White Paper

Economic Potential of Faster and More Reliable Broadband: A Community Economics Perspective

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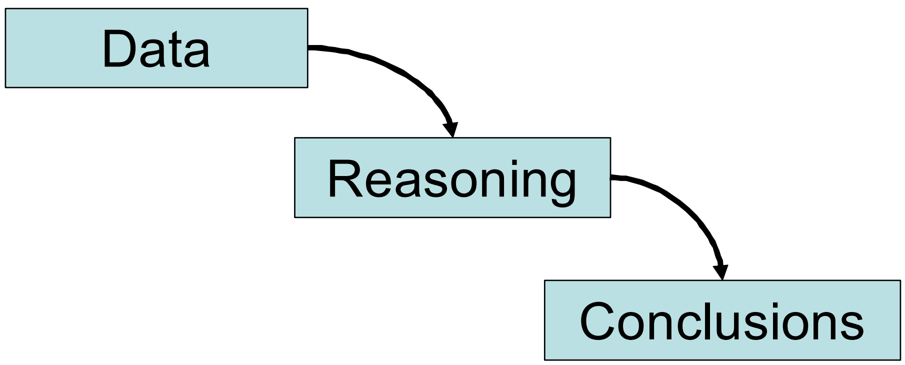

Abstract

Faster, more reliable, and secure broadband access to the internet is the fundamental infrastructure of the knowledge economy for the 21st century. Those who have it will prosper – those who do not will flounder and watch as the rest of the world moves ahead. "Faster" broadband is relative. Today, the FCC's technical threshold for broadband is 25 Mbps download and 3 Mbps upload (25/3). This level of service is rapidly becoming inadequate with the rapid growth of video, voice, big data transmission, artificial intelligence, and critical real time connectivity. This is especially true with new approaches to work, education, and healthcare delivery. Due to the high fixed cost associated with the technologies, both public and private involvement in broadband development is warranted in the financial and regulatory realms to ensure adequate levels of competition which will deliver more favorable pricing and customer service to the consumer and organizations in the long-run. While placing a monetary value on broadband and calculating a ROI is difficult, the broad consensus considers the returns very substantial. This whitepaper briefly considers challenges, value, and approaches of securing needed broadband at the community level.

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Introduction

Today many organizations and employed individuals cannot operate effectively without broadband. At the household level high speed internet access creates substantial benefits. It saves money and enhances the quality of life by creating greater and faster access to services, products, and family and friends. Expanding or extending broadband service is almost universally considered to have a positive socio-economic effect even though the degree of benefits to costs is still under study since the technology and resulting changes are relatively new. This whitepaper attempts to summarize the research available and create a sense of context for local decision makers and potential funding sources.

What is Broadband

Part of the challenge of documenting the impacts of broadband results from there being no single definition. Furthermore, it is not a uniform product. Technically, broadband is high-speed and high-bandwidth communication infrastructure that can be delivered through multiple technologies such as fiber optics, wireless, cable, DLS, and satellite. Broadband comes in different speeds and through different channels. Unfortunately, the definition of broadband matters a lot. According to Federal Communication Commission (FCC), broadband was defined as internet service with download speed of at least 4 Mps (Megabits per second) and upload speeds of at least 1 Mps (abbreviated as 4/1) prior to 2015. In most of the developed world such a level of service will be woefully inadequate with the rapid growth of video, voice, and data transmission. This is especially true with new work, education, and healthcare delivery models that have been accelerated in response to the Covid19 pandemic.

The escalating need for more rapid and reliable broadband pre-dates the pandemic as can be seen in 2015 when the FCC increased the technical threshold for internet to be considered broadband from 4/1 Mbps to a new standard of 25 Mbps download and 3 Mbps upload (25/3). Most recently, consideration is being given to raise the standard to 50/10 as part of infrastructure development proposals in the U.S. In the recent ARPA federal funding the minimum speed requirements are 100/25.

