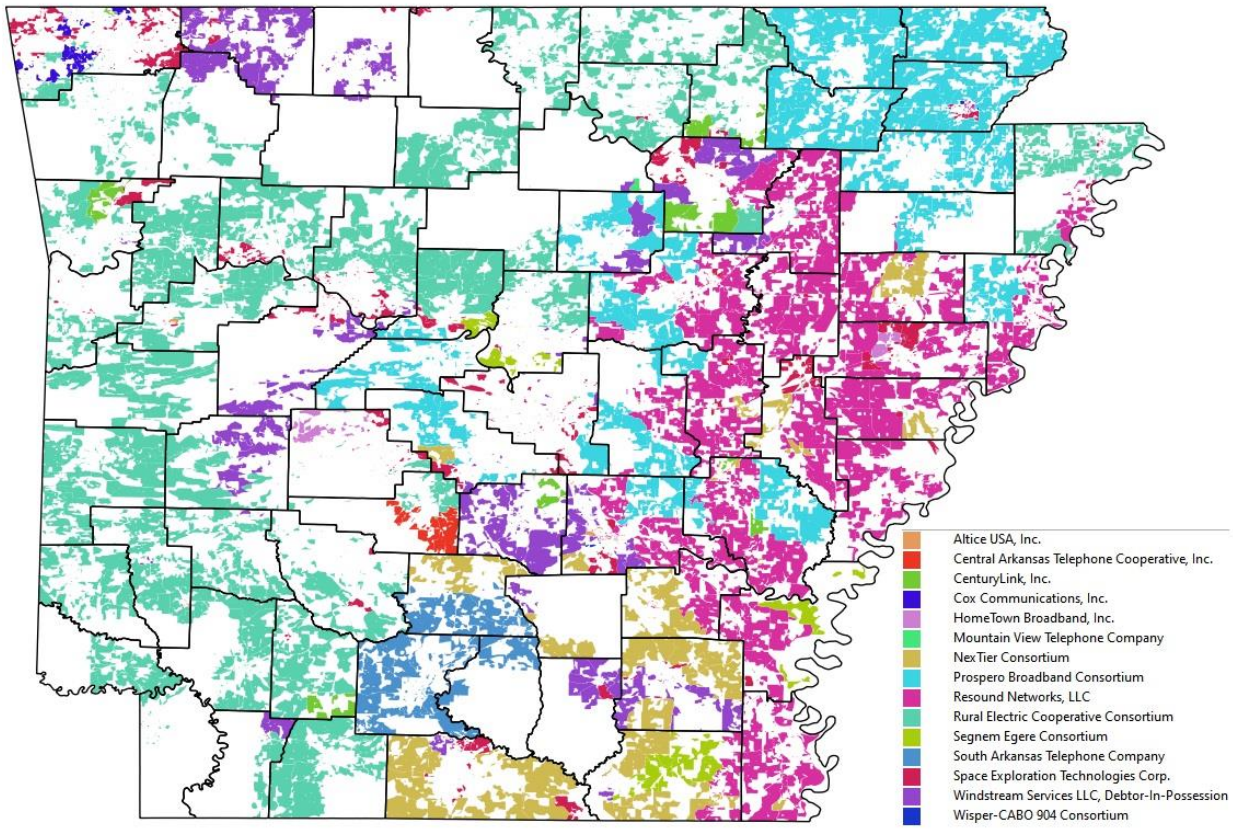
Table 7: RDOF winners by locations, with support per location

RDOF Winner	Locations	Support	% locations	% support	Support / location
Rural Electric Cooperative Consortium	73,018	$179,437,597	36.4%	42.3%	$2,457.44
Resound Networks, LLC	26,119	$60,111,774	13.0%	14.2%	$2,301.46
Windstream Services LLC, Debtor-In-Possession	19,172	$56,934,479	9.6%	13.4%	$2,969.67
Prospero Broadband Consortium	36,969	$50,921,581	18.4%	12.0%	$1,377.41
NexTier Consortium	10,739	$32,255,789	5.4%	7.6%	$3,003.61
Space Exploration Technologies Corp.	17,725	$12,383,309	8.8%	2.9%	$698.64
South Arkansas Telephone Company	5,093	$11,387,246	2.5%	2.7%	$2,235.86
CenturyLink, Inc.	2,958	$9,378,742	1.5%	2.2%	$3,170.64
Segnem Egere Consortium	3,335	$6,485,974	1.7%	1.5%	$1,944.82

