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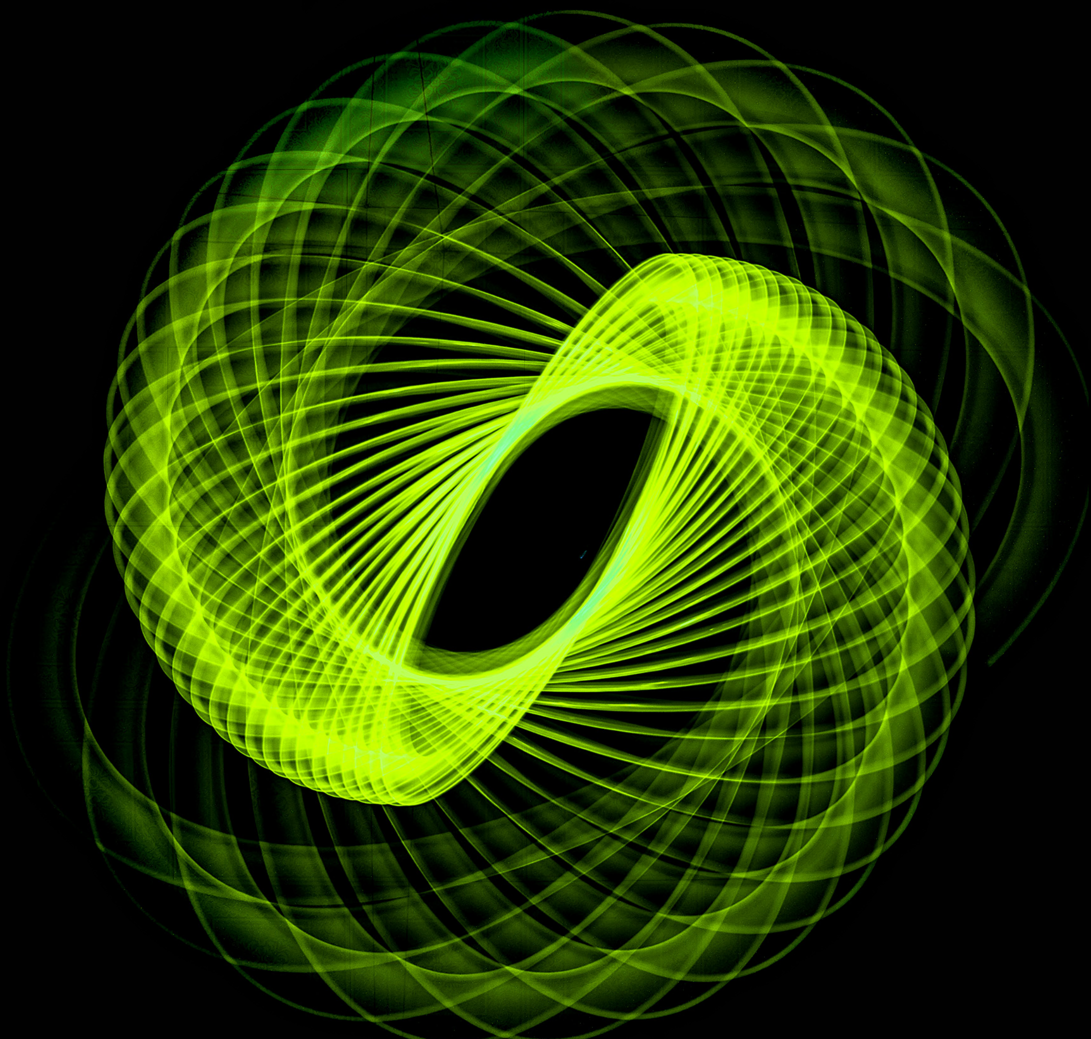


# Broadband for all: charting a path to economic growth

April 2021

# Executive summary

The COVID-19 pandemic has placed the US economy at another pivotal moment when economic prosperity may depend on reliable, affordable and fast internet connectivity for all. The pandemic forced much of the US population to trade classrooms, offices, and conference rooms for at-home screens, and many Americans were left stranded by inadequate or unaffordable access to internet connectivity or devices.

This "digital divide" was first noted more than 25 years ago as consumer communications needs shifted from landline voice to internet access.[1] The economics of broadband spawned availability, adoption, and affordability disparities between rural and urban geographies and between lower- and higher-income segments. Today, the digital divide still presents a significant gap after more than $100 billion of infrastructure investment has been allocated by the US government over the past decade to address this issue. The current debate regarding additional funds for broadband deployment implies that further examination is warranted regarding how to close the digital divide and achieve the resulting economic prosperity.

Quantifying the economic impact of closing the digital divide clearly shows the criticality of broadband infrastructure to the US economy. Deloitte developed economic models to evaluate the relationship between broadband and economic growth. Our models indicate that a 10-percentage-point increase of **broadband penetration** in 2016 would have resulted in more than 806,000 additional jobs in 2019, or an average annual increase of 269,000 jobs. Moreover, we found a strong correlation between **broadband availability** and jobs and GDP growth. A 10-percentage-point increase of broadband access in 2014 would have resulted in more than 875,000 additional US jobs and $186B more in economic output in 2019. The analysis also showed that higher **broadband speeds** drive noticeable improvements in job growth, albeit with diminishing returns. As an example, the gain in jobs from 50 to 100 Mbps is more than the gain in jobs from 100 to 150 Mbps.

The findings suggest further analysis is warranted before setting too high a threshold for broadband speeds (both uplink and downlink). Doing so could discourage investment in promising new technology that doesn't yet meet predetermined thresholds but offers potential cost and rapid deployment advantages over today's solutions. Furthermore, innovative solutions can help spawn a competitive broadband environment that improves broadband affordability for all households. Overly stringent mandates on speed, on the other hand, run the risk of ruling out these innovations before they gain a market foothold.

