THE OHIO STATE UNIVERSITY

C. William Swank Program in Rural-Urban Policy

FINDING THE MISSING DOTS: AN UPDATE ON OHIO BROADBAND POLICY

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April 2022

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Led by Professor Mark Partridge, the Swank Program combines innovative approaches in economic theory, planning, advanced statistical research, and geographical information systems to create products that can be used by the academic community, stakeholders, policymakers, students, and the public. In turn, the Swank Program will help inform and facilitate teaching and student research at Ohio State and elsewhere.

The Swank Program conducts and supports research, teaching, and outreach within the College of Food, Agricultural, and Environmental Sciences; the Ohio Agricultural Research and Development Center; and Ohio State University Extension.

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Executive Summary

Since the production of our 2017 policy brief, *Connecting the Dots of Ohio's Broadband Policy*, much has changed in the state and nation's broadband landscape. The last few years saw a rapid transformation of broadband use throughout America with almost every aspect of life now wholly reliant on digital technology. Streaming services such as Netflix and Hulu have increased their prevalence in our everyday lives, while other traditional entertainment services like cable and gaming transition to digital to capture a piece of the lucrative market. Meanwhile, telehealth and telework options have exploded, with the former now being a viable option for rural communities void of healthcare providers and the latter permeating almost every industry.

These rapid developments were only exacerbated by the onset of the COVID-19 Pandemic, as the public health crisis sent shockwaves through our daily lives and accelerated our reliance on quality broadband service. The impact was acutely visible throughout education, as school districts and universities had to quickly pivot to remote learning. As the immediate concerns of the pandemic subside, remote schooling, telework and telehealth remain viable paths for decades to come.

This accelerated digital revolution requires massive amounts of public funding to provide all Americans access to quality broadband services. Yet current funding still lags what is necessary to reach these goals. However, recent developments brought by the American Rescue Plan of 2021 and the Infrastructure Investment and Jobs Act of 2021 provide much needed money towards bridging the broadband gap and has given states latitude in how they utilize the funds, with Ohio focusing on grants for public-private partnerships. Facilitation of these funds has eased greatly because of the establishment of a statewide broadband office, BroadbandOhio (a recommendation from our 2017 policy brief).

However, more can be done. We recommend the following policies to facilitate broadband expansion and maximize the impacts of public investment in this critical service:

- Revise the formal FCC definition of broadband. With everyday tasks and applications being internet intensive, the current definition of broadband (25 Mbps upload/3 Mbps download) does not reflect the required speeds for proper usage. Required speeds are only likely to increase with technological change and new applications come online. We recommend, at a minimum, to revise the definition to 100 Mbps upload/10 Mbps download. However, we also acknowledge further revisions of the broadband definition down the line and suggest measuring broadband in terms of common task usage to be more resilient to technological changes in the future. If the FCC drags its feet in revising its definition, Ohio should create its own in terms of planning and future investments.

- Across the US, Ohio performs about average in terms of broadband/mobile quality, with Cincinnati, Cleveland, and Columbus being well above average among large US cities in terms of mobile

network speeds, but middling to below average fixed-broadband speeds.[1] But, we caution that even for Columbus, which ranked as having the 15th fastest mobile network speed among the 100 largest US cities, its speed is still below Bulgaria's average and barely above Croatia. In terms of cost, though comparisons are difficult, Ohio appears to have among the lowest fiber optic internet costs, below average DSL broadband costs, and above average cable internet costs. According to the Tax Foundation, Ohio's cell service taxes and fees are the 42nd highest, coming in at 8.52% in 2020, or about 4 percentage points below the US state average. Illinois had the highest tax rate of 22.37%.

- Increase competition among internet service providers. We acknowledge a major component of broadband access is affordability — a component stifled by lack of competition. To combat this, we suggest further regulation by the FCC to expand consumer choice and cultivate competition. We also encourage local governments to explore, invest, and operate their own internet service providers to counter market challenges that may inhibit private investment, as well as to provide needed competition to keep service affordable.

- The lax US regulatory environment has not unleashed a wave of low prices and high quality. As discussed in the Conclusion, US broadband and US mobile cell costs are well above the global average—e.g., one gigabyte (GB) of cell data costs an average of $3.33 in the US, $0.41 in France, and $0.52 in China. Yet, high US prices have not bought US consumers high quality broadband and mobile service. Across the board, China has better quality than the US in terms of download speeds. Countries like South Korea, Norway, and Sweden far outperformed the US, while even countries like Bulgaria tended to have better quality. In terms of download speeds in February 2022, the US ranked 9th out of 41 countries considered by the speed-test firm Ookla, which was a drop of 4 spots over the previous year. The US ranked an even more dismal 22nd out of 41 for mobile network download speeds. The US 5G network speeds were particularly anemic compared to global competitors, with speeds less than one-fifth of global leaders. Overall, countries with strict regulatory environments have less expensive and better internet service.

- Pair broadband investments with other work-training programs and investments. Previous research has shown a strong correlation between growth in high-skilled sectors and broadband infrastructure and quality. As such, we strongly encourage policymakers to pair rural broadband investment projects with workforce training programs that raise skill levels in lagging regions. We also suggest using federal and state funds for providing adequate devices for internet usage. Such investments should be especially aimed at school districts with large shares of students without at-home high-speed internet access. Access to these devices provide an opportunity to increase college or professional degree attainment for disadvantaged children.

[1]Quality variation across states and cities can be rather large. For fixed-broadband median-download speeds in February 2022, Ookla reported that New Jersey had the fastest speed of 178.3mbps, while Wyoming had the slowest speed of 61.7mbps. Ohio ranked 26th with a speed of 116.8 mbps, versus the US average of 146.2mbps. The corresponding figures for mobile median-download speeds, District of Columbia was number 1 at 100.4mbps and Mississippi was 51st at 28.1mbps. Ohio ranked 16th at 56.4mbps, compared to the national average 63.3mbps.

Introduction

In our 2017 Swank Program Policy brief, *Connecting the Dots of Ohio's Broadband Policy*, we assessed the state of U.S. and Ohio broadband internet access and policy. At the time, high speed internet was nascently viewed as core infrastructure, alongside traditional services such as utility lines and roadways. In the five years since, American life continues to go digital, including work, health, education, entertainment, and communication. This has raised the stakes for rural areas across the nation still lacking high-speed internet access at affordable prices, as individuals can no longer participate in modern society without having acceptable highspeed internet.[2] Likewise, businesses may face ruin without adequate internet availability. Poor internet service can debilitate economic development and quality-of-life in rural communities and can simultaneously plague urban neighborhoods that lack quality and affordable access. What is more, the Covid-19 Pandemic accelerated demands for high-speed internet as lockdowns in the spring of 2020 forced tens of millions of students to learn virtually, and a large fraction of the U.S. labor force to work remotely.

Broadband Needs Remain Unmet

At the advent of the "public" internet in the late 1980s, a smaller need and more simple applications met that broadband internet was more of an expensive luxury. Today, advancements in technology and shifts in how we work, go to school, interact with governments, and consume goods & services make broadband a practical necessity for full participation in American society. However, as we discuss extensively in this brief, broadband needs of many Ohioans go unmet.

First, investments in broadband infrastructure have drastically lagged the pace of technological innovation and public adoption. Policy goals based on technological standards and definitions a few years ago are obsolete by the time they are implemented. Indeed, in 2010, the Federal Communications Commission (FCC) revised its *minimum* definition of high-speed broadband download speeds – the minimum speeds at which users can acquire content from the internet— to 4mbps. Just five years later, it re-revised its definition to 25mbps—more than 6 times faster than its 2010 minimal definition. Evidence suggests that in 2022, an internet download

[2] We use the terms high-speed internet and broadband interchangeably throughout this brief. Refer to the section titled "What is Broadband?" for a technical definition of broadband, access, and affordability.

speed of 25mbps is already woefully inadequate for most users.

The second reason for unmet broadband needs provides an explanation for why this has been the case—there are many more users, doing more online than ever before. Internet usage by students, teachers, workers, parents, children, gamers, doctors, and businesses from banks to grocery stores has never been higher and many goods and services from healthcare to education and forms of entertainment such as cable-TV and movie purchases have moved toward streaming and away from alternative mediums. On the surface, these transitions and developments are positive and increase convenience and variety for consumers, while increasing productivity or reach for businesses. But the benefits of these transitions have been shared unequally, especially across geographic areas and by income class. Unequal investments in broadband technology and infrastructure have created inequities in both access and affordability for consumers. These disparities, referred to since the 1990s as the "digital divide," tend to manifest most prominently between high-income urban neighborhoods with rural communities and low-income urban neighborhoods. Most of the public and our focus is on the shortcomings in rural areas, but we will briefly discuss shortcomings in parts of urban areas.

Broadband Demand Increases

The impact of rapid technological advancement and increasing internet usage since 2017 motivates this update to our previous policy brief. For instance, maps that show areas with access to highspeed internet using the 2017 25mbps FCC standard vastly overstate highspeed-broadband availability when considering current needs for download speed (often at or above 100 Mbps). Beyond FCC definition changes, government investments to close the digital divide have received renewed attention in the last few years. For example, broadband is a highly touted component of the Infrastructure Investment and Jobs Act passed in 2021. The onset of the COVID-19 pandemic further changed broadband needs in ways that placed broadband squarely on the radar of policymakers, whose constituents demand access to affordable broadband internet.

As of 2020, the U.S. Census Bureau estimates that 81% of rural households and 86% of urban households have broadband access of any speed, leaving close to 18.2 million U.S. households without broadband access of any kind—a significant disadvantage when considering the growing needs for remote work, education, entertainment, government services, and business. When Covid-19 stay-at-home orders were issued in Spring 2020, 16 million students lacked access to reliable, high-speed

internet, with many falling behind their peers in learning—an educational cost that can disadvantage students for decades. Beyond school and work, households without broadband access are denied access to other services often assumed by policymakers. For example, President Biden and Vice President Harris both stated during the COVID-19 pandemic that Americans should "Google" to set up appointments for vaccinations, even as large numbers of Americans lacked the internet access to do so. Similarly, telehealth, a rapidly growing component of healthcare delivery, remains unavailable for the millions without high-speed internet service capable of reliably hosting video conferences with healthcare providers. The resulting disparities in broadband access and the subsequent inequalities in education, employment, and healthcare are a concern for local governments, employers, and schools.

Recent Government Investments

Governments have recently prioritized more funding for enhancing high-speed internet access to more people. In 2020, individual schools and local school districts utilized federal funds from the 2020 Coronavirus Aid, Relief, and Economic Security (CARES) Act to improve broadband access for underserved students. For instance, Ohio awarded $50 million in "Connectivity Grants" through BroadbandOhio to nearly 1,000 Ohio schools.[3] But these investments alone are insufficient given the scope of the problem. While $50 million may seem like a large investment, it equals only $4.50 per Ohio resident, meaning such efforts remain woefully inadequate. Perhaps the largest effort has come in the form of the 2021 American Rescue Plan (ARP) and the American Infrastructure and Jobs Act (IIJA). The IIJA alone allocated over $42 billion to states for broadband infrastructure investments, with Ohio set to receive hundreds of millions of federal dollars in broadband funding—though bear in mind that IJUA is spread out over multiple years, meaning many needs will go unmet.

Policy Recommendations

Given the rapid and drastic changes since our 2017 brief, including these major federal funding packages and state agency changes, we draw several important conclusions relevant for policy.