Central Arkansas Telephone Cooperative, Inc.	1,004	$1,629,931	0.5%	0.4%	$1,623.44
Cox Communications, Inc.	1,665	$1,430,663	0.8%	0.3%	$859.26
HomeTown Broadband, Inc.	1,295	$1,424,229	0.6%	0.3%	$1,099.79
Mountain View Telephone Company	43	$298,572	0.0%	0.1%	$6,943.53
Wisper-CABO 904 Consortium	949	$104,926	0.5%	0.0%	$110.56
Altice USA, Inc.	528	$58,415	0.3%	0.0%	$110.63
TOTAL	200,612	$424,243,227	100.0%	100.0%	$2,114.75

Figure 23 shows the allocation of territories in Arkansas among RDOF winners. Unfortunately, the structure of the RDOF encouraged ISPs to bid through consortia, the names of which sometimes conceal the identities of the companies which comprise them. Some of the RDOF winners, such as Windstream, Cox, CenturyLink, CATC and SATCO are easily identified. But the Broadband Office currently has no information about the Prospero Broadband Consortium, which won large areas of central and northeast Arkansas, or the NexTier Consortium, a major winner in southern parts of the Arkansas Delta, and it is not allowed to inquire because of the FCC's "quiet period" rules, which will remain in force until the end of January 2021. The Rural Electric Cooperative Consortium, which dominated the CAF II auction in 2018, is one of the less surprising winners, yet its RDOF victories give a more definite shape to a future in which electric power and internet service will be provided by the same companies throughout much of rural western and northern Arkansas.

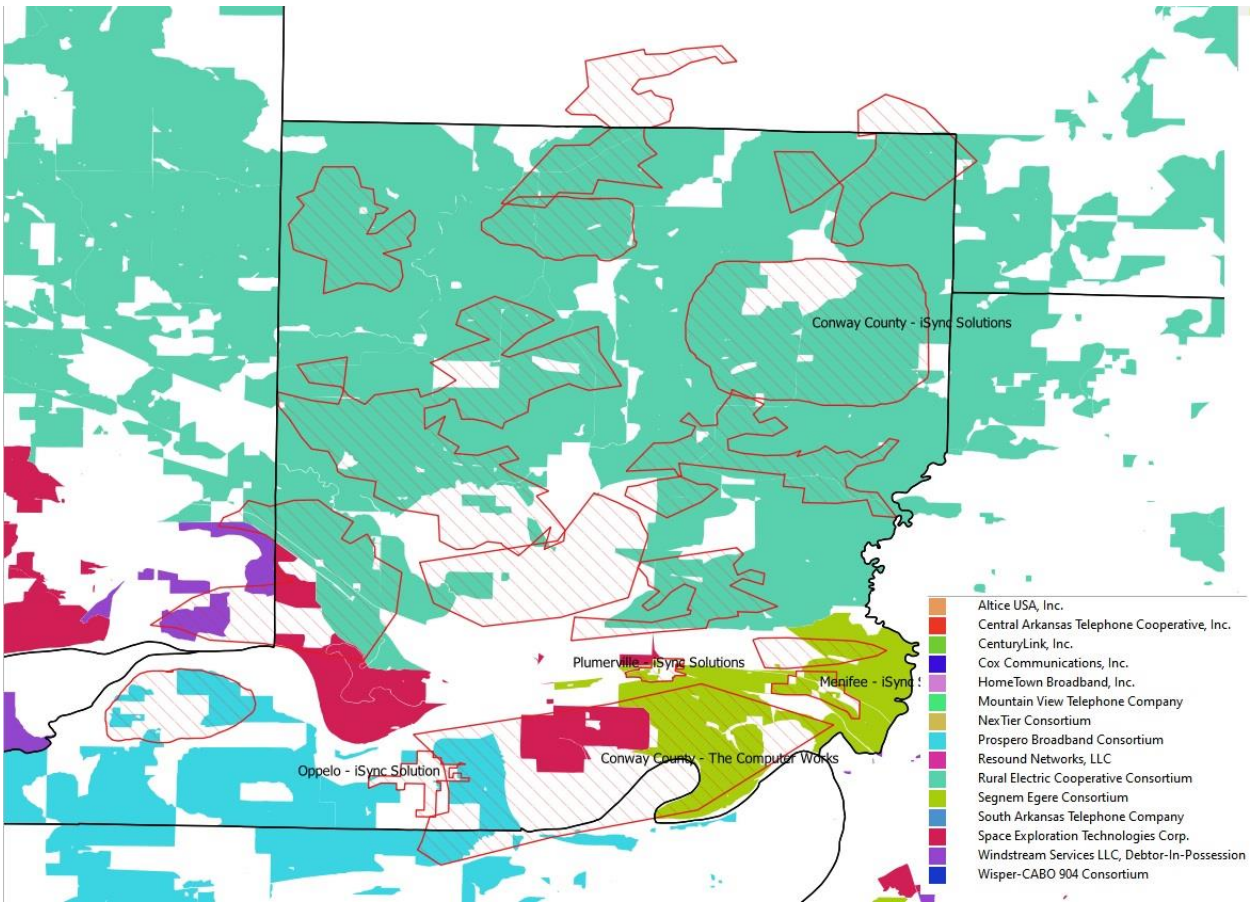
Figure 23: Allocation of areas among RDOF winners