Stakeholders should focus on several considerations as they move forward.

01. Place a renewed emphasis on adoption and affordability by ensuring consistent user experiences, analyzing trade-offs between delivering higher speeds and innovative new technologies, and seeking diverse solutions for unique, underserved geographies.
02. Segment underserved US geographies into more granular categories that recognize the vastly different coverage and affordability needs of underserved geographies.
03. Incorporate the expected growth in broadband consumption into future investments and programs by utilizing subscriber data (e.g. running an FCC speed test).

Solving the digital divide will likely require public or private investment in the country's communication infrastructure including both wireless and wireline. Regardless of the specifics of the investment, these guiding principles can help yield immediate gains in providing affordable access to underserved segments of the population and move the nation closer toward bridging the digital divide.

# Introduction

The COVID-19 pandemic has placed the US economy at another pivotal moment when economic prosperity depends on reliable, affordable, and fast internet connectivity for all. The pandemic left much of the US and global population with no choice but to make a dramatic shift to distance learning, remote medicine, and e-commerce. Businesses were forced to rapidly embrace online customer interactions for curbside pickup and other no-touch functions. Prognostications of a digital future that many foresaw occurring over the course of a decade became an almost instant reality.

But millions across the United States confronted a far different reality in 2020 and continue to do so in 2021. As much of the country traded classrooms, offices, and conference rooms for at-home screens, many others were left stranded by inadequate or unaffordable access to internet connectivity and devices. The pandemic highlighted that significant gaps persist. Addressing such gaps will require answering tough questions that can help create internet equality, including:

- What broadband speeds are necessary to achieve the full social and economic benefits of the internet? What are the incremental benefits and/or diminishing returns of faster speeds?
- How can the United States address affordability of internet access and devices in addition to the availability of sufficient broadband speeds?
- Are customers (versus government) best equipped to determine which technologies and solutions best meet their needs?

Previous efforts to address the digital divide adopted a uniform definition of broadband speed despite unique geographic characteristics that have implications for affordability and access. In this paper, Deloitte examines a geographic segmentation that distinguishes the specific needs of different underserved geographies and better reflects their unique challenges. Moreover, Deloitte uses economic models to understand the benefits of broadband coverage and speeds. Our research and modeling yield insights into the benefits associated with various broadband speeds (upstream and downstream) and adoption rates in an effort to optimize the economic and social benefits while preventing wasted investment (public or private).

# History of the divide

The term "digital divide" is now common when referring to inequities in internet access. However, a 1995 report published by the US Commerce Department's National Telecommunications and Information Association (NTIA), titled "Falling Through the Net: A Survey of the 'Have Nots' in Rural and Urban America," is typically cited as the first instance when the US federal government focused on the imbalance between geographies and demographics for information-era technologies. The report notes that the goal of US telecommunications policy is "universal service" for telephone service and that the primary metric for success has been "the percentage of all US households that have a telephone on-premises." However, this same report also notes that this historical measure of successful telecommunications policy is incomplete in two respects: 1) lack of geographic identifiers and 2) limiting the definition of communications to wired voice communications, ignoring the growing prominence of personal computers accessing the internet via dial-up modems and budding wireless technologies of the era. The 1995 NTIA report states:

> "The FCC's periodic reports cannot indicate how telephone subscribership varies geographically—how, for example, telephone penetration in rural areas compares to penetration in suburbia or central cities ... There are legitimate questions about linking universal service solely to telephone service in a society where individuals' economic and social well-being increasingly depends on their ability to access, accumulate, and assimilate information. While a standard telephone line can be an individual's pathway to the riches of the Information Age, a personal computer and modem are rapidly becoming the keys to the vault."[1]

It is certainly conceivable that the authors did not envision that the insights of their report would still dominate telecom policymaking more than 25 years later. Since the NTIA first highlighted the concept of a digital divide with regard to internet access, many positive developments have occurred. During that period, our nation's communications service providers invested $1.7 trillion in infrastructure to improve access and speed on both wireless and wireline networks.[2] Wireless carriers alone spent about $400 billion on spectrum and infrastructure, including wireless equipment, towers, fiber, and the labor to deploy LTE, between 2010 and 2019.[3] Moreover, computing has become dramatically more affordable. The price of computing is roughly one hundred-millionth of what it was in 1970, driven by exponential improvements in processing, networking, and storage.[4] Moreover, the number of connected devices has proliferated to about 11 per household in the United States.[5]

However, as internet access shifted from dial-up and ISDN to broadband connections over DSL, DOCSIS cable, fiber, wireless, and satellite, it became apparent that the economics of broadband deployment favored densely populated urban areas over more sparsely populated rural geographies. It also became obvious that broadband adoption rates were significantly lower in economically challenged geographies than in high-income areas. Regulators and policymakers were quick to recognize this disparity and began the now decades-old campaign to eliminate the digital divide.