The Digital Agenda for Europe distinguishes different ranges of broadband based on download speeds :

- Basic broadband (between 256 Kbps and 30 Mbps),
- Fast broadband (above 30 Mbps and up to 100 Mbps),
- Ultra-fast broadband (above 100 Mbps),
- Very high-speed broadband includes both fast, and ultra-fast broadband with speed above 30Mbps.

These expanding definitions reflect efforts towards broadband stepping up to the next level to handle more robust data like video as well as multiple users. In addition, integrating into the digital workplace and school requires faster upload speeds as well – often at the same speeds as download (known as synchronous speed).

This ability to be synchronous may still be manipulated by internet service providers to meet organizational needs. For instance, TV streaming would focus, as is currently the case, on faster downloads, while hotels, not wanting to burden their broadband capacity may limit download speeds while maximizing upload so visitors can let the world know where they are complete with pictures and smartphone video. Schools may seek a more synchronous mix while businesses will vary based upon data critical to their individual business. Film editors, for instance, need synchronous 1,000 Mbps (1 Gigabit per second). It is easy to see that with the myriad of needs for different speeds, a key future location criterium for households and business will be the reliable internet speed available at a given location. The cost of access will also be a critical factor.

Fundamental Societal Impacts

Transportation, information, and communications are the most significant economic growth drivers across cultures and history. These fundamental realms are all related to human wellbeing and interaction. In essence, they define time, space, and knowledge. Whereas 20 miles may have been a day's journey in the past, today it is covered in a matter of minutes. Sharing information half-way around the world to create widespread knowledge may have taken years while today the transfer happens in nano seconds. A change in any one of these shift the balance of advantage and disadvantage in the world of economic productivity, trade, military prowess, and political power. The more substantial the change, the more transformational the ultimate outcome, including income disparities among regions and nations.

History provides plenty of lessons on the economic impacts from technological breakthroughs such as the tamed horse, aqueducts, steam engines, homing pigeons, telegraph, aircraft, telephone, the internal combustion engine, and electricity. Those who possess the new technologies advance more rapidly and experience higher standards of living gains as well as greater cross-cultural interaction. Places that were once inaccessible can become a paradise for human habitation. Just as the railroad created entire cities in the 1800s and highspeed highways killed many small towns in the 1950s and 1960s, highspeed internet or broadband will determine winners and losers for decades to come.

Where there is no or very limited internet, the degree of socio-economic inequality and isolation is far greater than areas with internet. While dial-up and other low speed internet technologies enhance human connectivity, it may only be marginally better and limited to text data. Ultimately, speeds for uploading and downloading video and critical data so that the interaction is fluid and without interruption are required to make distance meaningless. As more people are currently and projected to be working and learning from home or in neighborhood centers, speed and reliability become an even greater issue - especially as multiple people from single households all begin relying heavily on the internet simultaneously.

In 2001, United States was ranked 15th among 30 developing nations in deploying broadband services according to the Organization for Economic and Development (OCED). This is a huge departure from where this country stood in prior decades when it was one of the leaders in providing internet services. The biggest challenges associated with broadband access in United States is that it's not universally available in all parts of the country and speeds vary greatly. This appears largely due to the wide range of population densities across the county. According to Broadbandnow.com, the District of Columbia is ranked highest with the fastest average speed of the top decile of speeds (474 mbps) while Montana has the slowest speeds in the 90th percentile (111 mbps). As a general rule, faster speeds are available in the Northeast and Illinois and the slowest speeds are in the Rocky Mountain states except Colorado, Idaho, and Utah (Cooper and Tanberk, 2018). Providing service to less populated areas can prove to be unprofitable for the private sector, making access uneven and spotty. Public subsidies, public-private partnerships and more pervasive satellite delivery of broadband are required to overcome the disparities.