First, official FCC definitions of "highspeed" broadband have generally proven obsolete shortly after their enactment. As a result, public investments to meet current high-speed definitions are likely to be insufficient by

[3] BroadbandOhio, established in March 2020 by Governor DeWine, is housed within the state's Development Services Agency and seeks to increase "high-speed internet access to underserved and unserved Ohioans across the state." BroadbandOhio's creation established an office committed to increasing high-speed internet across the state, a key feature of the governor's Ohio Broadband Strategy.

the time they are completed. For instance, if the current government infrastructure investments just meet the current FCC high-speed internet definition (from 2017), it will be already considerably inadequate for today's needs. It is like building a highway that only meets one-fourth of the capacity needs of today. All of this under the unlikely assumption that broadband speed requirements don't further increase.

Second, policymakers should not only consider the physical infrastructure necessary for high speeds, such as fiber-optic cables that deliver broadband, but also improve competition by increasing the number of internet service providers (ISPs) for the public—especially in currently underserved areas. The current landscape often leaves consumers with relatively few ISP choices outside of major cities and lack of competition generally results in higher prices and less accessibility. Current official measures of access, such as considering an area to have sufficient broadband coverage when there is at least one provider, often ignore affordability and overlook reliability issues that can occur when ISPs lack competition to ensure network reliability.

Third, we welcome the recent increases in public investment into broadband access. Yet, the scale of investment is insufficient given the sheer scale of the needs, including affordability. Moreover, it is especially insufficient when considering that a rationale forward-looking investment strategy would account for *future* broadband requirements several years in the future (both in terms of increased speed and increase usage), not meeting backward-looking standards of the past.

Fourth, policy interventions that encourage alternative broadband delivery models are necessary. Specifically, municipalities, counties, or economic development districts may be the only viable delivery/provision option for adequate and affordable broadband in areas with low population densities or difficult terrain with greater construction costs. High construction costs spread over a small customer base in these areas deter private firms because of difficulties in recovering investment costs. Moreover public ISPs can enhance competition to maintain affordability. In this regard, Ohio fortunately avoided a potentially large roadblock in bringing reliable and affordable broadband to underserved areas when the 2021 General Assembly did not ban local governments from directly providing broadband services as was proposed in early bills. Such bills are very unwise given the market challenges some Ohio communities face.

Fifth, there is typically a myopic focus in broadband policy on providing adequate

broadband *fiber*. A related issue often overlooked is whether households, students, businesses, etc. possess adequate *hardware devices* to connect to the internet. Such devices include smart phones, tablets, laptop computers, and desktop computers with Ethernet ports and WiFi cards capable of utilizing higher internet speeds. If users lack access to such devices, then even the most expensive advanced broadband fiber cable is of little value, even if highly affordable. Thus, providing universal internet service requires users have adequate connectivity devices.

The remainder of this brief proceeds to discuss these issues in detail. We first provide a summary on the overall economic impact of broadband, and specifically on employment. Next, we offer an overview of the increasing intensity with which households and businesses use the internet in nearly all facets of daily life. We then reflect on the COVID-19 pandemic and ongoing shifts to remote work and digital education—trends which are likely to continue, particularly for high-skill jobs and education. Finally, we will explore broadband trends in Ohio and a more detailed overview on federal and state investments in broadband infrastructure.

Defining "broadband" and "access"

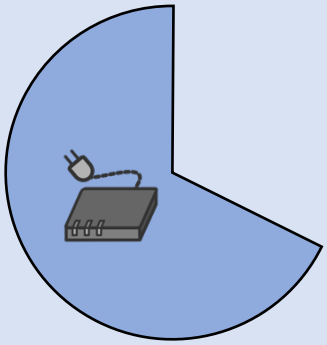
The word "broadband" is a marketing term used to refer to high-speed internet access. The U.S. Federal Communications Commission (FCC) sets the technical definitions for broadband quality. Early in the internet's history, "broadband" simply referred to faster internet than dial-up, which was notoriously slow and utilized phone-lines. Now, most broadband uses dedicated lines and provides faster download speeds. Increasing technology and needs have led to revisions to the definition of *high-speed* broadband over time. Here, we define terms crucial to broadband policy discussion and this brief.

1. **The FCC measures broadband with upload speeds and download speeds.**

Upload speed *is the rate at which users can send information to the internet. For internet access to be considered broadband, they must have upload speeds at least 25 megabits per second (mbps).*

Download speed *is the rate at which users can access internet content. For internet access to be considered broadband, they must have download speeds at least 3 mbps.*

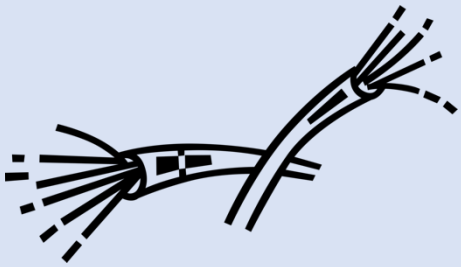
2. Most broadband technologies today are fixed, wired services delivered on legacy infrastructure.



*Wired broadband is delivered over copper wires by phone companies and coaxial cables by cable TV providers. This form of broadband accounted for **nearly 70% of all household internet subscriptions** in 2017.*

3. Fiber optic cables are growing in popularity, but the technology is still scarce.

Similar to electric cables, fiber optic cables contain one or more optical fibers that are used to carry light. They can deliver extraordinarily fast speeds and are largely futureproof. However, as of the start of 2020, only four internet service providers (ISPs) offer fiber-optic internet plans to at least 30% of their customers.

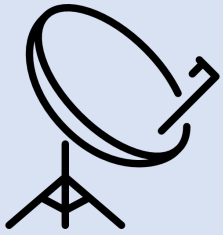


4. Another form of broadband internet connection is mobile.

Mobile internet connection is delivered by cell phone towers to smart phones or hotspot devices, which allow other devices to connect to the mobile service. Speeds for so-called 4G LTE cellular connections can range from 15 to 20 mbps. 5G mobile networks offer, in some cases, up to 1 gigabit (Gb) speed.

5. Between the two technologies of fixed broadband and mobile networks sits fixed-wireless.

Fixed wireless systems use radio frequencies to provide service to users in a defined geographic area. Customers receive the internet signal via an antenna connected to a router. This form has been proposed to bridge the "last mile" – in other words, getting service to specific households and neighborhoods that don't have the established infrastructure for other forms. Like cell or satellite service, such technologies have shortcomings in hilly or mountainous terrain.



6. **Broadband access refers not just to physical infrastructure, but also to affordability and having appropriate devices.**

Access goes beyond physical cables or radio infrastructure. It also includes affordability and connectivity components. It means little if households have access to physical infrastructure with fiber-optic internet speeds but cannot afford the price or lack appropriate modern devices (computers, tablets, phones, modems, and routers) capable of utilizing it.

7. **A major factor in broadband access is the number of providers in a region.**

According to 2021 FCC data, just three ISPs (AT&T, Comcast Xfinity, and Charter Spectrum) offered service to more than 30% of the U.S. with Verizon, CenturyLink, and Frontier offering service to more than 10% of the U.S.

Less competition among ISPs generally leads to higher prices and likely lower quality, impairing access for many households and leaving them with few choices.

The Economic Impact of Broadband

Broadband's Value to Consumers

Although some policymakers are skeptical about the ambiguous relationship between broadband access and economic growth, a growing body of research concludes it has positive economic value for consumers. On a national scale, estimates of the increase in value of broadband to consumers—if access were to become truly universal across the United States—are as high as $351 billion per year, or about 1.5% of annual GDP. Wireless internet (Wi-Fi) has become a major form of consumer access both at home and in public, with businesses such as McDonald's to Starbucks providing free Wi-Fi access. A September 2021 economic study commissioned by the Wi-Fi Alliance, a global non-profit aimed to improve user access to wireless internet, estimated that by 2025 the global economic value of just *wireless* high-speed internet will be nearly $5 trillion for all households. While studies conducted by advocacy groups should

always be taken with a grain of salt, it is fair to say the impact is large. Another 2021 study commissioned in part to quantify the economic impact of individuals transitioning to work from home estimate a 1.1% earnings-weighted productivity increase from a shift to increased telework — implying an annual GDP gain of $160 billion and a $4 trillion lifetime increase.

When examining broadband access through the lens of individual consumers, we see why the national numbers are so high. The Internet Innovation Alliance, a broadband advocacy organization, estimated in 2015 that the average consumer could have realized more than $9,000 in savings through receiving more information, and increasing both convenience and competition among online sellers. With the growth of digital retail platforms like Amazon and the increase of grocery and restaurant applications such as Instacart and Doordash, savings are likely even higher today and beyond.

A second common approach economists use to value broadband economists is to compare how much a consumer would be *willing-to-pay* for a service as compared to what they actually pay. If a consumer is willing to pay more than their actual bill for internet service, this is known as consumer surplus and measures the gain to consumers from having an available service. Dutz et al (2009) estimated consumer surplus from home broadband use to be approximately $500 per subscriber. In 2012, Greenstein and McDevitt updated that estimate to $1,500 in consumer surplus per US broadband subscriber (or about $1,900 in 2022 dollars). Given the rapid increase in usage by the average household for remote work, services such as healthcare and entertainment, and retail and grocery goods, consumer surplus figures to be substantially larger in 2022 than a decade ago. Indeed, based on our 2017 estimates, it is likely that the consumer surplus to individual households now conservatively exceeds $2,000 per year.

Broadband and Economic Growth

Many proponents now consider broadband to be an essential utility to support economic development, especially in rural areas lagging in economic growth. They argue investments made to expand broadband access ultimately serve to attract companies into the region and help existing companies grow. These argued benefits are not always obvious. While expansion of broadband to rural regions does have positive impacts on competitiveness and economic growth due to expanding markets for rural firms, broadband also exposes rural firms to greater competition from online retailers and urban “brick and mortar” competitors—e.g., it may expand competition from Amazon. While rural firms may also experience productivity gains, such as those found by Kolko (2011), higher data speeds may also enable outsourcing

of operations to urban areas. Indeed, Kolko notes that even if firms were to adopt broadband and related technologies to increase productivity, the net benefits in terms of employment could be in regions where broadband is already more widely available.

The question of employment increases due to broadband is important and nuanced. Gillett et al. (2006) and Stenberg et al. (2009) conclude that ZIP codes with more broadband providers experience statistically higher local employment. Additionally, Crandall et al. (2007), Van Gaasbeck et al. (2007) and Shideler et al. (2007) use active per-capita broadband lines, county-level surveys, and provider infrastructure measures to conclude a net-positive local-employment effect. However, one should keep in mind that even if these studies are accurate (for which we have no reason to believe they are not well done), they are reporting the expected effect for the *average community*. It very well could be that such *actual* effects are negative in some local cases.

These results should also be evaluated carefully because of the statistical problem of "correlation is not causation." *It is not statistically clear if the broadband expansion observed in these studies is what causes economic growth or if ISPs expand to communities that are already experiencing increasing employment*. Recent studies use more advanced statistical methods to draw conclusions about whether enhanced broadband speeds *cause* increased economic growth. However, such studies have found little evidence. Even here, such recent studies employing the most advanced economic statistical approaches may be outdated, given how the intensity of internet use continues to increase, as well as the disruptions from the COVID-19 pandemic that promoted more remote work. Nonetheless, the evidence that supports large benefits to increased broadband access is more from the gains to households than businesses.

Broadband studies often generally do not account for how the economic gains of broadband expansion are realized. Even if broadband positively impacts a community's employment, it is unclear if these new jobs or any associated wage increases are realized by existing residents or by new residents who move to the region. For example, it may be new residents that possess sufficient technical skills that benefit from enhanced utilize broadband technologies. In other words, the intended local beneficiaries promised the gains of broadband expansion are *not* the actual beneficiaries. Indeed, Mack and Faggian (2013) find that skill composition of rural areas play a crucial role in whether not the region experiences employment gains from broadband expansion. They find that the positive employment effects occur in rural counties with high levels of

educational attainment and a high share of workers *already* employed in high-skilled occupations. Once they statistically account for these local skill differences, the effect of broadband has offsetting negative employment effects. This provides some evidence to support the idea that extending broadband to at least some rural areas may reduce employment as firms outsource jobs to urban areas or substitute technology for workers. Even so, Briglauer et al. (2019) find that although some broadband aid programs may have no net effects on job creation, there is evidence to suggest that increased access helps protect rural areas from depopulation—probably due to the "amenity" effects for households that increase their willingness to remain in rural areas.