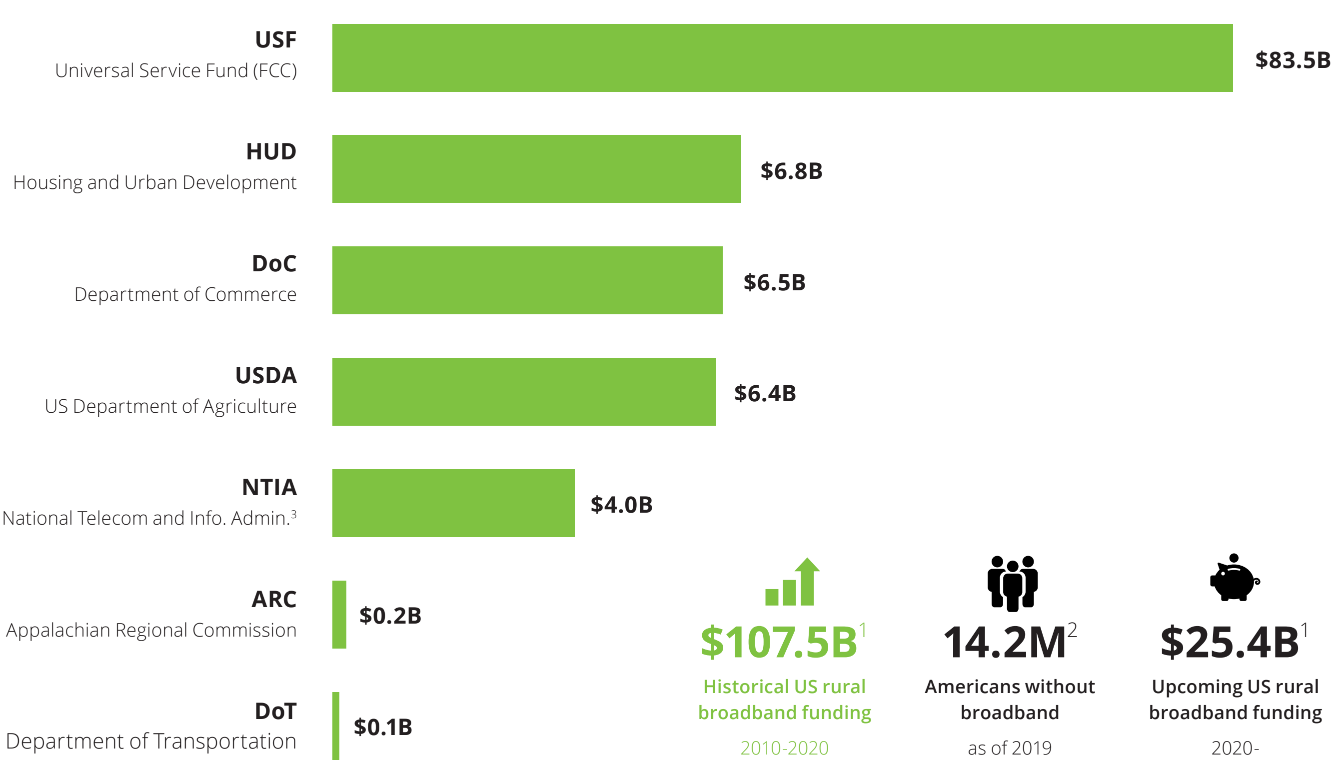
Since 1996, the US government has set minimum speed requirements to define broadband service,[6] with the hopes of keeping pace with the exponential growth in consumption.[7] These minimum performance expectations have changed as applications require increasing amounts of bandwidth. From 2011 to 2014, the FCC definition of broadband was 4 Mbps uplink and 1 Mbps downlink. In 2015, the FCC updated its definition of broadband to speeds of 25 Mbps downlink and 3 Mbps uplink. The 2015 broadband definition, which persists today, was more suitable to support new applications. Now, pandemic-induced requirements for streaming, videoconferencing, and the promise of further innovation make the FCC's 2015 broadband definition of 25/3 the topic of ongoing debate at both the state and federal levels.

# Investment and results

The ever-changing definitions of broadband imply that investment directed to close the digital divide are, in essence, chasing a moving target. Regardless, a multitude of programs intended to achieve ubiquitous internet access for residences and business locations afforded reason for optimism. As depicted in figure 1, between 2010 and 2020, federal programs, including USAC and the Rural Digital Opportunity Fund (RDOF), among others, spent about $107 billion dollars.[8] At the start of 2021, over $25 billion of additional funds were earmarked for broadband development in addition to other proposed broadband expenditures through various programs.

