FiberBroadband ASSOCIATION

The Rural Digital Divide

Fiber Broadband Can Eliminate The North American Rural Digital Divide

a **Whitepaper** by the
Fiber Broadband Association

fiberbroadband.org 3050 K Street NW, Suite 400, Washington, DC 20007, USA

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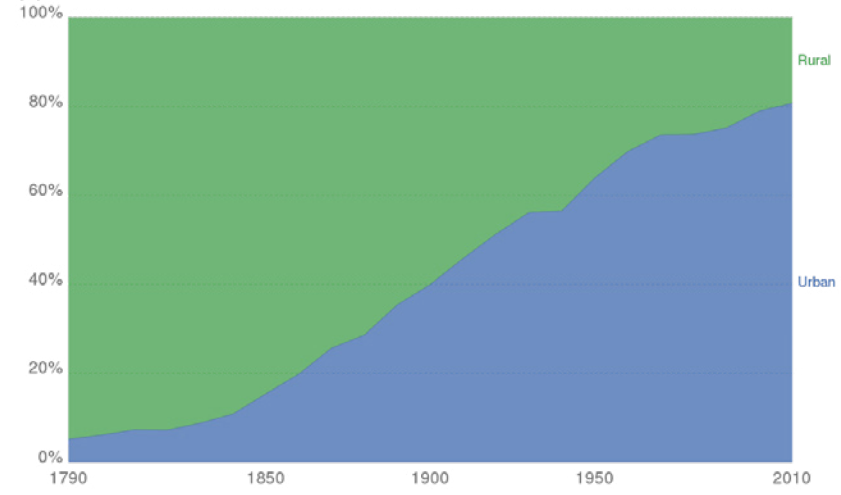
A. What Is The Rural Digital Divide?

The lack of adequate high speed broadband availability in rural areas compared to metropolitan areas has been a persistent challenge in North America for many years. That challenge exploded in importance as the pandemic forced nearly all interactions to be conducted from the home, further exposing the insufficiency of the broadband available in many rural areas of North America. The result is lower productivity, lagging education, declining economic development opportunities and poorer health outcomes for rural residents. Fiber Broadband to the Home can permanently close the rural high-speed broadband availability divide.

B. Why Is Eliminating The Rural Digital Divide Important?

FIGURE 1

URBAN AND RURAL POPULATIONS IN THE UNITED STATES



Source: US Census Bureau (2010)

At a recent conference discussing the rural digital divide, one participant questioned, "Why should we care about this divide? If people there want better Internet, they can just move to the city like the rest of us."

Indeed, there has been a massive population shift to cities in the past 100 years in North America. Figure 1 shows the 2010 Census showed nearly 80% of the U.S. population now live in urban areas. On the other hand, since about 1970, the urbanization trend appears to be slowing (and as will be seen, the trend may now be reversing).

There are many essential economic endeavors best suited to rural areas, including agriculture, transcontinental transportation, forestry, mining, energy production (both fossil fuels and alternative energy), and many types of manufacturing. Of course, they all require a rural workforce.

As is the case for nearly every economic activity nowadays, high quality, and reliable broadband is required to facilitate increased productivity. A prime example is precision farming using ground sensor, drone, and satellite data to precisely analyze needs and monitor applications on a foot-by-foot basis for water and nutrients, etc. Another example is coordinating via broadband the smaller, distributed energy sources scattered throughout rural areas, such as windfarms, solar farms, etc.

In addition to having a rural population to meet the needs of essential economic activities, there is also a clear strategic advantage to both the U.S. and Canada in having a more dispersed population overall. This fact has clearly been highlighted by the 2020 COVID-19 pandemic. Those in concentrated areas have generally experienced greater pandemic impacts than in the rural areas. The same strategic logic applies for nearly any national emergency one can envision – hurricanes, earthquakes, war, terrorism, etc. In all these cases, it is desirable to have a dispersed population.

Interestingly, one of the primary drivers of urban concentration, the need for physical proximity to work facilities has become less important. The Internet has demonstrated how remote work, shopping, health, learning, and even entertainment are now possible regardless of where an individual lives. This "virtual" access to work and services greatly accelerated during the 2020 pandemic.