Finally, as we noted in 2017, a common argument for broadband expansion is that it promotes entrepreneurship. Kim and Orazem (2016) test this idea but ultimately find that the positive effects on new firm creation is concentrated in larger rural towns and specifically those closer to metropolitan areas.

Nonetheless, broadband expansion appears to improve the economic prospects of women. Conroy and Low (2021) find that broadband access plays an important role for rural non-employer businesses (i.e., with one self-employed owner) without a storefront and allows these small businesses entry to nontraditional markets. Noting these businesses are more likely to be owned by women, broadband appears to support the creation of female-led business startups in rural areas.

In summary, broadband can be effective as an economic development tool in some rural areas. Specifically, it can increase entrepreneurship in specific types of industries and may increase employment in more skilled and heavily populated rural areas near metropolitan areas. Furthermore, there is some evidence it may help insulate rural areas against depopulation. In other rural regions, additional economic development efforts such as workforce skill development or support for entrepreneurship may be necessary to offset the adverse effects from firms adopting technologies to outsource or replace workers. Again, if rural population retention is a key factor, it is gains to household quality-of-life that allows many residents to stay in their rural communities, who in turn allow local businesses to remain open and rural public services such as schools to continue to be provided

Growing Demands for Internet Usage

More people and households use the internet every day in nearly every aspect of their lives. Advancements in technology – not just in broadband but in computing power, storage, and cloud-based services have combined with structural shifts in how society consumes and uses the internet. High bandwidth activities such as for video streaming, once solely dominated by Netflix (currently 214 million subscribers), have increased to include other companies seeking a share of the lucrative market. Many film and TV studios such as HBO and NBC have launched streaming services within the last two years as they pivot away from their traditional markets. The best known example is the multimedia conglomerate Disney, who launched Disney+ in November 2019, which ended 2020 with 73.7 million subscribers and added another 90-plus million in 2021. But it is not just movie studios that made the digital transition. With record numbers of Americans "cutting the cord" on high-priced cable TV subscriptions, low-cost alternatives such as YouTubeTV and Sling offer streaming services that include the same TV channels as cable and offer live news and sports. While these services give viewers access to millions of titles and lower prices than traditional media, streaming TV and movies requires households to have more bandwidth and higher internet speeds.

The last decade has also seen rapid increases in other video streaming services. Research by software company Zyro found the world spends over 142 billion hours on YouTube a year with an average visit duration of 23 minutes. Indeed, users on YouTube can watch highlight reels of popular sporting events, news clips, "how-to" videos, and even tutorials to help with math homework. Other websites have also seen dramatic viewership increases. Twitch, a website that focuses on live video game streaming, has doubled its viewership from 3.1 billion hours in the first quarter of 2020 to 6.3 billion hours exactly one year later. The increase in video streaming has not gone unnoticed. In The 2019 Global Internet Phenomena Report, intelligence company Sandvine estimated video streaming takes up 60.3% of all internet traffic, far ahead of the next largest share, web browsing (13.1%). Experts say this number is set to increase, as video-streaming usage continues to grow.

Alongside higher numbers of video-streamer viewers, video-streaming's technology is improving. For example, TV, computer, and phone screens are measured by the number of pixels that combine to create a screen image. High-definition (HD) screens (screens that

display just over 2 million pixels) are quickly becoming replaced by 4K displays with nearly 8.3 million pixels—and 8K screens with 33 million pixels are on the horizon. The increase in pixels represents a technological improvement that dramatically increases the image quality as well as the internet bandwidth needed to stream those displays. To stream a 4K movie or sporting event requires more data to be downloaded than a high-definition movie, which requires more data in turn than a "standard definition" movie with lower quality. These technological advances in screen technology and streaming services have a direct impact on consumers' internet needs. A connection speed of at least 5 Mbps is needed for HD video streaming but increases to at least 25 Mbps for 4K video and is estimated to at least be 50 Mbps for 8K video. And even more need in the future.

Growing internet usage is not limited to entertainment. Telehealth has long been considered an important tool to increase healthcare access for rural communities. It is now widely used across the United States as consumers and providers sought safe ways to utilize basic healthcare during the COVID-19 pandemic. While telehealth utilization is below its April 2020 peak, there are signs that it will remain a viable option for years to come. Since June 2020, telehealth utilization has remained constant, with 13 to 17 percent of all office and outpatient visits occurring via telehealth. These increases are most evident within counseling and mental health appointments, where half of all appointments in February 2021 were via telehealth.

A large factor in the sustained use of telehealth services are temporary measures that made telehealth a viable and legal option for Medicaid patients. Many state legislatures though, noting its efficiency and convenience, have moved to make these measures permanent. Arkansas and Colorado, for example, approved laws to extend Medicaid coverage to behavioral health and substance abuse services provided remotely. Ohio passed The Telemedicine Expansion Act in December 2021, requiring both public and private insurance to reimburse medical providers for telehealth services. The act additionally prohibits insurance companies from requiring co-payments for telehealth patients that exceed comparable in-person co-payments. Given the more friendly regulatory environment and sustained usage of telehealth over the last two years, it's clear telemedicine will remain a viable option for many Americans, inevitably leading to increased bandwidth usage and intensifying internet utilization.

Overall, the increasing strain on home internet bandwidth of larger downloads for entertainment service and shifts in fundamental services like healthcare toward video

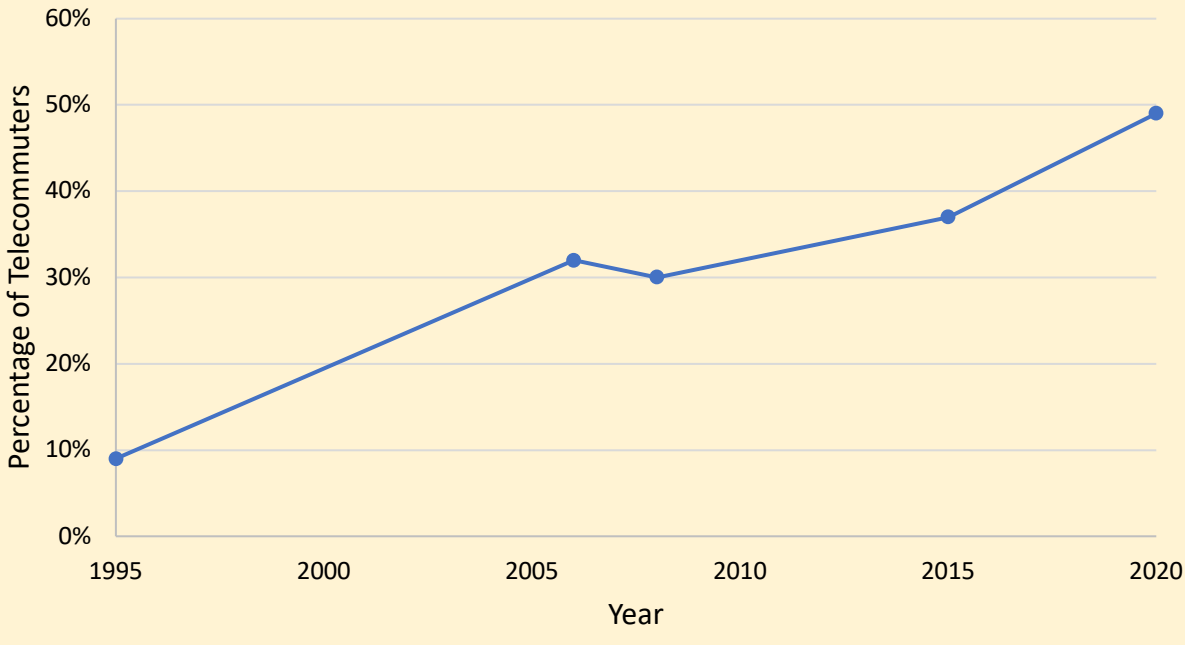
conferencing have increased the need for high internet speeds. But even these large shifts pale in comparison to two of the more seismic shifts: the increasing prevalence of work from home (WFH) arrangements and remote learning for students. Both trends pre-date the COVID-19 pandemic but they dramatically accelerated in 2020. Although there has been some drop-off since the early days of the pandemic, existing data indicates that work from home will remain much more prevalent post-COVID pandemic. We explore these trends, with special attention to the impact of the pandemic, in the following section.

COVID-19, Work from Home & Education

Changing Needs from COVID-19

The unexpected onset of the COVID-19 Pandemic in early 2020 greatly altered the broadband landscape. Yet even before March 2020, work from home (remote work) was growing in popularity. Surveys of American workers by Gallup show a dramatic increase in remote work, as internet speeds and technological advances improved. For instance, in 1995 only 9% of workers reported ever telecommuting. By 2006, employees who had experience working remotely increased to over 30% and has continued to steadily increase since 2008, rising to nearly 50% by 2020.

Figure 1 - Percentage of workers who have ever telecommuted[1]



[1] Data based on the question "Have you ever telecommuted, that is, worked from your home using a computer to communicate for your job?" **Source:** Gallup's Work and Education poll (2020)

Research conducted by the firm Global Workplace Analytics estimates that even before the pandemic struck, 5.7 million Americans worked remotely in 2019 – nearly 4.1% of the workforce. Using the 2015 American Time Use Survey, the U.S. Bureau of Labor Statistics (BLS) reported that nearly 24% of employees did some or all their work at home. The corresponding percentage of remote work nearly doubled to 42% according to the 2020 time-use survey. These trends were intensified by the COVID-19 pandemic, where 35.4% of all workers worked almost fully from home because of the pandemic in May 2020. While the number of employees who work from home full-time decreased to 11.1% in December 2021, this represents a large increase over pre-pandemic levels where remote work was more often part-time. For example, when the BLS began collecting data in July 2020, 26.4% of workers teleworked at least some of the time due to the pandemic, falling to only 13% in February 2022, nearly two years after the pandemic began.

Additionally, there is emerging evidence employees now greatly prefer the flexibility provided by work from home arrangements. Global Workplace Analytics reports that 56% of U.S. employees prefer a job with at least some remote-work over an entirely in-person job. Nearly 82% of U.S. employees prefer to work remotely at least once a week, with the median worker preferring to work from home roughly half the time. Remarkably, only 8% of workers prefer working entirely in-person. The growing popularity of remote work will continue to challenge the adequacy of the nation's broadband infrastructure, especially as work tasks become more data demanding with video calls and cloud-based services that stream over the internet.[4]

The challenges of the last few years increased the demand for higher-speed broadband. While previous standards for speed may have been adequate a decade ago, modern online-meeting software strains these "low" broadband bandwidths. For illustrative purposes, consider Zoom—one of the most popular remote-meeting platforms used by companies and schools. Zoom recommends that both video callers in a two-person meeting should have a downstream connection speed of

[4] There are several additional consequences from these ongoing shifts to remote work. First, less time spent commuting and more time for harried workers to spend with their family improves worker quality-of-life. Hence, nonemployed individuals would be more likely to enter the labor force because long-commutes would be less of a hinderance, which would help alleviate existing "labor shortages." i.e., enhanced broadband infrastructure helps increase labor supply. Second, one of the largest deterrents for city living is long commutes. Remote work improves urban quality-of-life, helping cities retain residents who may have instead migrated to smaller cities/rural areas in response to Covid-19. One implication is that the public and many policymakers hold the unproven belief that enhanced broadband will attract footloose residents to rural areas and small cities because of a growing desire for a more "slower" lifestyle. The actual outcome may be the reverse.