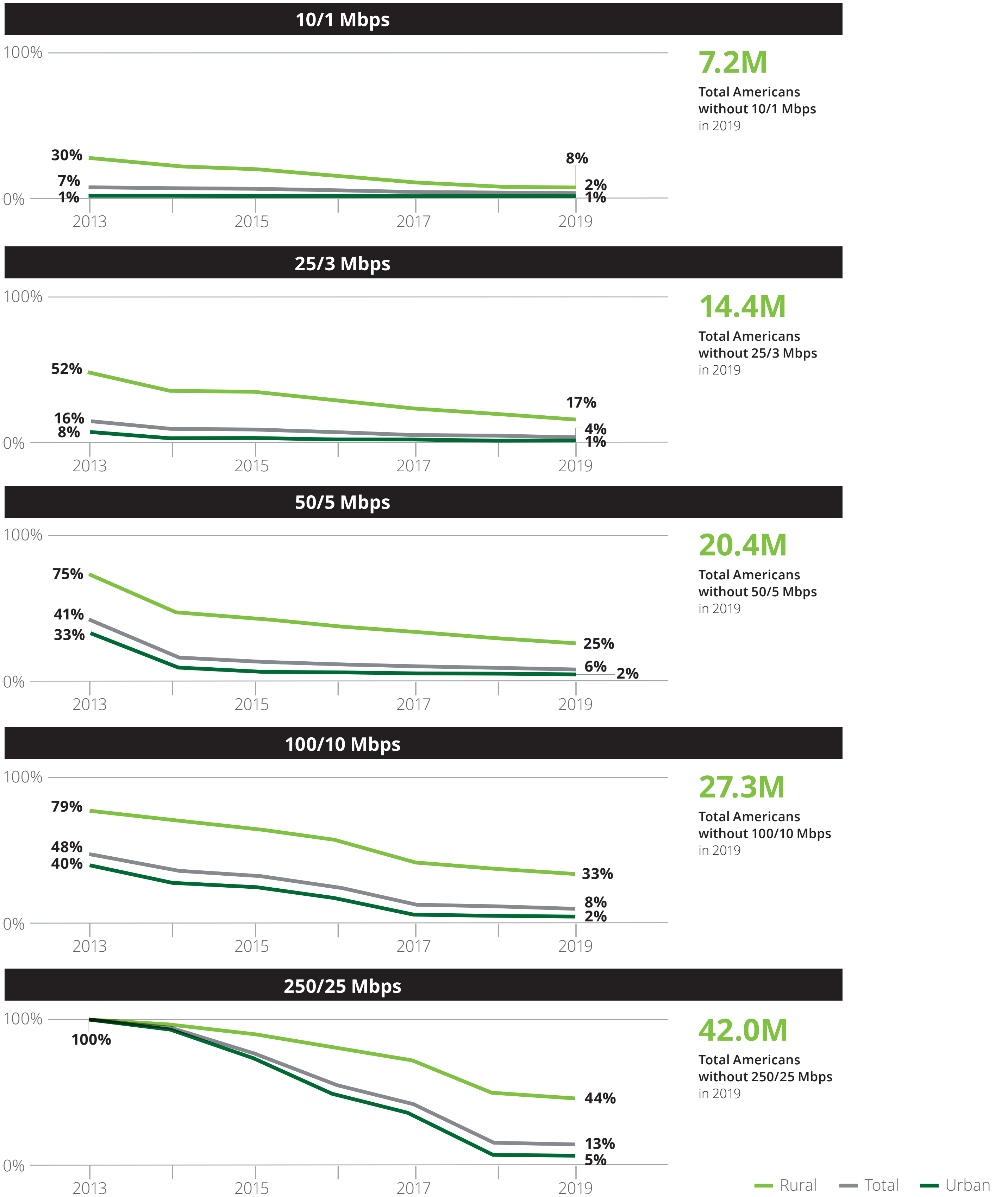
Optimism that the billions allocated to cover underserved geographies with broadband would help close the digital divide has somewhat waned, as broadband outcomes have often disappointed. In 2014, the last year of the 4 Mbps downlink benchmark, 16 million Americans (~5% of US population) did not have broadband services that met that standard. In 2019, after five years and about $54 billion dollars, 14.4 million Americans did not have home broadband that met the new FCC speed threshold (25 Mbps downlink). In other words, previous programs closed the digital divide by less than 1% (1.6 million people) between 2014 and 2019 partially as a result of the changing definition of broadband.

**Figure 1. Funding from federal programs (2010-2020)**




*Sources: [1]Deloitte research of federal broadband funding programs 2010-2019; [2]FCC, 2021 Broadband Report, [3]NTIA.*

**Figure 2. Availability gaps based on varying speed thresholds (2013-2019)**




*Sources: Deloitte analysis of publicly available FCC data*
*Notes: Based on deployments of fixed terrestrial services at different speed tiers; FCC reports data for all listed speed tiers from 2013 to 2019*

# Economic impact

For years, government, industry, and academia have discussed the societal impact produced by closing the digital divide. Providing wireless and wireline internet access to the unserved brings these individuals access to the most powerful medium in the world, opening them to opportunities to immerse in culture, learn new skills, communicate with like-minded people, and find new jobs. While the qualitative disadvantages for the unconnected are clear, looking more closely at the specific economic impact created by closing the digital divide shows how critical an effort it is for the broader US economy.

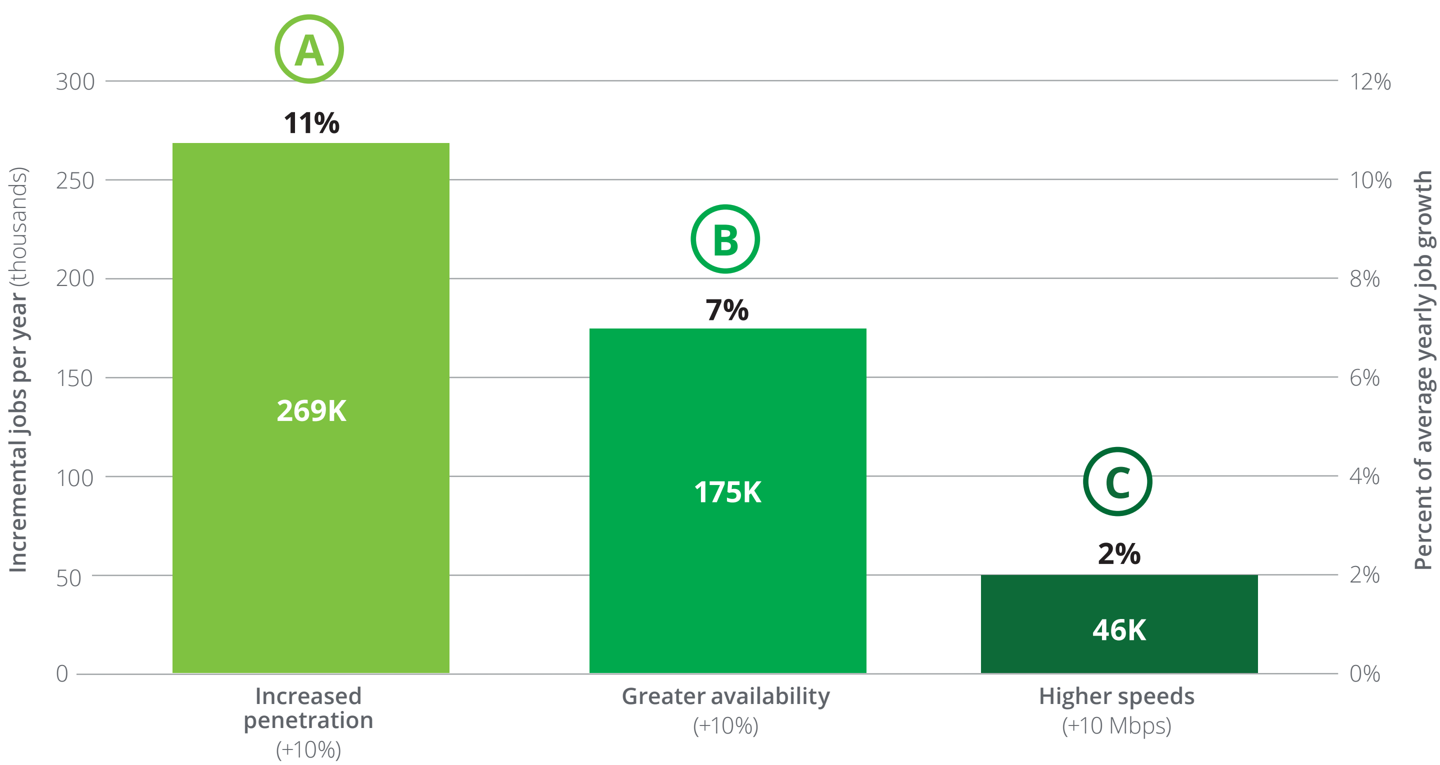
To better understand the relationship between broadband and the US economy, Deloitte developed economic models using publicly available information on broadband availability via the FCC Form 477, GDP, employment, household density, and other factors. Deloitte also analyzed customer purchasing behaviors to better understand broadband penetration at various speed tiers in different counties across the United States. Our models evaluated the relationship between broadband and economic growth.[9] Specifically, our models confirmed three hypotheses:

A. **Increased broadband penetration leads to economic growth:**
   Our models indicate that a 10-percentage-point increase of broadband penetration in 2016 would have resulted in more than 806,000 additional jobs in 2019, or an average annual increase of 269,000 jobs. Although the regression analysis measures the direct relationship between broadband and economic outcomes, further analysis is necessary to uncover the channels through which this occurs. One possible channel is that broadband can allow for greater access to formal education. In addition, it can expand the types of jobs available in a region, thereby raising the level of skills in the population. These positive effects on human capital can help sustain stronger economic growth moving forward.

B. **Greater broadband availability leads to economic growth:**
   We found a strong correlation between broadband availability and jobs and GDP growth. A 10-percentage-point increase in broadband access in 2014 would have resulted in more than 875,000 additional US jobs and $186B more in economic output in 2019. That is an average of 175,000 jobs and $37.2 billion in output per year.

C. **Greater penetration of higher speed broadband leads to economic growth:**
   The analysis also showed that adoption of higher speeds drives noticeable improvements in job growth. Adding 10 Mbps to average download speeds in 2016 would have resulted in 139,400 additional jobs in 2019 (2% of total created jobs) or about 46,500 additional jobs per year. While the analysis showed that increased speeds lead to greater job growth, it also indicated diminishing returns; the rate of job growth slowed as speeds continue to increase. As an example, the gain in jobs from 50 to 100 Mbps is more than the gain in jobs from 100 to 150 Mbps. This finding is significant, as it suggests that diminishing returns should be considered when evaluating future speed mandates. Our models and the limitations of available data evaluated diminishing returns at a national level; however, we speculate that the specific point of diminishing returns of internet speed likely varies across different geographic areas. Regardless, a more precise understanding of diminishing returns warrants additional exploration.

**Figure 3. Economic impact of digital divide**




*Sources: Deloitte analysis of broadband, economic, and population data (e.g., FCC, US Census Bureau of Labor Statistics, etc.)*

# Broadband speed scenarios

Speed requirements for a household depend on a multitude of factors that make it challenging to establish a single nationwide target that balances cost and performance. The requirements needed to support home broadband vary drastically and depend on the number of people in the household and how residents use bandwidth. For example, the FCC's current definition of 25/3 may be acceptable for a household consisting of only one person. However, a family of five, with multiple people videoconferencing for work or school throughout the day and simultaneously streaming television in the evenings may require far more downstream and upstream bandwidth than the current 25/3 threshold. Meanwhile, demand for content and quality of content (e.g., 4K, HD) continues to increase, furthering the need for greater broadband speeds and capacity.[10] Figure 4 provides download and upload bandwidth requirements for a variety of common applications.

To help gauge the implication of certain thresholds on varying household sizes, we examine three potential usage scenarios:

01. All household members simultaneously stream HD shows;
02. All household members simultaneously stream 4K shows; and
03. All household members simultaneously use 720 HD videoconferencing.