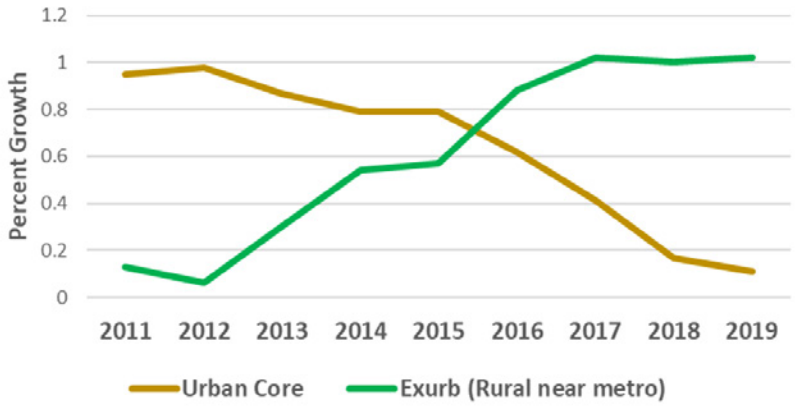
According to data from Brookings[1], in Figure 2, over the past decade and prior to the pandemic, population growth has been accelerating in exurban areas (rural and semi-rural counties near metro areas), while growth in the urban core has been declining. Recent pandemic and safety concerns seem to be accelerating this trend.

Coming advances such as autonomous vehicles will only enhance this trend. (Many could work from home in a rural area 3 or 4 days a week, and on other days make a long commute while working or relaxing safely and comfortably from an autonomous self-driving automobile.)

A recent Jefferies study of United States Postal Service mail forwarding requests spiked by 9% Year over Year at the beginning of the pandemic in March and April of 2020 and then re-accelerated into year-end 2020 with an increase of 8.1% in December, Year over Year. The data shows that these "move-out" requests originated from urban areas and the "move-in requests" originated in exurban and rural areas. Suburban areas remained largely unchanged.[2]

FIGURE 2

ANNUAL POPULATION GROWTH RATES: SEMI RURAL VERSUS URBAN



Source: Metropolitan Policy Program at Brookings

Further data on "market hotness" from Realtor.com, measuring page views per property and days on market, also shows that rural zip codes jumped the most, with a median of 846 points upwards in rankings, versus suburban zip codes up 404 points, while urban markets were up only 87 points.[3]

Many rural residents currently live in medical, education and other "deserts".

Likewise, Real Estate Brokerage Redfin CEO Glenn Kelman said, ***"We're also preparing for a seismic demographic shift toward smaller cities. Prior to this pandemic, the housing affordability crisis was already driving people from large cities to small. Now, more permissive policies around remote work and a rising wariness about close quarters will likely accelerate that trend."***

Obviously, those in rural areas lack **physical** proximity to all types of services, and therefore, even more than those in urban areas, need **virtual** proximity via high-speed broadband.

According to a 2019 study from Drake, Zhang, Chaiyachati, and Polsky, only 10% of physicians practice in rural areas where 25% of residents live.[4] A 2019 study from Carroll found that residents who live more than an hour away from their nearest hospital tend to be older and sicker, obviously needing medical care. The study also found these residents were least likely to have a broadband connection.

Blagg and Rosenboom (2018)[5] identified the phenomenon known as education deserts where there is no physical access to education campuses, and access to online education in these deserts is not feasible due to low available bandwidth. An estimated three million Americans live in an education desert and 82% of all education deserts are in rural areas. This is more important in 2021 as current stay-at-home orders curtail many face-to-face educational opportunities and more learners are relying on broadband.

Overall, those in remote areas appear to rely more heavily on broadband applications yet have less access to it.