Some of these RDOF winners may be causes for concern. Resound Networks, LLC, the biggest RDOF winner in Arkansas's Mississippi Delta, appears to be a Texas-based ISP. Previously, it had a small footprint in Texas and New Mexico, no presence in Arkansas at all, and a focus on fixed wireless technology. But Resound Networks has promised gigabit tier service, which is not typically delivered by fixed wireless networks. It seems likely that NexTier Consortium takes its name from NexTier Infrastructure Solutions, which seems to be not so much an ISP as a provider of upstream services such as engineering to ISPs. Arkansas should be alert to the possibility that ambitious but inexperienced companies may have overpromised to the FCC.

In some cases, ARC and RDOF awards overlap. Figure 24 shows an example from Conway County.

Figure 24: ARC and RDOF overlap in Conway County



In large areas of Conway County, a rural electric coop seems to have won support from the FCC to deploy gigabit speed broadband, while at the same time, Arkansas Rural Connect is funding either Natural State Wireless or The Computer Works to serve the same areas. Further south, the Segnem Egere Consortium has been awarded FCC support for some areas where Arkansas Rural Connect has funded service by The Computer Works. More positively, some areas where SpaceX was, unhelpfully, the RDOF winner, will get terrestrial fixed wireless service thanks to Arkansas Rural Connect.

Overlaps such as these are more or less contrary to the intent of both the FCC and the Arkansas State Broadband Office, yet FCC secrecy surrounding the RDOF auction, combined with the crisis-driven speed with which Arkansas Rural Connect executed its first round of grant funding, made it impossible to avoid them. The outcome is not necessarily bad. Residents of these overlap areas may benefit from competitive broadband offerings. It will be an unpleasant surprise for some ISPs, who will find themselves facing subsidized competitors that they might not have anticipated. A risk which should be borne in mind is that ISP who based their business case for a project on the expectation of more or less monopolizing a market may find they can't pay their bills with revenues reduced by competition.

2. USDA Programs

Community Connect Grants – The Community Connect Grants program offers financial assistance to applicants that will construct broadband networks to provide service on a community-oriented connectivity basis in rural areas. Eligible areas are rural areas that lack broadband service, and the funds may be used for constructing, acquiring, or leasing facilities, buildings, spectrum, or land used to deploy broadband services to residences, businesses, community facilities, or other customers.

The grant application window closes on December 23rd.

ReConnect Program – The ReConnect Program furnishes loans and grants to provide funds for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide broadband service in eligible rural areas. Over $1.3 billion has been awarded nationally from the two rounds of the program. Eligible areas are mostly rural areas that lack quality broadband service.

In Round 2 of the ReConnect program, Arkansas broadband providers were awarded $11.8 million to provide high-speed broadband in rural Arkansas. Those awards include the following:

Mountain View Telephone Company (MVTC) will use a $2.9 million ReConnect grant to deploy a fiber-to-the-premises network to connect 1,331 people, 39 farms, six businesses, two fire stations, and one post office to high-speed broadband internet in Stone County, Arkansas.