Allowing people to take advantage of broadband's potential to improve the user's wellbeing, whether it's for business development, improved healthcare, education or entertainment is the ultimate goal of broadband investment. Widespread broadband access is a trend the U.S. is rapidly moving toward and overcoming obstacles ranging from jurisdictional conflicts to the lack of effective planning and business models to sustain public broadband services. This increasingly requires public private partnerships at the federal, state, county, and municipal level. These partnerships will remain critical in the future. Once faster broadband is achieved in any community, redundant or diverse delivery systems such as fiber optics, satellite, and 5G telecom towers become important, especially for the reliable delivery of business and government services as well as homeland defense.

Primary Areas of Broadband Impact

Economic Development

The link between broadband and economic growth is one topic that has piqued the curiosity of state and local officials. Twenty-two Organization for Economic Cooperation and Development (OECD) countries have done national studies that show a positive, direct association between broadband infrastructure and GDP (Koutroumpis, 2009). Other studies focused on the local economy revealed a link between broadband availability and economic growth (Kolko, 2012; Holt & Jamison, 2009), as well as higher home prices (Kolko, 2012; Holt & Jamison, 2009).

Broadband access supports entrepreneurship, which is a favored economic development method. The theory that infrastructure boosts start-up activity was evaluated in a study, which found that while infrastructure boosts start-up activity in general, particular types of infrastructure, such as broadband, are more conducive to it than highways and railroads.

Another study found that entrepreneurs who are inventive versus non-innovative are more sensitive to broadband connectivity, among other things (Gallardo & Scammahorn, 2011).

The impact of e-commerce is also a developing topic worth considering. Early studies from Oklahoma revealed that counties with higher broadband adoption rates experienced no loss of local sales tax revenue (Whitacre B., 2011). Although there has been some speculation in the popular press about a “retail apocalypse” (Thompson, 2017), a recent analysis from the Progressive Policy Institute (PPI) shows that this is not the case. This conclusion is backed up by a recent analysis from comScore, which indicated that retail digital commerce (including desktop and mobile) hit $100.1 billion in the first quarter of 2017, up 20% year over year and the first non-holiday quarter to break the $100 billion mark (Lipsman, 2017)

This idea is based on the Internet of Things (IoT), which allows the “physical world to be digitized, monitored, analyzed, and optimized,” with a projected annual economic effect of $3.9 to $11 trillion by 2025. (Baily & Manyika, 2015). Big data and artificial intelligence are important components of the Internet of Things. Big data, according to futurists, is the oil of the twenty-first century, but it, like oil, has its limitations. According to a report published by the professional services firm PwC, artificial intelligence alone will add $15.7 trillion to the global economy by 2030 (PwC, 2017), and that when electrical gadgets are “cognified,” there is enormous potential (Kelly, 2016). Artificial intelligence and the Internet of Things are two components of Industry 4.0, which are having an impact on industrial productivity and growth. Using Germany as an example, the Boston Consulting Group anticipated that over the next five to ten years, Industry 4.0 will increase productivity by €90 to €150 billion and employment by 6% across all manufacturing sectors. It is useful to think of Industry 4.0 as a fourth wave of technological innovation that follows the steam engine, electrification, and automation, encompassing augmented reality, autonomous robotics, simulation, additive manufacturing (commonly known as 3D printing), and cybersecurity, among other things (Rubmann, et al., 2015).

As faster and faster broadband becomes pervasive every sector of the economy will be revolutionized and radically disrupted. Communities and businesses that adopt will adapt. This can already be seen in the earliest of all industries – agriculture. A technique called “precision agriculture” has relied on multiple technologies such as GPS-guided equipment for several decades (Alabama Cooperative Extension System, 2014) and now is leveraging newer technologies, such as unmanned aerial systems (Dillow, 2015) to collect and transmit production data for real time assessment. Broadband is a key integrative element in the process. A study found that the U.S. counties most heavily involved in agricultural production have better connectivity than the average nonmetro county; however, many still lack the capacity to upload large amounts of information that may be required for some precision agricultural techniques (Whitacre, Mark, & Griffin, 2014).