For rural North America to reach its future potential, higher speed and more reliable broadband is essential. This may seem self-evident: How many 25-year-olds, especially those with a college education, will stay in, or move to, a small community with poor broadband? Academic research backs this up. Studies from Steve Ross with Broadband Communities Magazine have shown that higher speed broadband is related to positive local rural population change and lower poverty rates, with evidence of causality[6]. Another study from Lobo, Alam, Whitacre shows that better high speed broadband availability appears to improve rural employment. [7]

High-speed reliable broadband is the second most desired characteristic in a community after safe streets, according to attitudinal studies of both urban and rural residents by RVA.

C. What Is the Current Status of The Rural Digital Divide in North America?

Bandwidth demands have increased by over 100 times since the 1990s and continue increasing.

The perception and understanding of what the internet versus what broadband access is, has been muddled from a consumer viewpoint. The confusion is in part, because it has been a changing and evolving industry and never completely defined. When the internet became publicly available around 1995, the only option to connect was through dial-up, which provided the average user somewhere around 30 Kilobits per second (Kbps). This could alternately be called 0.03 Megabits per second (0.03 Mbps). As applications requiring more bandwidth began to appear, and new methods of transmission such as DSL, Cable modem and Satellite emerged, regulators such as the U.S. FCC began to define what a "high bandwidth" or "broadband" service would be – i.e., what service level would generally allow a reasonably good online experience.

his definition has been somewhat arbitrary, a moving target, and increased by 125 times since the 1990s. It needs to continue increasing now. The FCC first defined broadband as 200 kbps down (0.2 Mbps), and later as 4 Mbps down / 1 Mbps up (4/1), and most recently, as 25/3. A review of bandwidth requirements of common household devices and services indicate that 25/3 service is inadequate today, particularly following the Covid pandemic when a larger number of people are working and learning from home. [8]

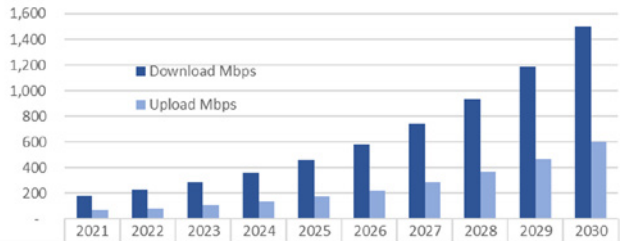
Ookla, the global speed test provider, reports average U.S. fixed broadband speeds of 179/65 Mbps in Jan 2021, ranking 12th Globally. Over the past 5 years U.S. fixed broadband speeds for download and upload have been increasing at a compound annual growth rate of 27% and 28% respectively, from 65/19 Mbps in 2016. If these growth rates continue over the next decade, the average U.S. fixed broadband speeds will be 1500/599 Mbps by 2030.[9]

Emerging augmented reality (AR) and virtual reality (VR) applications may require symmetrical upload and download speeds[10]. This suggests that upload speeds might grow at a higher compound annual growth rate than the 28% we have seen in the past 5 years, perhaps 35% or more in the next decade. In that case, average U.S Fixed broadband speeds will be 1500/966 Mbps by 2030.

FIGURE 3

SPEED TEST DATA SUGGEST GIGABIT DEMAND BY 2030

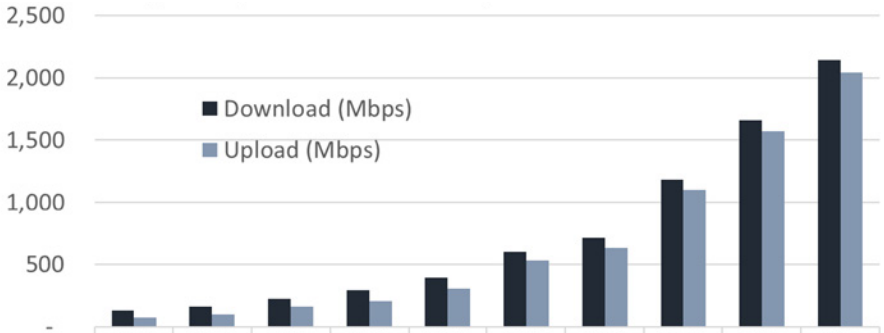
Year	Download (Mbps)	Upload (Mbps)
2016	54.97	18.88
2021	179.06	64.89
CAGR	27%	28%