Of course, households use broadband for a variety of functions beyond streaming and video conferencing, such as gaming, commerce, email, etc. The preceding scenarios use streaming video and videoconferencing as examples because they currently comprise the most widely used bandwidth-intensive applications. Indeed, 60% to 80% of current internet traffic is streaming video.[11,12]

Figure 5 depicts how households of different sizes fare under different speed tiers for each scenario. The figure shows that the current definition that has been in place since 2015 warrants immediate upgrade, since it meets the needs of only 28% of US households in a 4K streaming scenario and

**Figure 4. Application speed requirements**

| Use case | | Download requirements | Upload requirements |
|---|---|---|---|
| **Videoconference – 1:1** | 1080 HD | 3.0 Mbps | 3.8 Mbps |
| | 720 HD | 1.2 Mbps | 1.2 Mbps |
| | High-quality | 0.6 Mbps | 0.6 Mbps |
| **Videoconference – Group call** | 1080 HD | 3.0 Mbps | 3.8 Mbps |
| | 720 HD | 1.8 Mbps | 2.6 Mbps |
| | High-quality | 600 kbps | 1.0 Mbps |
| **Streaming** | 4K UHD | 25 Mbps | N/A |
| | Full HD | 5 Mbps | N/A |
| | SD quality | 3 Mbps | N/A |
| **Gaming** | Competitive | 50 Mbps | 10 Mbps |
| | Highly interactive | 25 Mbps | 5 Mbps |
| | Casual | 3 Mbps | 0.5 Mbps |

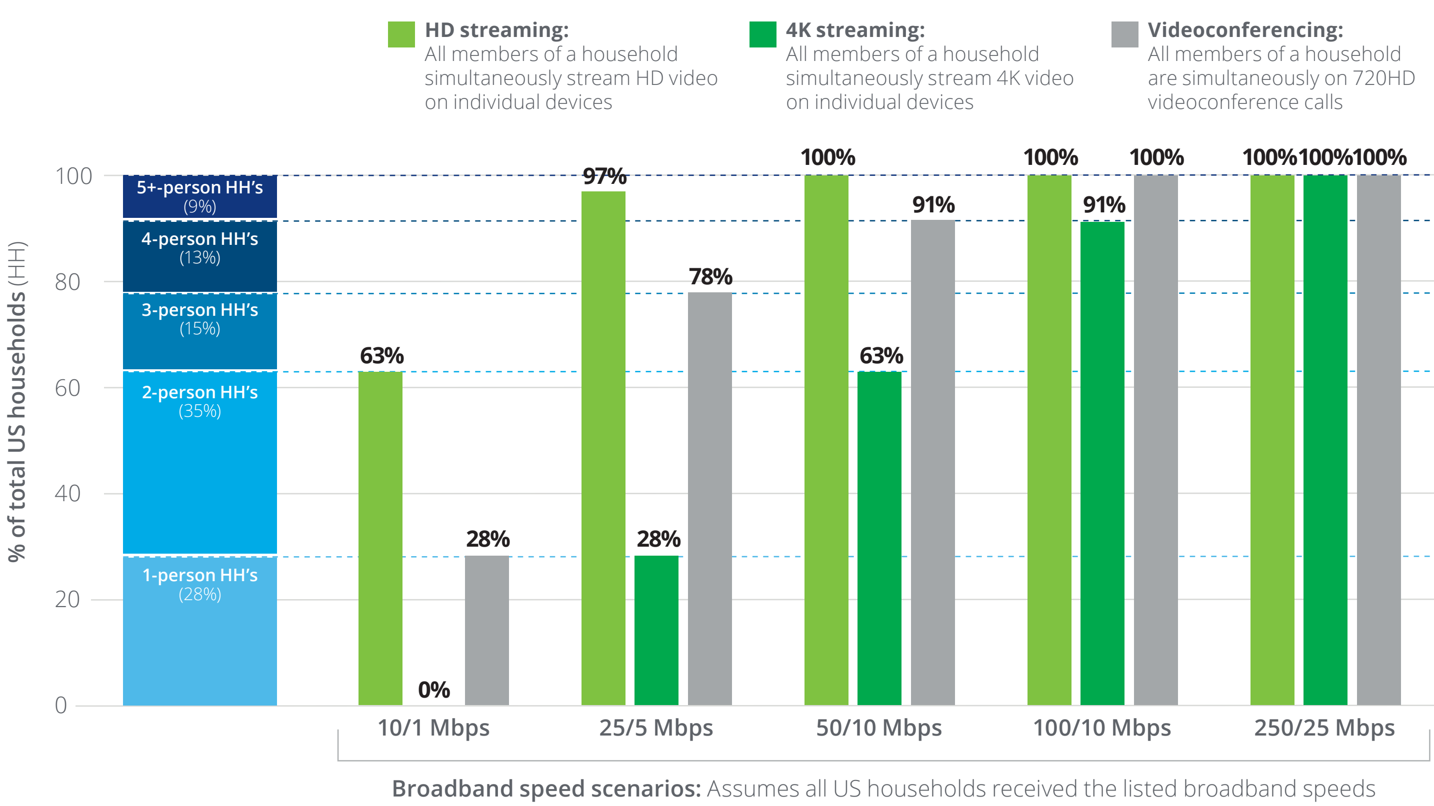
*Sources: Deloitte analysis of suggested bandwidth requirements of streaming and videoconferencing platforms* about three-quarters of US households in a videoconferencing scenario. A broadband threshold of 100 Mbps downstream and 10 Mbps upstream fares much better. In this scenario where every person in every household was individually streaming 4K videos, only 10% of households would be affected and a potential impact could be a reduction of video quality to HD in 1080p. A threshold of 250 Mbps downstream and 25 Mbps upstream appears enough for all US households under each scenario considered.

Even the fastest broadband speeds can meet bottlenecks once inside the home. Wireless routers, for example, operate on low-power, unlicensed airwaves that help prevent interference with other homes, but also may cause spotty coverage inside a home. Speeds and capabilities of the embedded base of home routers must be considered when debating how to set baseline broadband speeds. Furthermore, adjacent technologies such as compression can help solve speed or capacity shortfalls at a lower capital price than network upgrades. Advanced video coding (AVC) technology was introduced in 2003, enabling 1080p streaming at 8 Mbps. High-efficiency video coding (HEVC), introduced in 2012, now allows 1080p streaming at 4-5 Mbps.