1.5-3.0 Mbps to ensure successful calls. On the surface, this may seem like a trivial requirement when 25Mbps speed is the minimum necessary to qualify as high-speed by the FCC. However, when we look deeper there are complicating factors for this assumption:

1) 1.5-3.0 Mbps is required for **one** individual on an average Zoom call to another colleague. If that individual is instead participating in a larger meeting with multiple video feeds or is simultaneously completing other online tasks such as accessing data portals, virtual chatting, or using email, capacity constraints become more problematic. Moreover, for larger meetings, the additional broadband needs apply to each participant—the quality and productivity of a call depends on everyone having access to adequate high-speed internet.
2) The speed advertised by internet service providers (ISPs) is not always the actual point-of-connection speed. One reason is that as more users draw broadband capacity, the network becomes more sluggish. Another reason is that some ISPs engage in "throttling," or reducing speeds during peak-use times (such as during the work/school day). ISP's data limits are another cause of throttling. If a household hits their data limit, the ISP throttles their account to free up bandwidth for others. Additionally, advertised speeds assume the user is on a device hardwired to the modem, where service enters the household. Users on Wi-Fi often experience up to one-third lower speeds throughout their home on Wi-Fi versus what they are paying for.
3) Bandwidth is also sucked up when users connect added devices such as tablets, smart phones, televisions, or game systems to the same network. In many households these devices are always connected and always on, even in rest modes, and consume bandwidth with automatic updates and downloads that users may not be aware of.
4) Other adults and children in the household who are working from home or attending school remotely over the same network will have similar data needs, causing serious congestion and strain on internet speeds in a household.

Considering this, it is easy to imagine a scenario when an ISP's advertised 25 Mbps speed would prove insufficient for a household with two remote workers. Capacity constraints would be increasingly reached for the same reasons described above—e.g., two large-scale Zoom meetings held on Wi-Fi, with multiple

phones or tablets connected. Additionally, if there are children at home who are either engaged in online school or streaming video, congestion increases even more. This can be frustrating for users as the household's remote workers would face a growing inability to join meetings, be forced to close other online applications, turn off other devices such as phones, and to reboot equipment such as routers and modems to try and free-up bandwidth.

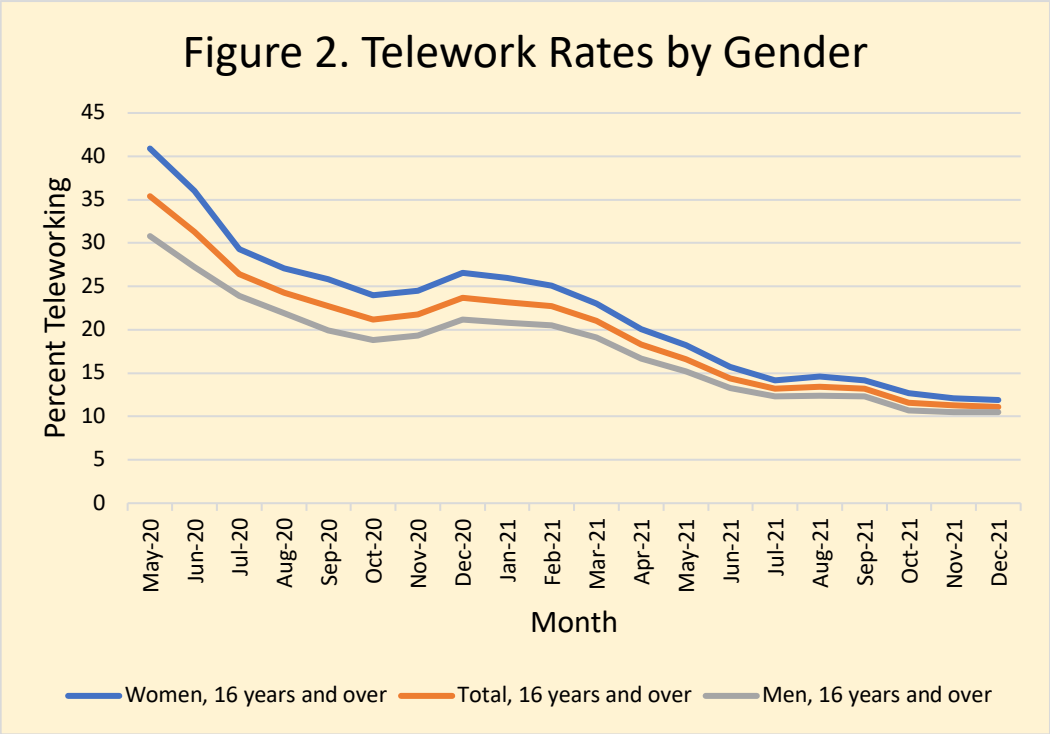
Now imagine if this hypothetical family resides in an area lacking access to high-speed broadband. The two remote workers would experience sharp productivity declines and may not be able to work remotely or even work in that job. Conversely, it is apparent why regions with especially large broadband capacities would garner an economic development edge due to growing preferences for remote work. In fact, given urban areas generally have faster broadband, they would especially benefit due to ongoing remote-work trends, placing rural areas (and underserved urban neighborhoods) at a greater disadvantage. And if urban areas experience faster economic growth, their growth further encourages broadband ISPs to add even more urban capacity, further supporting more remote work in *urban areas*. Indeed, the growing trends in remote work could, in some regions, exacerbate the digital divide rather than close it. **This underscores the need of governments at all levels to make serious investments in broadband access and affordability and to plan current investments to meet future broadband-capacity needs.**

Broadband's Impact on Local Labor Markets and Economies

The increasing trend in employees working from home has broader consequences for the workforce. Greater opportunities for remote work likely improve employee morale due to better home-work balance, reduced monetary commuting costs, leisure time freed up from less commuting, and greater childcare flexibility. But the benefits of work from home aren't just accrued by the employee. Though companies may lose some ability to monitor workers, positive effects on employee satisfaction likely reduce turnover. Companies in nonmetropolitan areas may more easily recruit and hire high-skill workers from higher population regions. In some cases, remote work may allow companies to pay relatively lower wages than competitors through a compensating differential due to the fact that poor worker satisfaction or working conditions are generally associated with higher wages to attract employees. Overall, increasing remote-work opportunities appears to be a net positive for many workers and firms.

The overall trend in remote work is not necessarily positive news for all workers, however. The pandemic revealed important

disparities in the labor market across different demographic groups. During the pandemic's first year, there was a sizable gender gap in remote work, with women 10% more likely to work from home. More investigation is needed to identify the precise forces driving this trend, though childcare challenges and differing occupation composition across genders appear to be primary causes. The gender gap in the remote workforce should be a consideration as policymakers evaluate the role of work from home and invest in high-speed internet. Considering which types of jobs can become virtual as well as the impact of the availability and affordability of other services like childcare will be crucial. Additionally, employee skills and the nature of the job play large roles in work from home trends.

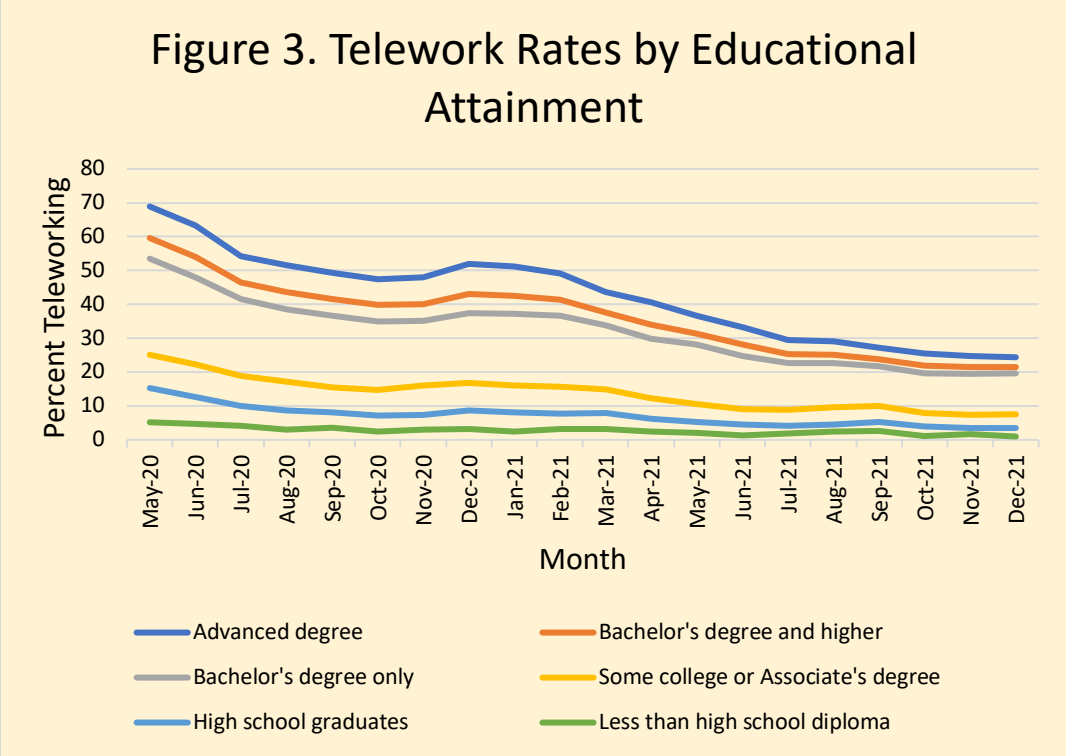


Source: Bureau of Labor Statistics' Current Population Survey. May 2020 – December 2021.

High-Skill Jobs are More Likely to Be Remote

Educational attainment is strongly linked with increased remote work. This trend is likely driven by the fact that jobs which require advanced degrees or skills, such as software development, web-design, legal services, or data analysis, are more often service-based and can be more easily done virtually. In May of 2020, 70% of advanced-degree holders worked remotely followed by 65% of employed bachelor's degree holders. Only about 15% of workers holding only a high school diploma worked remotely. Though the rate of telework has decreased overall, data from December of

2021 shows that these gaps persist and advanced-degree holders remain 2 to 3 times more likely to work from home.