Telehealth

Telehealth, in addition to telework, is another way broadband will transform lives. Telehealth is defined as "the use of electronic information and telecommunication technologies to support long-distance clinical health care, patient and professional health-related education, public health, and health administration" according to the United States Department of Health and Human Services. A decade ago, telemedicine (which is considered a telehealth component) provided an average of half a million dollars annually to local rural economies (Whitacre B. E., 2011) and reduced nursing home residents' hospitalizations, resulting in Medicare savings (Grabowski & O'Malley, 2014). A patient-centered medical home model that used information technology to reduce medical and pharmaceutical expenses, as well as hospital admissions and readmissions, was also tested (Rosenberg, Peele, Keyser, McAnallen, & Holder, 2012). Another study estimated that each rural medical center might save over $180,000 per year (Schadelbauer, 2017). This seems rather conservative. Even though telehealth is approaching popular adoption, considerable legal and administrative impediments, as well as a lack of connectivity or bandwidth, persist (Chapman, 2017) (Settles, 2017).

The mHealth market enabled by mobile communications is predicted to reach $102 billion by 2022, according to market research firm Zion (Zion Market Research, 2016). It, along with all telehealth clearly will revolutionize healthcare access and quality and possibly cost.

Education

Education throughout much of the developed world would have come to an absolute stop during the Covid19 pandemic were it not for the internet. Communities, especially those with moderate-to-high incomes, were in a better position to adjust to the online education environment due to broadband access as compared to slower speed internet. Higher income and more educated urban households also had higher adoption rates compared to other groups. These higher adoption rates are partially due to economic affordability and partially cultural preference. The result of the differentials in pre-Covid19 access and adoption rates left rural communities and lower income households experiencing significant setbacks to education during the early months of the pandemic. As the crisis lingers with each parent, school district, and state pursuing different responses, the disparity in broadband amongst groups will increase the educational divide in the U.S.

While the recent setbacks are disconcerting, when education is viewed as an economic sector competing, like all industries, for public and private dollars or resources, it's easy to fathom education being radically transformed in the coming decades as high speed broadband becomes more ubiquitous. This transformation and greater access and adoption by lower income and more remote households could help close the education gap by providing better access to quality educational programs based on new delivery and assessment methods made possible by the internet. In more rural locations, and even urban education market niches, there could be a return to the one room schoolhouse where teachers are facilitators and coaches to students receiving focused content over the internet.

Higher education has engaged new approaches for over two decades and while it was primarily small private upstarts and lesser known institutions ramping up new approaches, the major universities with strong brands are now playing increasing dominant roles.

The role of the professor or teacher in the classroom is increasingly transitioning to facilitator and tutor on education platforms. This enables a greater degree of self-paced learning where students earn badges to demonstrate proficiency of different disciplines at different levels. With more self-pacing, monitoring, and merit-based advancement, the emphasis is more likely to shift to quality of education, which is a greater contributor to economic wellbeing (Hanushek, 2013), as opposed to grade level attainment.

It is clear education plays a vital role in determining achievable levels of economic wellbeing (Becker, 1993) as well as the long-term viability of democracies. The role of broadband in most educational sectors cannot be overstated. The major roles of broadband in lifelong learning run the gamut including:

1. Improved access to a wide range of professional development opportunities for educators and adult learners,
2. Improved access to high-quality educational services through distance learning programs and online learning,
3. Modules for learning and access to relevant content from any location,
4. Facilitation of the collection and analysis of student data to track student performance more accurately, and
5. Access to “how to” knowledge enabling individuals, households, and communities to take on tasks previously requiring specialists.

Broadband is likely to fundamentally change the organizational model associated with public education. For the last century education moved towards larger schools and class sizes to achieve economies of scale thereby keeping the education cost per student lower. With broadband and a significant shifting of education to online modalities, the future of education is more likely to succeed based upon economies of scope whereby more individualized education is not only desirable, but also financially feasible.