Our scenarios highlight the need for higher speed thresholds to meet the demands of new use cases. However, the analysis also points to certain risks when setting national thresholds. Firstly, equal upload and download speeds will place unnatural constraints on broadband consumption. Any increase in upload speed likely requires reducing download capacity.

Secondly, setting too high a threshold for broadband speeds risks discouraging investment in promising new technologies that do not yet meet the thresholds and may risk stranding capital that could be applied elsewhere. Fixed wireless 5G access and satellite broadband are current examples of technologies that cannot yet meet a 250/25 threshold in most geographies but offer potential cost and rapid deployment advantages versus fixed-line solutions that are important factors in solving the digital divide. Overly stringent mandates on speed thresholds run the risk of ruling out these innovations before they gain a market foothold.

**Figure 5. Potential supported households by speed tier and use case**




*Sources: Deloitte analysis of publicly available census data and industry benchmarks*

**CASE STUDY**

# Alger County, Michigan

An in-depth look at the broadband challenges for rural towns and remote habitations.

Alger County, Michigan is a mix of unserved rural towns and remote habitations. It is adjacent to CAF II areas, but was not part of CAF II. The county has a population of ~9,000[13] and is composed of nine townships, two of which are classified as *rural towns* and seven as *remote habitations* per the categories outlined in figure 6.

Broadband providers in Alger County include one cable company, two telephone companies, and two wireless companies, with many of these players serving separate areas. In 2017 and 2018 alone, the High Cost fund paid these providers a total of ~$26.7M.[14] A Deloitte analysis estimated 50% of these funds (~$13.3M) went to Alger County. With fewer than 4,000 occupied households, these two years of subsidy alone amount to almost $3,500 per household.

Carriers serving Alger County have made advancements in broadband deployment, but still lag in terms of competitive broadband service. The 2012 Broadband Report shows that 84% of the population in Alger County had access to 3/0.768 Mbps broadband,[15] close to the FCC baseline speed of 4/1 Mbps, but by 2017, only 74% had access to the new baseline of 25/3 Mbps fixed broadband.[16]

Limited competition exists in both the *rural towns* and *remote habitations,* with the issue becoming even more apparent once outside of the best-covered portion of the county, Munising city limits. The costs associated with network deployment and limited market competition provide little incentive to upgrade and expand advanced connectivity services for Alger County.

The decline of homes in Alger County meeting the FCC broadband threshold in tandem with the county receiving substantial funding highlights that money to address broadband availability is not the sole answer to closing the digital divide. Additional factors for consideration include addressing affordability issues in terms of both broadband service and devices (PCs, smartphones, Wi-Fi access points, and gateways) and attaining meaningful competition between providers to achieve the lowest reasonable price to maximize both investment and adoption.

# Addressing broadband availability and affordability

Identifying underserved geographies and targeting funds toward those areas have been part of most government funding efforts to close the digital divide. Establishing a baseline data set could help target the geographies most in need of support and subsequently measure the degree of progress over time. To date, regulators have relied on self-reported forms and mapping efforts to quantify broadband availability challenges facing customers in different geographies. Recent auctions and disbursement of broadband funds, such as CAF II Auction and RDOF, leveraged Form 477 data as of December 31, 2016.

While accurate maps are essential to efficient disbursement of funds, it may not be sufficiently insightful. An approach that recognizes the vastly different coverage and affordability needs of underserved geographies can provide useful insight to stakeholders who share the common goal of increasing affordability and access. Deloitte segments underserved geographies into four categories, each with starkly different challenges to achieve sufficient broadband coverage, accessibility, and affordability. The categories and associated challenges are listed in figure 6:

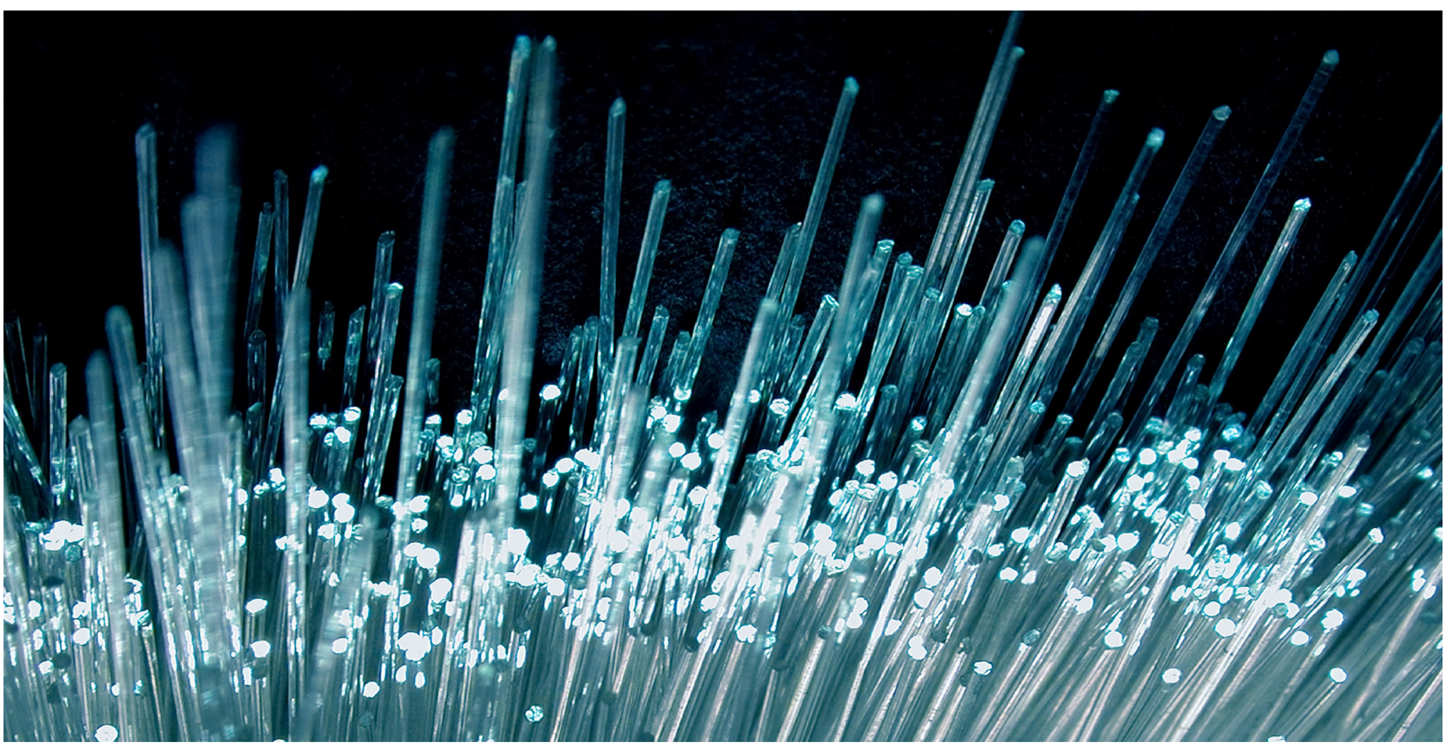
**Figure 6. Segmentation of underserved geographies**