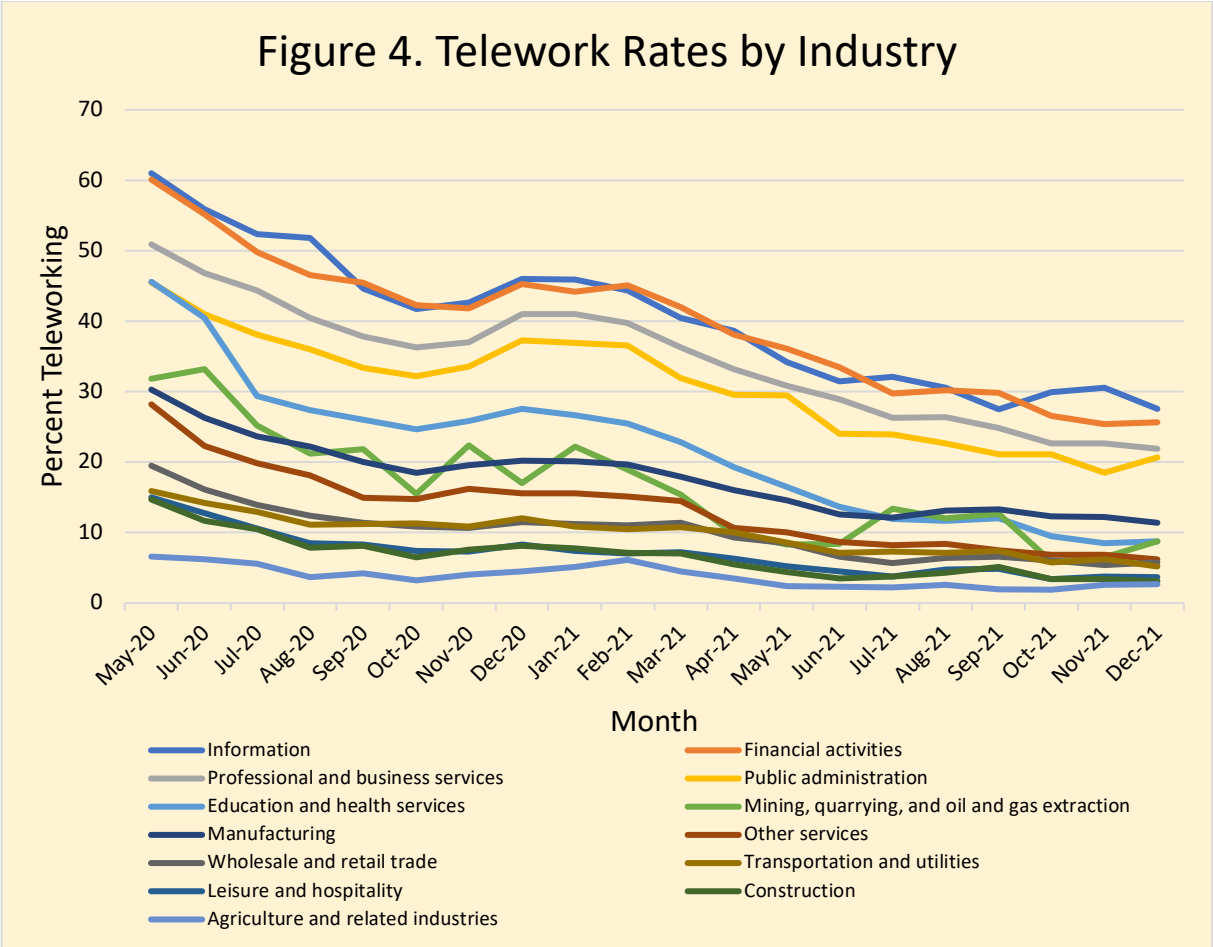
Source: Bureau of Labor Statistics' Current Population Survey. May 2020 – December 2021.

A portion of this gap in May 2020 is likely linked to the distribution of jobs that firms deemed "essential" in deciding which workers needed to be in-person as the pandemic began. Essential workers are typically less-educated frontline employees who are concentrated in grocery stores; warehousing; delivery; personal services such as cooks, housekeepers, and orderlies; and food-processing production workers such as in meatpacking. Other jobs such as construction require employees to be on site by their very nature and such positions are typically held by less-educated workers.

The type of industry also greatly impacts the ability of their employees to work from home. Information and financial sector jobs, which also generally require a four-year college degree or above, have a much higher propensity for remote-work (60% were remotely working near the start of the pandemic). Other industries like construction, transportation, and agriculture had much lower shares (25% or less working remotely near the start of the pandemic).

As the pandemic progressed, the share of remote workers steadily declined from April-

May 2020 peaks, falling from 35.4% to 11.1% at the end of 2021. Even so, some gaps remained between men and women, across levels of educational attainment, and across industries.



Source: Bureau of Labor Statistics' Current Population Survey. May 2020 – December 2021.

Generally, remote work patterns remained above their pre-2020 levels at the end of 2021. A major factor for some workers was their children's school and childcare status. Indeed, the value of in-person schools was shown during the pandemic as many children shifted to remote learning throughout 2020, nearly requiring at least one parent to work from home and often to provide supervision and support to their students.

Remote Schooling and Broadband Access

Even prior to COVID-19, school curriculums increasingly relied on students having home access to reliable highspeed internet for research, workbooks, videos, and completion of assignments. Developing technological skills and the ability to retrieve and analyze information from the internet is a prerequisite for American students to compete in the global economy. The pandemic reinforced these

trends, supporting the notion that ***having*** *quality broadband service—not just having* ***access*** *to quality broadband*—is becoming a necessity for student success.

A first-order development induced by the pandemic was the sudden mass transition to virtual schooling because of stay-at-home orders. Not every worker shifted to remote work during the COVID-19 pandemic— but nearly every student learned virtually. According to a Ohio Department of Education survey, school districts reported that, on average, 83% of their students had internet connectivity. These findings obfuscate the real issue, however, as internet connectivity is not the same as reliable, affordable, high-speed broadband. Students need broadband speeds capable of streaming live classes synchronously or watching video recordings. Unstable or slow connections cannot provide those assurances, as they lead to disconnections and learning disruptions. Students with slow internet speeds face challenges in asking questions in real-time and these technological barriers generally limit student learning. How many students face these barriers is an important question to ask. In Ohio, school districts are unable to determine the internet status of nearly 14% of their students—a figure that encompasses thousands of Ohio students, illustrating the large scale of our general ignorance of broadband needs. The seemingly high estimate of 83% student connectivity also obscures many underlying disparities. For one, that means 17% do *not* have adequate connectivity, a shocking figure.

Additionally, the divide for students often manifests as a gap between suburban, urban, and rural districts, as disparities exist not just in internet speed, but in the types of devices students use to connect to the internet.[5] While many students have laptops or tablets to access the internet, some students only own a smartphone (or less), greatly putting them at a disadvantage. For instance, even with the best-possible broadband in the world, following class instruction on a smartphone is not an optimal way to learn complex subjects—imagine discerning chemistry equations or writing research papers on a smartphone. This scenario is most likely to occur among rural students, with 4% reporting using a smartphone as their primary technology device at home and only 45% having home access to a desktop, laptop, or tablet. This stands in contrast to more "urban/suburban" districts, where nearly 90% of students report having home access to a desktop, laptop, or tablet. Given education's mass shift to using online resources, students now require software for writing, opening assignments, and browsing multiple sources of

[5] Ohio's Department of Education stratifies districts into eight separate typologies: two classifications for rural, two classifications for small town, two classifications for suburban, and two classifications for urban.

information all at once. These gaps in connectivity hardware, software for learning activities, and access/affordability of reliable highspeed internet likely have differential impacts regionally. The likely losers are rural children and children in low-income urban areas. Even if they have devices, students in rural districts (10%) and major urban districts (23%) are more heavily reliant on cellular connectivity, such as mobile hotspots, compared to just 3% in relatively wealthy suburban districts. This suggests that access to high-speed broadband, which is more prevalent in cities, is ultimately still inaccessible to large numbers of students. Ohio's urban school districts (as classified by the Ohio Department of Education) report that they do not know how 3% of their students connect to the internet (totaling about 4,800 students).[6] However, Ohio's *major* urban districts do not fully know how 25% (46,000) of their students connect to the internet.[7]

Large-scale ignorance of critical data hinders the ability to design optimal policies. At best, we too often get "good policies" aimed at nonexistent problems, while critical student needs go unmet. Good broadband policy is more than laying the most modern fiber-optic cables. Spending tens of billions of dollars on building the most advanced broadband is wasted if students are using inadequate devices for their internet connectivity. Well-designed broadband policy includes providing reliable high-quality laptops or tablets to students.

Disparities are not just regional and can exist on a micro-level. Even within the city of Columbus, Ohio, both internet speeds and the number of available ISPs can greatly vary across neighborhoods. This reinforces educational inequities as ISPs typically focus their infrastructure investments on more affluent areas, with more customers willing to pay for expensive services. This market reality reinforces the need for governments to promote competition of internet, cable, and streaming services to low-income neighborhoods. Economic theory suggests that reduced competition in low-income neighborhoods leads to higher prices. Many customers are effectively priced out, which further reduces incentives for ISPs to make broadband investments in the poor neighborhoods with the greatest needs. The resulting broadband-service deficiencies lead to the poor educational outcomes described above.

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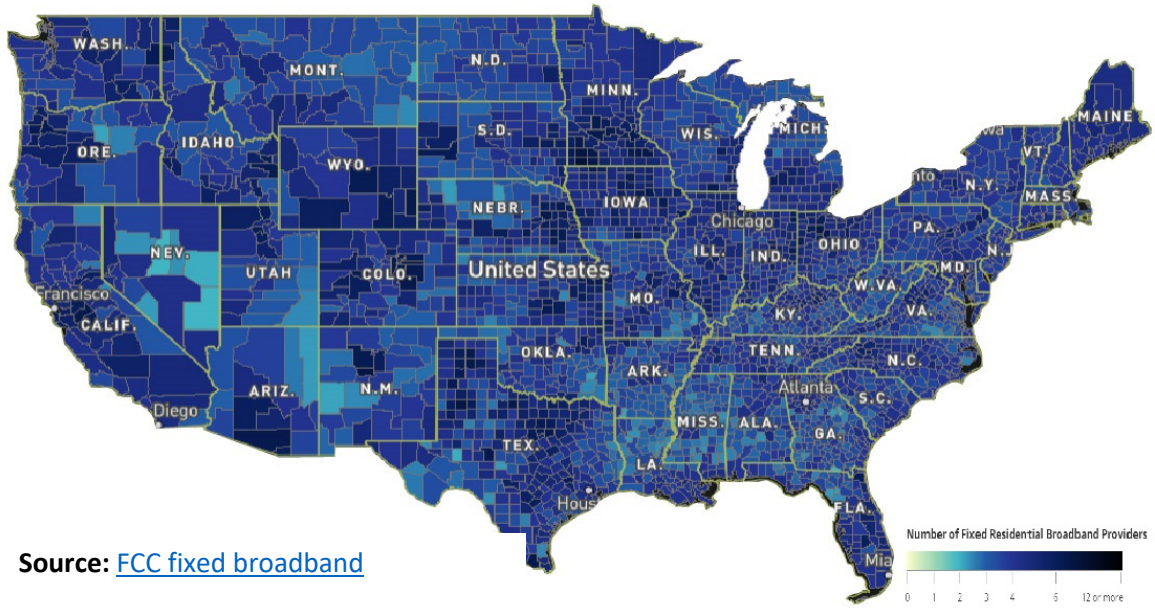
[6] Urban school districts comprise 47 school districts in Ohio and roughly 210,000 students. Examples of urban school districts include Euclid City (Cuyahoga County), Whitehall City (Franklin County), and Massillon City (Stark County).

[7] There are eight major urban districts: Columbus City, Cincinnati City, Toledo City, Dayton City, Akron City, Canton City, and Youngstown City. For this analysis, seven of the eight major urban districts participated in the survey. It was not made available which district abstained.

Ohio Lags Nearby Peers in Broadband

Using the current federal definition of broadband accessibility implies that the country is generally well served, even in rural areas. Figure 5 displays the variation in broadband providers offering minimum broadband speeds throughout the continental United States but notably uses the generally obsolete current FCC definition from 2015 of 25 Mbps—not the 100 Mbps speed that is more suitable in 2022. Using the FCC definition, *access* to broadband providers is greatest in the Midwest and east coast, with the lowest in the South (particularly Mississippi and Louisiana) and parts of the southwest (Nevada and Utah). Broadband access in the upper Midwest is particularly high, with southern Minnesota and Iowa having an abundance of providers. However, note that this map is at the county level and does not mean that all areas have equal numbers of ISPs. Indeed, rural parts of a county may have none. Moreover, access to providers does not directly translate into households purchasing affordable broadband at speeds suitable for modern needs. Two conclusions from Figure 5 are: (1) official definitions can vastly overstate the actual access to adequate internet for the conditions of 2022 and (2) maps of broadband access need to be at a much finer scale than at the county level—preferably at the neighborhood levels in towns and cities.

Figure 5: Broadband Providers of 25 Mbps or More



Source: [FCC fixed broadband]

Table 1 describes underlying features associated with broadband availability across the Great Lakes region. Of particular interest is column six which reports the estimated

population unable to purchase wired or fixed wireless broadband due to no local ISPs. According to Table 1, 1.4 million Ohioans lack broadband access—roughly 12% of the state's population.[8] Ohio's figures are near the US average, with 13% of Americans lacking broadband connectivity. However, given Ohio's high population density, one would expect that the state would fare considerably better than the U.S. average.