Northern Arkansas Telephone Company (NATCO) will use a $4.7 million ReConnect grant to deploy a fiber-to-the-premises network to connect 1,202 people, 68 farms, and six businesses to high-speed broadband internet in Marion County, Arkansas.

Arkansas Telephone Company (ATC) will use a $4.1 million grant to deploy a fiber-to-the-premises network to connect 491 people, 92 farms, and four businesses to high-speed broadband internet in Pope and Van Buren counties in Arkansas.

Distance Learning & Telemedicine (DLT) Grants – The DLT Grant program helps rural communities acquire technology and training necessary to connect educational and medical professionals with the teachers and medical providers who serve rural residents at the local level. Rural areas with populations of 20,000 or less are eligible for the program. The grant funds may be used for audio/video equipment; broadband facilities that support distance learning or telemedicine; computer hardware, network components, or software; acquisition of instructional programming; or acquisition of technical assistance and instruction for using eligible equipment.

In 2020, $72 million was available in the DLT program; however, Arkansas was not awarded any funds from the program.

Rural Broadband Access Loan and Loan Guarantee Program - Rural Broadband Access Loan and Loan Guarantee Program furnishes loans and loan guarantees to provide funds for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide service at the broadband lending speed in eligible rural areas. Eligible areas include rural areas that have at least 15% of the

households in the area to be unserved and have no more than three incumbent service providers in the area. Funds may be used for the construction, improvement, and acquisition of facilities required to provide service at the broadband lending speed including facilities required for providing other services through the same facilities; the cost of leasing facilities required to provide service at the broadband Lending speed if such lease qualifies as a capital lease under Generally Accepted Accounting Principles (GAAP); or an acquisition, under certain circumstances and with restrictions.

Currently, the program is closed and did not have any awards in 2020.

Telecommunications Infrastructure Loans & Loan Guarantees – The Telecommunications Infrastructure Loans & Loan Guarantees program provides financing for the construction, maintenance, improvement and expansion of telephone service and broadband in rural areas. Eligible areas are rural areas and towns with a population of 5,000 or less and that lack telecommunications facilities. The funds may be used to finance broadband capable telecommunications service improvements, expansions, construction, and in some cases acquisitions or refinancing.

Currently, the program is closed and did not have any awards in 2020.

Relevant Links

Brookings Institution. “Telecommuting will likely continue long after the pandemic.” April 6, 2020. https://www.brookings.edu/blog/up-front/2020/04/06/telecommuting-will-likely-continue-long-after-the-pandemic/

Richard Laermer at Think magazine. “I Let My Staff Work From Home, Then Realized It Wasn’t Working.” https://www.nbcnews.com/think/opinion/i-let-my-staff-work-home-then-realized-it-wasn-ncna814751

“Zillow, Redfin predict a ‘suburban boom’ in US real estate market as remote work becomes more common.” May/Sep 2020. *Seattle Post-Intelligencer*. Callie Craighead. https://www.seattlepi.com/coronavirus/article/zillow-predicts-suburban-boom-in-real-estate-covid-15281310.php

“Home offices separate, unequal.” *Arkansas Democrat-Gazette*, August 30, 2020. Elizabeth Patton. https://www.arkansasonline.com/news/2020/aug/30/home-offices-separate-unequal/

“Teleworking: the new normal?” *Arkansas Democrat-Gazette,* May 3, 2020. Melissa Tooley. https://www.arkansasonline.com/news/2020/may/03/teleworking-the-new-normal-20200503/

“Could Big Tech’s move to permanent remote work save the American heartland?” Brookings Institution. May 26, 2020. https://www.brookings.edu/blog/the-avenue/2020/05/26/could-big-techs-move-to-permanent-remote-work-save-the-american-heartland/

“CNN: Where Schools are Reopening in the US.” October 5, 2020. https://www.cnn.com/interactive/2020/health/coronavirus-schools-reopening/

“FCC Decision on 6 GHz Unlicensed Spectrum May Supercharge the Wi-Fi Industry, Fixed Wireless.” April 23, 2020. https://www.telecompetitor.com/fcc-decision-on-6-ghz-unlicensed-spectrum-may-supercharge-the-wi-fi-industry-fixed-wireless/#:~:text=The%20FCC%20today%20freed%20up,be%20deployed%20in%20rural%20areas.