| Client | Coverage | Affordability |
|---|---|---|
| **Underserved dense urban areas** | Household density allows for fiber and wireline extension to support higher speeds; large cities often have slower and more cumbersome processes for infrastructure deployment, disincentivizing ISPs from building additional coverage | Low broadband penetration driven by inability to afford internet access plans and supporting devices (PCs, tablets, smartphones, Wi-Fi, etc.) |
| **Sparsely populated areas adjacent to cities** | Sparse population densities limit intermodal competition (e.g., telecom, cable, wireless), even in locations with attractive build economics | Lack of competition often increases rates for basic and high-speed plans |
| **Rural towns** | Fiber and wireline buildout or extension is expensive given middle-mile capacity can be a bottleneck; lack of specialized labor for deployment, operations and services | Lower household incomes and preponderance of households served by only one provider challenge affordability |
| **Remote habitation** | Cost of fiber and wireline buildout or extension and geographic barriers (e.g., mountains, lakes, distance from urban areas) often mean complete lack of coverage | Lower household incomes and preponderance of households served by only one provider challenge affordability |

Underserved urban areas pose a different challenge than their rural counterparts. The urban geographic category contains some of the most densely populated territories in the United States, implying fiber extension or wireless coverage is far less costly than in rural areas. In fact, many underserved urban areas have significant wireless data coverage.

But network build costs and coverage are only part of the picture. Devices such as tablets, smartphones, and PCs are essential tools for daily activities, including work, education, medical care, and grocery shopping. Moreover, additional expenses, such as Wi-Fi gateways and tech support, must be considered to make digital access truly affordable for an underserved, low-income demographic. Adhering to categories such as those described here can help address both affordability and availability for wireless and wireline broadband.

Our suggestion to split rural into three underserved categories highlights that rural geographies differ greatly in terms of coverage and affordability challenges. Collectively, the three rural categories (sparsely populated areas adjacent to cities, rural towns, and remote habitation) represent about 19% of the US population, 97% of the land area, and about 25 million homes.[17] Remote habitation areas are the most sparsely populated areas of these three categories, posing the most challenging economics for broadband coverage. This category is comprised of approximately 20 million households spread across 3 million square miles. In other words, this single category contains approximately 85% of the US land area and 16% of US households. Comparatively, the two remaining rural categories contain about 7 million homes covering about 110,000 square miles of territory.[18] The stark difference in population density between these rural categories demonstrates the need to seek different economic, subsidy and technology solutions for each category of underserved geography.



# Conclusions

While most agree that solving the digital divide requires public or private investment in the country's wireless and wireline communications infrastructure, we expect debate on the specifics of that investment. Our analysis has led to the following guiding principles that can help yield immediate gains to addressing the digital divide:

## A renewed emphasis on both adoption and affordability can help achieve digital connectivity for all Americans

A focus on network performance measures (e.g., upload and download speeds) is necessary but insufficient. Focus on creating consistent user experiences (e.g., application usability, security, etc.) to provide underserved households with more technology options and improve affordability by not constraining low-cost innovations that may underperform on speed in the short term.

Analyze tradeoffs between investing in higher speeds and innovative new technologies that may not meet immediate requirements, but can be accretive in the future (i.e., satellite, 5G, etc.).

Seek different solutions for unique categories of underserved geographies. For example, Ames, Iowa (Iowa State), and Columbia, South Carolina (USC), are both college towns, but require different economic and technology solutions to address fiber extension costs and incent competition.

## Incorporate the expected growth in broadband consumption and importance into future investments and programs

Stakeholders can obtain broadband access data by utilizing FCC speed tests from subscribers in rural and underserved geographies.

Consider holistic solutions to connectivity that contribute to closing the digital divide, including data compression, unlicensed spectrum, easing of rights-of-way constraints, etc.

The pandemic hastened the pace of a decades-long trend in which innovative applications are increasingly essential to enhance educational opportunities, organize our lives, connect with colleagues and friends, improve workplace productivity, and enhance our quality of life. Progress will be increasingly difficult if a segment of our population lacks the necessary communications infrastructure.

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# Acknowledgments

The authors would like to thank **Brett Haan, Michael Wolf, Matthew Cherry,** and **Matthew Lawton** for their contributions to this article.

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