When comparing on a more "apples-on-apples" basis, there are considerable differences between Ohio and its neighbors. For example, over 50% of West Virginians lack access to broadband service verses only 6.5% of New Yorkers, though West Virginia is uniformly inhibited by difficult terrain. Ohio's relative performance is middling, with some states achieving higher broadband penetration, e.g. Illinois (90.3%) and New York (93.5%), while other states fare considerably worse than Ohio, e.g. West Virginia (49.8%) and Kentucky (81.4%). Wisconsin and Indiana, meanwhile, have similar broadband access levels (Wisconsin (88.5%) and Indiana (86.8%)).

Table 2 reports the share of households with broadband subscriptions in Ohio and neighboring states.[9] Subscriptions, as we have noted, is a more accurate measure internet availability because it reflects both factors of access and affordability. It shows that broadband subscriptions increased in households throughout the region by roughly 10% from 2015-2019. The share of Ohio households with a broadband subscription was 85% in 2019, an increase of 9% from 2015. This is slightly below the US average of 86% and on par with Ohio's neighbors. Neighboring Indiana and Kentucky are marginally behind Ohio, but their share of households with broadband subscriptions increased at a greater rate than Ohio since 2015. Table 3 shows that almost all of Ohio's 2019 household internet subscriptions were broadband and only 10,000 were dialup.

Table 4 separates broadband subscriptions by household income brackets. It shows the expected positive relationship between income and subscriptions. Eighty-seven percent of Ohio households with annual income of $20,000 or less have a broadband subscription, with the rate changing little for households between $20,000-$35,000 annual income (86%). **There is a sharp break in subscription rates when annual income is above $35,000**, with 96% of

[8]Table 1's broadband estimates are from both the FCC and BroadbandNow. Different figures in the table generally arise from differing definitions and measurement practices.

[9]As defined by the American Community Survey: "A 'broadband' Internet subscription refers to having at least one type of Internet subscription other than a dial-up subscription alone. In the American Community Survey, it specifically refers to those who said 'Yes' to one or more of the following types of subscriptions: broadband (high speed) such as cable, fiber optic or Digital Subscriber Line (DSL); cellular data plan for a smartphone or other mobile device; satellite; or some other service other than dial up."

Table 1. Availability of Broadband Access across Selected Nearby States							
	Observed FCC Error Rate[1]	Urbanization Rate (2019)[2]	Population (2019)[3]	Population without Broadband Access (2019)[4]	Population without Broadband Access (2021)[5]	Population share without Broadband Access (2019)[4]	Population share without Broadband Access (2021)[5]
Illinois	23%	88%	12,672,000	259,000	1,226,709	2.0%	9.7%
Indiana	19%	72%	6,732,000	261,000	890,116	3.9%	13.2%
Kentucky	25%	59%	4,468,000	257,000	832,791	5.8%	18.6%
Michigan	20%	74%	9,986,000	421,000	1,317,805	4.2%	13.2%
Minnesota	18%	73%	5,639,000	139,000	880,011	2.5%	15.6%
New York	20%	88%	19,454,000	250,000	1,258,600	1.3%	06.5%
Ohio	**19%**	**78%**	**11,689,000**	**328,000**	**1,404,448**	**2.8%**	**12.0%**
Pennsylvania	15%	79%	12,802,000	525,000	1,224,298	4.1%	09.6%
Wisconsin	17%	70%	5,822,000	394,000	670,592	6.8%	11.5%
West Virginia	36%	49%	1,792,000	319,000	900,010	17.8%	50.2%
United States	21%	80%	328,211,000	14,462,000	43,658,570	4.4%	13.3%

[1] Percentage of address-provider combinations where FCC reports service and provider-check availability tools indicate service is unavailable.

[2] Percentage of the 2019 population living in urban areas, from the FCC.

[3] Population (millions) from the FCC's 14th Broadband Deployment Report

[4] Population (millions) unserved by terrestrial broadband internet from the FCC's 14th Broadband Deployment Report.

[5] Population (millions) unserved by terrestrial broadband internet according to BroadbandNow Research 2021 Study.

Source: BroadbandNow (2021)

Table 2. Share of Households with a Broadband Subscription[1]		
	2019	2015
Ohio	**85%**	**76%**
Pennsylvania	86%	76%
Michigan	86%	74%
Indiana	84%	73%
Kentucky	83%	72%
United States	86%	77%

[1] As defined by the American Community Survey: "A 'broadband' Internet subscription refers to having at least one type of Internet subscription other than a dial-up subscription alone. In the American Community Survey, it specifically refers to those who said 'Yes' to one or more of the following types of subscriptions: broadband (high speed) such as cable, fiber optic or Digital Subscriber Line (DSL); cellular data plan for a smartphone or other mobile device; satellite; or some other service other than dial up."
Source: American Community Survey

Table 3. Presence and Types of Household Internet Subscription, Ohio – 2019[1]		
	Households	Percent
With an Internet-subscription	4,048,969	85.60%
Dial-Up	10,309	0.20%
Broadband, *any type*	4,038,660	85.40%
Cellular Data Plan	3,599,169	76.10%
Broadband, *cable/fiber optic/DSL*	3,341,334	70.60%
Satellite Internet Service	278,221	5.90%
Internet Access without subscription	114,151	2.40%
No Internet Access	567,220	12.00%

[1] As defined by the American Community Survey: "A 'broadband' Internet subscription refers to having at least one type of Internet subscription other than a dial-up subscription alone. In the American Community Survey, it specifically refers to those who said 'Yes' to one or more of the following types of subscriptions: broadband (high speed) such as cable, fiber optic or Digital Subscriber Line (DSL); cellular data plan for a smartphone or other mobile device; satellite; or some other service other than dial up."
Source: American Community Survey

households with annual income between $35,000 - $50,000 having a broadband subscription, an increase of ten percentage points. These trends continue as household income increases, eventually reaching 100% for all households with annual income of $75,000 or more. As we have noted, inconsistent definitions and changing benchmarks for what constitutes high-speed broadband access means that subscription rates are also unlikely to tell the whole story. Most publicly available data on broadband access either use definitions for speed (25 Mbps) that are already obsolete in 2022 or do not consider the quality of devices households connect with. We explore the impact of how these speed definitions change

conclusions when considering who has access to broadband.

Table 4. Percentage of Ohio Households with Broadband	
Less than $10,000:	87%
$10,000 to $19,999:	87%
$20,000 to $34,999:	86%
$35,000 to $49,999:	96%
$50,000 to $74,999:	97%
$75,000 or more:	100%

Source: American Community Survey 2019, 1-Year Estimates

Broadband Access Statistics Are Distorted by the Definition

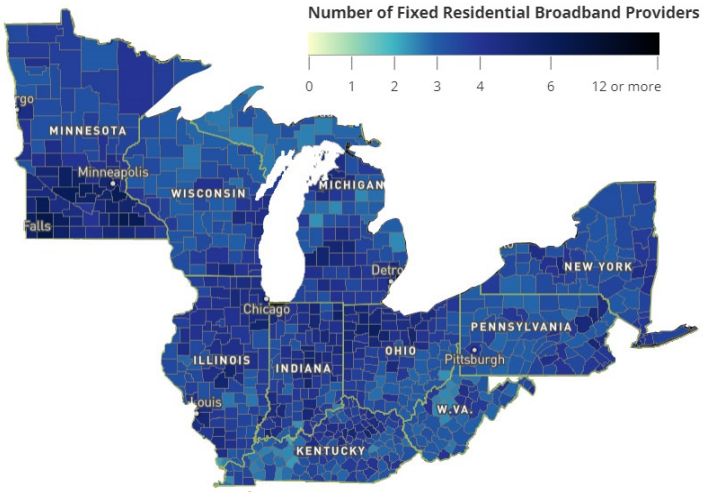
The supposed success in bridging the broadband gap is overstated because the official FCC broadband definition, set in 2015, is already obsolete. Previously, the FCC gave broadband a formal definition in 2010, with download speeds of at least 4 Mbps and upload speeds of at least 1 Mbps. However, citing the rapid increase in internet demand and usage, the FCC updated their definition for broadband in 2015, staying intact thereafter. The changes we have discussed in entertainment, healthcare, work, and school show that such speeds can be severely inadequate in 2022.[10]

Obsolete speed definitions lead to misleading conclusions about households' accessibility to "modern" broadband. For instance, if we apply the 25 Mbps definition, Ohio has made significant strides in providing broadband internet. Figure 6 shows that every Ohio county had at least two residential ISPs, with many counties having three to five—increasing both physical availability and competition that lowers prices. While other states may struggle with having enough ISPs (e.g., central West Virginia and the Jackson Purchase of Kentucky), most areas are generally served by multiple ISPs.

A recent proposal by a bipartisan group of U.S. Senators, including Ohio Senator Rob Portman, has called for a more robust broadband definition. They requested that the FCC update its broadband definition by raising minimum speed requirements to 100 Mbps for both downloads and uploads, citing that federal funding to rural areas should support the type

[10] The Jackson Purchase of Kentucky is the western-most portion of Kentucky, bought from the Chickasaw Indians in 1818. The area includes the eight Kentucky counties of Hickman, Calloway, Graves, McCracken, Marshall, Ballard, Fulton, and Carlisle.

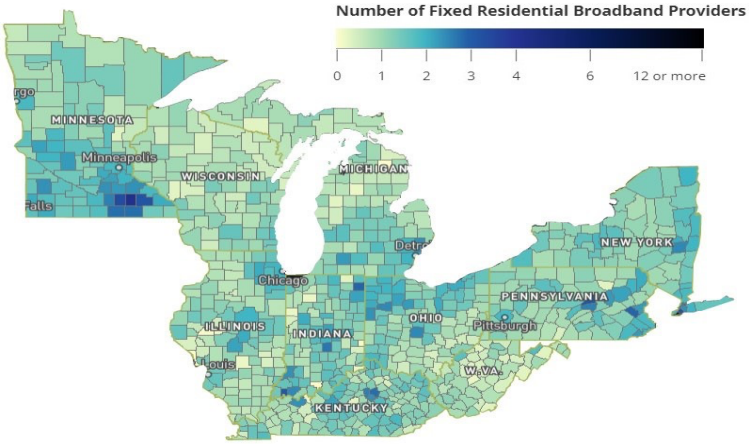
Figure 6: Broadband Providers of 25 Mbps or More



Source: FCC fixed broadband deployment

of speeds used by household in well-served urban and suburban areas. Taking the proposed definition, Figure 7 updates Figure 6 with broadband providers of 100mbps or more. The contrast is staggering. States that seemingly had nearly full broadband accessibility struggle to achieve even one provider per county at the more "modern" 100 Mbps standard. And even there, as we noted, demands for even faster speed suggest that even a 100 Mbps standard will soon be obsolete. This is especially evident in Ohio. For example, there are usually only one or two ISPs across northern Ohio with speeds over 100 Mbps. Availability is even sparser for rural and Appalachian areas in Southeast Ohio, where many counties simply have no ISP meeting a 100 Mbps standard.

Figure 7: Broadband Providers of 100 Mbps or More



Source: FCC fixed broadband deployment (2020)

As of our writing, the FCC had not increased its speed definition for broadband above 25 Mbps. However, Table 5 presents the FCC's more cautious 2020 internet-speed "recommendations" based on light, moderate, and high use consumers. "High-use households" with more than 1 device connected (such as a phone and TV), which is likely a minimal need for most households, are recommended to have a connection above the current FCC formal definition of 25 Mbps. A household with 2 or more users simultaneously streaming television, video games, or teleconferencing is surely far underserved by the current FCC definition.