Smart Everything

Smart phones are now ubiquitous connecting both to the internet and telecom 3rd thru 5th generation networks. There are many areas where smart technology, which relies primarily on all the wireless technologies for connectivity, are also showing dramatic results in enhancing efficiency, effectiveness, and the overall wellbeing of those with access. Perhaps most notable, and seldom discussed, are smart grids whereby our essential utilities like power, are automated and able to respond instantaneously to changes in power supply and demand as well as point to deteriorating service for earlier maintenance interventions to minimize disruptions in service. The same real time flow of information into early warning and artificial intelligence systems already saves industry and governments billions of dollars annually and is assisting in saving the planet through lower CO2 emissions. Cars sensing their environment and connecting smartly to other vehicles promises a future of autonomous driving. The early dividends of smart cars are already noticeable resulting in safer driving and early rerouting to minimize congestion and fuel consumption.

Value and Return on Investment

It is way too early to reliably forecast a monetary value associated with communities accessing and adopting broadband if none exists or faster broadband if some level already exists (the case in most developed economies). All we really know is that the payoff will be transformative. Some studies are beginning to emerge with one of the more comprehensive being Dr. Lobo's 2020 study estimating the return from a $220 million investment made in "fiber-to-the home" in Hamilton County (Chattanooga) Tennessee beginning in 2010. The study found 40% of new jobs were related to expanded broadband and cite value of the resulting investment in different sectors of the community exceeding costs by a factor of 4.4 times. Fifty-two percent of the benefit manifested in economic development, 28% related to efficiencies in the local electric smart grid, and 20% from business efficiencies and local household and community effects (Lobo 2020).

While we find a lack of detailed research on returns on investment, a number commonly used in rural areas comes from research from The Ohio State University's Swank Program in Urban-Rural Policy. The research concludes, based upon a review of other economists' research, a total household benefit of between $1,500 and $2,200 per household (Rembert, Feng, Partridge, 2017). This range is used by an increasing number of communities and foundations to estimate the ROI of broadband investment. Using $1,850 in benefit per household, the Blandon Foundation in Minnesota estimates a one year or less return of public capital invested in four of five rural counties reviewed (2017). The one outlier in the study was forecasted to recover its public investment in six years. More notable were results assuming a 3% increase in residential property values. This is an interesting notion which is quite credible based upon hedonic values associated with real estate where the economic benefits to households are internalized into the value buyers are willing to pay for homes with certain attributes (in this case access to fast broadband).

Public and Private Involvement

Given the technologies currently deemed best suited for high speed internet access are fiber optics, satellite networks, and wireless networks through towers, the role of the public sector is to either directly invest in these network technologies, or to incentivize the private sector to make those investments. There are plenty of historical precedents with this type of investment. In the early 1800s the capital required to build the transcontinental railroad system was massive. To get the job done the federal government granted railroad developers land along the tracks in a pattern of alternating square miles – one mile for the railroad and one mile for the federal government. The checkerboard stretched six miles on each side of the tracks. From 1850 to 1870 approximately 7% of the continental U.S. was granted to eighty railway companies (Olmanson, 2020). The alternating square mile pattern guaranteed future land sales would be competitive. Despite the grand incentives, sometime the federal government had to go even further, and guarantee bonds issued by the railway companies.

More recently our interstate highway system was almost entirely financed with federal funding while more localized expressways or extensions/expansions of the primary interstate roadway were funded by states or the private sector through toll roads. In some cases, the toll system was time limited expiring after investors, or the state was repaid. In other cases, the granting of toll rights to private road developers might be granted in perpetuity. A different development model emerged with airports throughout the U.S. Here airports are almost always a local public enterprise that is heavily supported with federal investment somewhat predicated on economic access and on the need for a dispersed system of airports for homeland defense.