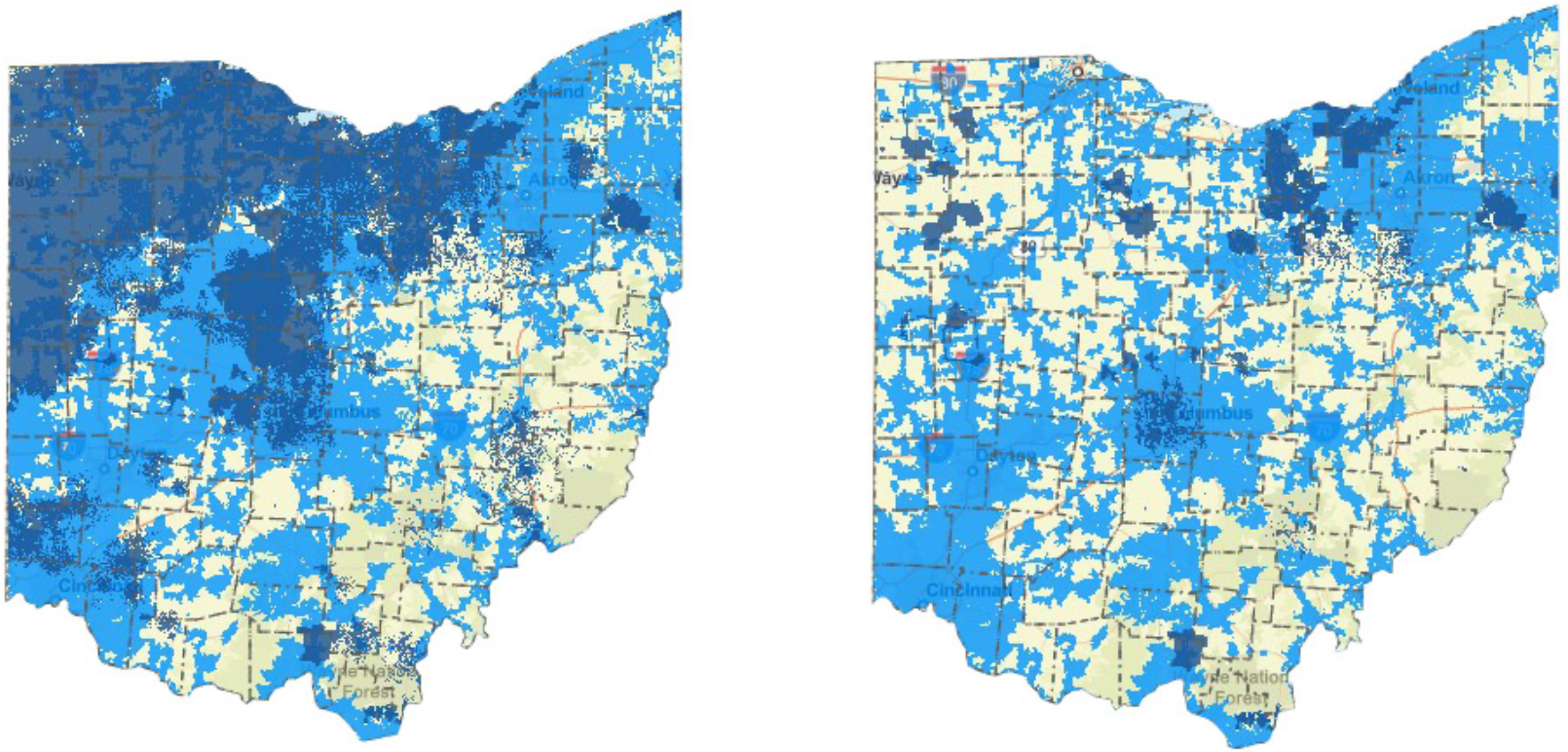
Table 5. Suggested Household Internet Speeds for Satisfactory Service

	Light Use[1]	Moderate Use[2]	High Use[3]
1 user on 1 device	3-8 Mbps	3-8 Mbps	12-25 Mbps
2 users or devices at a time	3-8 Mbps	12-25 Mbps	> 25 Mbps
3 users or devices at a time	12-25 Mbps	12-25 Mbps	> 25 Mbps
4 users or devices at a time	12-25 Mbps	> 25 Mbps	> 25 Mbps

[1] Light Use: Basic functions of e-mail, browsing, basic video, Voice over Internet Protocol (VoIP), Internet radio
[2] Moderate Use: Basic functions plus *one* high-demand application: streaming HD video, multiparty video conferencing, online gaming, telecommuting
[3] High Use: Basic functions plus *more than one* high-demand application running at the same time
Source: FCC "Household Broadband Guide," February 5, 2020.

The discrepancy between the number of ISPs at 25 Mbps and 100 Mbps are further evident for Ohio in Figure 8. Figure 8a maps broadband service availability with speeds of 25 Mbps and Figure 8b maps coverage for the 100 Mbps proposed definition. Northern Ohio counties generally have high availability using the outdated FCC definition, while southern Ohio countries struggle. Only 50% of the land areas of Coshocton, Monroe, and Harrison Counties, for example, meet the obsolete FCC definition. Current coverage using the more adequate 100 Mbps proposed definition is limited to Ohio's major metropolitan areas—Cleveland, Columbus, and Cincinnati—as well as patches of eastern Ohio. Even cities such as Toledo, flush with broadband coverage at 25 Mbps, has few ISPs offering 100 Mbps. What is more, within the state's Big-3 metropolitan areas, there are significant holes when using the 100 Mbps standard. Again, service can vary widely within a city or county. In sum, while many counties are flushed with ISPs using the current (obsolete) 25 Mbps standard, considerably fewer Ohioans would have broadband access using an updated standard.

Figure 8: Ohio Broadband Providers



(a) 25 Mbps Download/3 Mbps Upload

(b) 100 Mbps Download/10 Mbps Upload

Source: BroadbandOhio (2022)

Recent Ohio Investments in Broadband

The 2019 Ohio Broadband Strategy is the state's roadmap to increase broadband coverage to **all** Ohioans. One major component of the strategy includes the provision of grants to underserved areas, with the ultimate target of universal broadband service. Despite this plan and the state's related goals of increasing rural competitiveness and low-cost telehealth access, the General Assembly has been stingy in providing state resources to fund broadband initiatives. Because of this, new funds are mainly limited to federal sources.

The state's broadband strategy further plans on using so-called "private-public partnerships" to leverage private resources in expanding broadband access. To be sure, using private-public partnerships require strict contractual language to ensure that each partnership does not becomes another example of "crony capitalism"— money grabs for well-connected corporations that do not serve the broader public. As some economists say, "private-public partnerships tend to socialize the losses onto the public and privatize the gains for the private investor." The wreckage from the 2019 Ohio House Bill 6 scandal serves as a clear warning for how connected interests can co-opt governments for their own benefit (for a discussion of the HB6 scandal, see here) and the public should generally be wary of the details when relying on such agreements for fundamental infrastructure such as internet.

In 2021, the Ohio General Assembly also created the Ohio Residential Broadband Expansion Grant Program (RBEGP). The program, funded through the state's 2022-2023 operating budget, provides $250 million to award ISPs grants for broadband construction projects in underserved areas. The aim is to expand broadband into previously cost-prohibitive regions, such as those with low access described in the maps above. As of March 2022, $232 million in grants were awarded to 11 ISPs for 33 projects that are purported to be completed in the next two years, though it is not clear how these projects and amounts were determined. These projects cover more than 43,000 households in 31 counties. Additionally, ISPs claim that they will complete 71 other projects totaling $248 million to service 52,000 Ohio households. A potentially favorable development in ensuring public benefits is the state says it will fine the providers for any projects not completed in the next two years. Hopefully, such fines are sufficient to deter any unnecessary delays or incomplete work.

Beginning in 2021, the FCC provided Ohio another $170 million over ten years through its Rural Digital Opportunity Fund (RDOF). The RDOF aims to expand highspeed broadband service to rural homes and small businesses.

Phase I awards went to census blocks that entirely lack broadband service.[11]

Although these investments coupled with nearly $1 billion expected from the Infrastructure Investment and Jobs Act (IIJA) over five years for Ohio seem large, it is important to note both the cost of providing universal broadband infrastructure is actually quite large. Advocates estimate that it would require $1.7 billion (more than the total state and federal funding allocations) to build out fiber internet access for the state, which is likely an underestimate when considering the need for much faster speeds than used in the (obsolete) official FCC high-speed definition. Furthermore, to address affordability issues that limit access, the total cost to provide and subsidize adequate broadband access for the state is estimated to cost between $3.9 and $5.2 billion. It becomes increasingly clear that the planned public investments are insufficient to truly bring universal broadband access to the state. Given the rapid increase in technology and use that has occurred in just the past 5 years—both Ohio and the U.S. at large seem on track to repeat the mistakes of the past.

Federal Policy & Broadband's Future

The American Recovery Act

Both the Presidential election of 2020 and the COVID-19 Pandemic have impacted federal policy toward broadband access. Recent federal legislation championed by the Biden administration has increased the focus on enhancing broadband infrastructure in underserved communities, but as mentioned above, these investments are likely insufficient to meet future demands. The March 2021 American Rescue Plan (ARP) expanded funding for broadband by providing $350 billion to state and local governments. Though state and local governments have considerable discretion in spending these funds, developing broadband infrastructure is a bipartisan focus for many administrations. For example, Virginia allocated $700 million to improve universal broadband access and California used $3 billion to facilitate "last-mile" connections.[12] Ohio, which was allocated $5.4 billion from the ARP over two years ($2.7 billion annually), has used the money to fund various infrastructure projects beyond broadband, including $250 million for water and sewer quality programs.

[11] Census blocks are statistical areas bound by physical or geographic features such as roads, streams, property lines or city limits. They are the smallest geographical measure the U.S. Census Bureau collects data on and covers the entirety of the United States. They are typically a city block. For more information on census blocks, refer here.

[12] See "Defining Broadband and Access" on p.10 for definition of "last mile" connections.

The ARP also sets aside $10 billion for a Capital Projects Fund. U.S. Treasury Department spending guidance suggests that states use these funds on broadband. Based on the Treasury Department's allocation formula, Ohio will receive about $268.5 million in related federal funds, which is a good first-step to jumpstart Ohio's broadband expansion efforts. These funds can also support the continuous need for investments to forestall current infrastructure from becoming obsolete.

The ARP also allocated a one-time annual payment of $7.17 billion for a new Emergency Connectivity Fund (ECF) to be administered by the FCC to help schools and libraries purchase broadband-enabled devices. Since January 2022, the FCC received over $6.5 billion in funding requests and $4.2 billion in funding commitments that cover 4.7 million broadband connections for over 9,800 schools and 800 libraries. Of the $6.5 billion requested nationwide, institutions in Ohio have requested $126.13 million with $97.09 billion so far approved and committed.

The Infrastructure Investment and Jobs Act

The recently passed Infrastructure Investment and Jobs Act (IIJA) also includes funds for broadband infrastructure projects. Signed into law on November 15, 2021, IIJA provides $550 billion in new funding spread across five years ($110 billion annually). Among new funding, the $550 billion includes $110 billion in funding for roads, bridges, and major infrastructure projects ($22 billion annually), $66 billion for passenger and freight rails ($13.2 billion annually), and $65 billion to expand broadband ($13 billion annually). Analysis by the Congressional Budget Office, however, finds the funding to be less, only increasing discretionary funding by $415 billion over five years ($83 billion annually). Further discretionary funding after the five-year period (2022-2026) reduces to zero, unless acted upon by Congress. For perspective, IIJA's new expenditures represent about 0.3% of annual GDP for the next five years. With such small investment, IIJA will hardly be noticed by Americans. Indeed, the $13 billion annual investment in broadband seems paltry when the FCC estimates that close to $40 billion is required to just bring broadband to the 2% of hardest to reach U.S. households. And it is likely that the cost estimate is only for broadband meeting the current obsolete FCC standard.