While these comparative models of transportation development demonstrate the need for government financial and rights granting involvement with major infrastructure projects, the development of telecommunications through the Bell System, subsequently AT&T, is more revealing about the present and evolving state of broadband development. Telephone service was initially a local service connecting homes and businesses together in a community. Development was slow at first until Alexander Graham Bell's patent expired in 1894 resulting in the creation of approximately 6,000 telephone businesses – often with localized monopolies or oligopolies building competing systems. The Bell Company was just a well-capitalized competitor in these markets.

AT&T was a subsidiary of the Bell Company formed to connect cities. In 1899 AT&T acquired the assets of the Bell Company and in 1907 began operating under the theory that telephone service was a natural monopoly whereby the greatest efficiency in delivering local, regional, and national telecommunications was derived from one regulated company. The basis of natural monopolies is that the fixed cost of running infrastructure, especially wires and cables in this case, throughout communities and the nation is shared by all consumers of the service. If there are more service providers, each with their own fixed networks, there is duplicated cost with fewer customers per network to share in the cost – hence everyone pays more. Furthermore, all equipment and protocols for connections become more or less standardized under natural monopolies. It was not until 1982 that Congress responded to new technologies challenging AT&T's fixed wire network and broke up the monopoly creating many Baby Bells which had to compete with rising stars from fiber optics, microwaves, and satellites. (Newlon, Spooner, & Spooner, 2021)

The future development of broadband must navigate similar landscapes with multifaceted business models, financing schemes, and public/private involvement. It is unlikely that any single approach or company will dominate, but there will be dominant players at the local level with a significant degree of monopolistic powers. This reality provides two fundamental responses to both encourage the development of more affordable broadband with quality customer service for decades to come. These are:

- Support common ownership of the middle mile and cell towers, typically through states, local governments, or local public enterprise utilities, and
- Provide incentives to for profit entities in the form of grants and low interest loans and/or exclusive, but regulated, rights to the communities being served.

Both approaches must compete with alternative satellite technology. While satellites are not bound to fiber optic cable to homes and businesses, or limited in geographic reach like wireless cell towers, they too face obstacles in the form of high cost and growing congestion in space among more global players and private entities. Hence, no entity is likely to achieve true monopoly status, but there are key elements to consider to best protect high speed internet access and affordability overtime.

Given it generally makes sense to have only one provider on any given stretch of middle mile of fiber optic in less densely populated areas, such providers must be regulated. Such regulation should follow suit to common carriers found with natural gas pipelines and cell phone networks whereby the middle mile investor is required to reserve some capacity for localized competitors thereby making the last mile competitive. These arrangements can still be problematic in that the middle mile provider has an advantage in access and can engage in transfer pricing thereby placing a greater burden on local competitors. Perverse incentives also exist under these common carrier arrangements to under invest so capacity is reached sooner; thereby providing little capacity for competitors on the common middle-mile line, and to charge customers a higher price since if there is a shortage of service relative to demand. The reality of the middle mile is that upsizing the fiber optics before placing it in the ground has a low marginal cost and should be pursued in the public interest.

Similar logic can be applied to telecom wireless towers capable of delivering 5G technology to smartphones and hotspots. While the cost of individual towers is not so great as to prevent other providers from building competing towers to deliver faster connectivity to the internet, the perceived non-monetary cost to communities is often high resulting in NIMBYism whereby nearby residents do not want towers in their backyard – especially tall towers capable of servicing larger geographic areas than their own immediate neighborhood. With towers, local and state governments must play the arbitrators role to help overcome legitimate local obstacles to promote more reliable and faster access at a lower average. If the approval process is not overly cumbersome, the private sector will, in most cases, respond favorably with tower development and lease space on the towers for competing wireless companies. Unfortunately, even under this scenario the number of providers is limited as the industry has become more concentrated over time. Given cellphone providers like Verizon and AT&T are multi-national in scale, it may require federal legislation to require the provision of new, high fixed cost, technologies into less dense communities.