The largest component of IIJA broadband infrastructure funds will go to a new U.S. Department of Commerce Broadband Equity, Access, and Deployment (BEAD) Program. The program will provide $42.45 billion over five years (or about $8.5 annually) to close the digital divide. Each state will be given a minimum of $100 million, with additional funding based on the number of unserved areas

in each state. Though the official amount for Ohio won't be established until the FCC releases BEAD requires broadband projects to have speeds of at least 100 Mbps for downloads and 20 Mbps for uploads. While this represents an improvement over the current obsolete FCC definition, it is still below the proposed speeds from the bipartisan Senate group. BIB also includes the Digital Equity Act of 2021, which provides $250 million to support state efforts to improve digital equity and inclusion.

One concern with BEAD and other recent federal/state broadband initiatives is that scarce federal funds are being used to develop broadband infrastructure that will be obsolete on the day the project is completed. Given the inevitable future needs for faster-and-faster internet speeds, even adopting the proposed bipartisan 100 Mbps upload/download standard as a minimum requirement for federal funding still risks the newly constructed infrastructure will only support adequate internet speeds for a short time and given the five-year timespan of the federal investments, they may be obsolete upon completion. It is disappointing that the recent federal bills were not more forward looking by requiring even faster Mbps to ensure future needs are met for a longer period. A somewhat mitigating factor is that these projects must be scalable to faster future speeds, but such a requirement implicitly new broadband maps, it is estimated the state will receive about $900 million in BEAD funds. presumes *future* broadband funding will be available, which is far from certain.

Regulation of Landlord-Provider Agreements

Another component of federal policy regarding broadband has focused on affordability and competition among service providers. While Ohio has taken steps to rein in excessive prices in electricity and water (see legislation here that restricts submetering), little has been done to address similar issues regarding broadband. Recently, the FCC sought comments on proposed regulatory investigations that would examine competitive access to broadband in apartments and office buildings. A major affordability issue which often goes unnoticed is that ISPs often enter mutually beneficial revenue-sharing agreements with landlords of multiple tenet environment (MTE) buildings. These agreements provide a share of revenue to landlords who market or urge tenets to use the partner ISP for internet service. These agreements generally harm consumers by restricting choice and inhibiting entry by competitive providers that would otherwise lower prices. They may also lock customers into slower internet speeds than may be available from other providers. It is important to note that although exclusive agreements, where

landlords *restrict* any other ISP from being offered at all, were technically outlawed by the FCC in 2008, there are still ways around these regulations. For instance, it is common for landlords to restrict physical access to drill and run wire through their buildings for non-revenue sharing ISPs. Additionally, landlords may market a specific ISP to their tenets when leases are signed, limiting consumer information on choice or leading them to believe there is no alternative provider available. Landlords can also engage in "bulk-billing" arrangements and factor the fees into the tenet's rent. More regulations to eliminate such schemes are needed to fulfill universal high-speed internet goals.

All in all, while the recent federal investments and regulatory changes represent a step in the right direction, U.S. policy suffers similar challenges that face many states: rapidly increasing technological developments continue to drive ever increasing needs for internet speed by households and businesses for more productive work, leisure, education, healthcare, and retail consumption. Policy and funding have not kept pace with these rapid changes and the COVID-19 pandemic has only hastened these demands. Below, we briefly revisit and expand on our previous policy recommendations when it comes to improving broadband access and affordability.

Conclusions for Policymakers

Broadband is now an essential utility whose use is rapidly accelerating. Most aspects of modern American economic and private life demand the higher download speeds provided be access to reliable and affordable broadband. Since our 2017 brief, funding as well as a state broadband agency in Ohio have been formed. Several other important policy recommendations, however, have gone unmet and are reiterated below in addition to several additional policies that should be implemented at the federal level. These stand in addition to our 2017 recommendations—the majority of which have net yet seen full implementation.

1. Revise the formal FCC definition of broadband.

As we noted, the FCC definition of broadband from 2015 is woefully outdated. Rising intensity in broadband usage for streaming TV, movies, music, games, as well as requirements for productive work, virtual learning, telehealth, and consumer shopping means additional bandwidth and speed requirements. The current definition leads to inadequate data on coverage, often overstating the access of millions of Americans, particularly in rural and hard-to-reach areas. It is nearly impossible to know, at

present, the actual connectivity of households and businesses in these regions. Proactively increasing formal definitions for high-speed internet would help set standards that are future-proof and facilitate policymaking at federal, state, and local levels to make more informed investments that are not be so quickly outpaced by technological developments.

While we recommend, at a bare minimum, to revise the formal FCC definition to 100 Mbps, we acknowledge the rapidly changing technological environment that will soon make 100 Mbps obsolete. Thus, to maintain an up-to-date broadband definition, we further recommend defining broadband not in terms of speed, but functionality. To do this, we recommend identifying internet applications that are crucial to meet the needs of a typical broadband user. These applications must be accessible and usable for the internet to be considered broadband. Further, it should recognize that most households have multiple users. The functionality definition should pay particular focus to requirements for telehealth, telework, and remote schooling. By setting a broadband definition in terms of functionality, issues of obsoletism that plague traditional speed definitions are circumvented.

2. Increase competition among internet service providers and enhance governmental regulations for ISPs.

A major component of broadband access is affordability. Yet, it is remarkable that despite the United States being the long-time global innovation hub for internet applications and technologies, the average advertised monthly cost of internet in the U.S. is $68.38 – higher than the average for the rest of North America ($49.59), Europe ($44.71), and Asia ($62.41).[13] Likewise, US broadband speeds and mobile internet speeds lag other countries and in many cases, are quite mediocre.[14] In part,

[13] The same issue persists for cellular data, with the United States ranking 154th of 230 countries in the average price of 1 GB of cellular data ($3.33). The U.S. lags its peers in Europe such as the United Kingdom at 78th ($1.42) and France at 11th ($0.41) as well as its counterparts in Asia such as India at 28th ($0.60) and China at 17th ($0.52).

[14] The firm Ookla conducts global speed tests for uploads and downloads and one can even test the speed of their home connections. With a median fixed-broadband download speed of 111.6 mbps, the US had the fifth fastest global download speed in February 2021 (out of 41 countries Ookla tests) (US upload speeds were identical in global ranking). Even though the US median download speed improved to 146.2mbps in February 2022, the US ranking fell to number 9, illustrating both a declining US quality trend and illustrates how internet speeds are rapidly increasing, far exceeding outdated FCC regulatory definitions. By comparison, China's median fixed broadband-download speed in February 2022 was 155.9mbps, or 8th fastest. Chile achieved the fastest download speed of 197.6 mbps, while Chile's upload speeds were nearly five times faster than the US (even Thailand's speed equaled 183mbps and the US barely edged Romania's speed). In mobile (cell) network speeds, the US performs even worse, with a global rank of 22 in median download speed in February 2022 (out of 41 countries). The US speed was about one-half as fast as the UAE, Norway, and South Korea, the three global leaders. US 5G network performance is even more anemic. In the 3rd quarter of 2021, Ookla reports that median US 5G download speed

these high costs and mediocre quality are driven by lack of consumer choice, insufficient competition among ISPs, and lax government regulations compared to the rest of the world. It is unclear what high US ISP prices are providing to their customers.

For millions of Americans who live in multi-tenet apartment buildings and businesses in multi-business office spaces, non-exclusive and informal revenue sharing agreements between ISPs and landlords further reduce access and affordability. The FCC should attempt to further regulate this type of activity beyond banning exclusive agreements. Expansion of consumer regulations will have the long-term effect of increasing consumer choice and ISP competition, resulting in lower prices and higher quality service for consumers. This echoes our 2017 recommendation to strengthen regulation and oversight of public-private partnerships aimed at expanding broadband access to prevent corruption or anti-consumer practices to ensure the "public" part of the partnership is served.

Increasing broadband access may require local governments, economic development districts, and other public entities to directly begin their own ISPs to counter market challenges such as low population densities and difficult terrain that inhibit private investment. There is a long tradition of local governments providing similar public utilities for a range of services (e.g., the New Deal's Rural Electrical Administration, Bonneville Power Administration, Tennessee Valley Authority). Ohio examples include local public-power utilities in cities like Cleveland and water utilities across the state. More recently, public ISPs have developed (e.g., Stevenson, Alabama; Dalton, Georgia; and Wadsworth, Ohio). A 2017 survey by Pew Charitable Trust found that 70% of Americans believe governments should have the right to start their own ISPs.

To date, few government policies have focused on ensuring adequate numbers of ISPs, with most policies focused on bringing broadband to rural regions. These policies lack a holistic approach and contribute to lagging internet usage among American households.

3. Pair recent broadband infrastructure investments with device subsidies and workforce training programs.

was 93.7 mbps, or less than one-fifth South Korea's 5G network speed and less than one-third the speed in China. New Zealand's speed was 296.2mbps, giving them the 10th ranking, which is about three times faster than the U.S. The U.S. also greatly lagged the median global average speed of 166.1mbps. Ookla also considered global 5G median download speeds in 41 world capital cities. Fortunately, Washington, DC had nearly double the US average speed, with a median 5G download speed of 160.4 mbps. Yet, all that got Washington was a ranking of 31, with speed about one-third of Seoul, Oslo, and Stockholm and barely one-half the speeds in Sofia, Bulgaria and Beijing.

It is naïve to view broadband as simply the wires, signals, and radio waves that deliver service to homes and buildings. As we have noted, the disparity in worker skill often exacerbates the disparity in internet access and usage, as well as economic growth that a region experiences through infrastructure investments alone. This was particularly apparent during the COVID-19 pandemic among highly educated workers, who were more able to make the transition to remote work, while less-educated workers were often concentrated in jobs that could not transition to remote work. Indeed, given the link between remote work and worker quality-of-life, the digital divide worsens inequality in other ways.

High-skill, knowledge economy jobs reliant on technology are more concentrated in metropolitan areas or metro-adjacent areas. Some evidence suggests that rural areas that invest heavily in broadband infrastructure experience growth—but only if they already have a higher proportion of high-skill workers. As such, we strongly encourage policymakers to pair rural broadband investment projects with workforce training programs that raise skill levels in lagging regions. This complimentary effort has shown to increase economic growth and employment opportunities due to broadband.

Additionally, some of the federal and state funds aimed at broadband expansion should be aimed at providing adequate devices for internet usage. What good is broadband fiber without the devices necessary to use it? Such investments should be especially aimed at school districts with large shares of students without at-home high-speed internet access. Modern devices capable of opening and completing assignments as well as streaming video calls and classes are a necessity to take advantage of broadband infrastructure. Disparities in devices not only widen the digital divide but have the potential to further widen the educational achievement gap between students in wealthy school districts with those in rural and poor-urban school districts. Access to the internet through a mobile-smart phone is insufficient for most students and employees with the ongoing trends of increased remote work and more virtual learning. Indeed, offering older students robust access to high-speed internet with appropriate devices provide an opportunity to increase college or professional degree attainment in rural areas.

Ohio has demonstrated, both in our 2017 and 2022 briefs, that is has the capacity to be a leader in increasing access to affordable high-speed broadband. Yet, there are still gains that must be made sooner rather than later. Much of the committed funding is on a timeline that is simply too long and aimed at a benchmark

that is too outdated to be meaningful in an age of rapid technological development. Additionally, policies aimed at expanding broadband access need to be more holistic and consider how people use the internet for productivity, economic activity, education, health, and leisure when developing strategy. Setting and prioritizing aggressive goals aimed at future-proofing broadband infrastructure and making access more equitable would likely contribute to Ohio's future success.

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