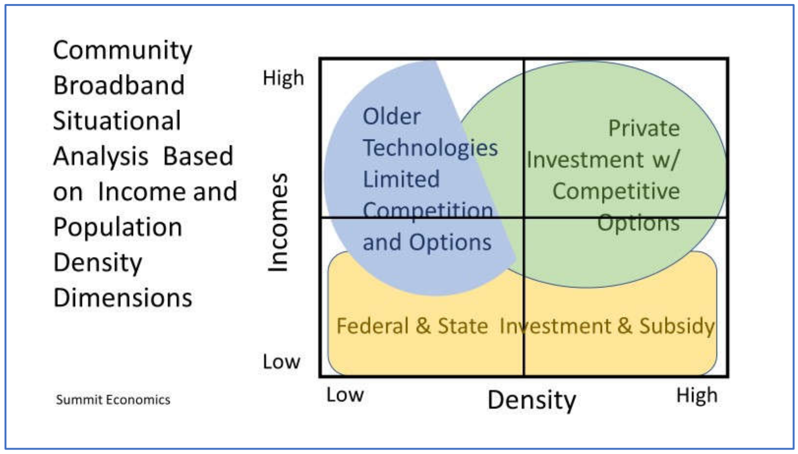
When the emphasis is on the short-term effort to get faster and affordable broadband to communities, the longer term is often forgotten. Near monopolies are notorious for poor customer service since the customer has very limited, if any, viable alternative. To mitigate this reality, communities should connect rates of return permitted for private sector providers or compensation for public sector enterprises to customer service metrics achieved over time. Ultimately, it makes sense for public private partnership agreements to be time limited to between 20 and 40 years so that local providers are constantly reminded of their need to operate both effectively in terms of service as well as efficiently as an operation.

Conclusions

Faster, more reliable, and secure broadband access to the internet is the fundamental infrastructure of the knowledge economy for the 21st century. Those who have it will prosper – those who do not will flounder and watch as the rest of the world moves ahead. The future with faster broadband, initially through fiber optics cables, 5G wireless telecom, and satellite connectivity will be no less transformative than the steam engine and telephone in prior centuries.

"Faster" broadband is relative. Today, the FCC's technical threshold for broadband is 25 Mbps download and 3 Mbps upload (25/3). This level of service is rapidly becoming inadequate with the rapid growth of video, voice, big data transmission, artificial intelligence, and critical real time connectivity. This is especially true with new approaches to work, education, and healthcare delivery. The current need for many households is for speeds from 30 to 100 Mbps. Many businesses and other organizations need synchronous speeds up to 1 gbps (1,000 Mbps).

The wide range of socio-economic impacts from faster and more reliable and secure internet connectivity make it difficult to quantify the impacts. However, the limited research that has occurred suggest very high levels of return on public investment in most cases. As shown in the adjacent perceptual map, where the return on private investment is significant, mainly in high density and above average income areas with high adoption rates, for-profit companies will commit capital to develop fiber optic networks and a reasonable level of competition results. Due to the high fixed cost of developing fiber optic networks needed for broadband, duplicate networks reduce the number of users per network and raise the cost per unit of service. Hence, limited competition and higher cost access results in lower income and less dense areas. Current efforts by state and local governments are targeting low-to-moderate income communities of moderate density. Unfortunately, moderate to high income rural areas are at risk of being left with slower and less reliable broadband. Satellite technologies like Starlink's array will provide access to households and businesses with open skies. Whether the satellite technology will be reliable at high usage levels is a question as is the ultimate capacity given emerging challenges of managing congestion in the satellite zone of the heavens. New 5G telecom technologies provide more localized solutions, but also require line of sight, and with fewer telecom providers, there is less incentive to upgrade to newer generations of technology in low-to-moderate income and/or lower population density communities.



Regardless of a given community's situation, surviving and thriving in the future requires expansion of broadband speeds, reliability, and security.

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