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Download Mbps	179	227	287	364	461	583	739	935	1,185	1,500
Upload Mbps	65	83	106	136	174	223	285	365	468	599

*upload speeds potentially change if AR/VR adoption increases in the market expands
Source: USources: Ookla January 2021 SpeedTest Data ; Vox Article on 2016 Speeds

FIGURE 4
PROJECTED PEAK BANDWIDTH REQUIREMENTS - HOUSEHOLD OF 4



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Download (Mbps)	131	158	222	293	396	601	709	1,182	1,658	2,141
Upload (Mbps)	73	98	160	203	302	529	633	1,100	1,570	2,044

- Does not include Robotics
- Early adopters, Radiologists, Power Users/Gamers, others may require much more

Source: Fiber Broadband Association Technology Committee

Students lacking access to AR and VR from home will be significantly disadvantaged. "AR and VR educational applications shift the learning process from passive to active, allowing students to interact with content and practice their knowledge in real-time conditions. Learning by experience leads to better understanding, enhances knowledge recall, and strengthens retention. Immersive and interactive experiences stimulate students' motivation and increase their engagement level, which are fundamental factors for achieving learning goals"[11]. Figure 4 shows an analysis by the Fiber Broadband Association's Technology committee of minimum peak bandwidth requirements for a household of four indicating 131/73 Mbps is required in 2021, growing to 2,141 / 2,044 Mbps by 2030. These trends clearly show the current federal broadband definition of 25/3 Mbps in America and Canada 50/10, is always way behind the reality of need.

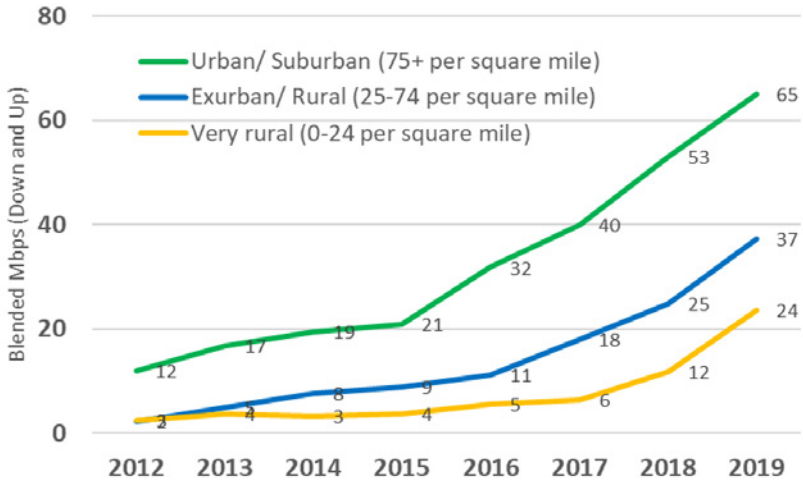
Given the significant and growing bandwidth demand of North American households, a more appropriate and future-ready measure of adequate broadband deployment is the availability of 1000/1000 Mbps service. Using just a 500 Mbps downstream threshold, some states have as low as 8% availability overall with rural areas having even lower availability. The Fiber Broadband Association recommends any new network built in 2021 should support a bare minimum of 100/100 Mbps, and preferably 1000/1000 Mbps to help avoid disadvantaging North Americans as fixed access bandwidth demand continues growing exponentially as it has over the past 25 years.

Figure 5 shows RVA data from speed tests taken during consumer surveys shows that for those who do have Internet, speeds have been increasing in all areas, but lag in rural areas, especially very rural areas.

Further, shown in Figure 6, when dividing RVA 2020 consumer respondents into five equal quantiles, rural areas have the highest percentage of the lowest two quantiles. In other words, 62% of the most rural areas have the lowest performing broadband. Speed for the lowest quantile is only 4 Mbps down and 1 Mbps up. Latency for this lowest quantile is extremely poor – averaging 783 milliseconds (almost a full second of delay, i.e., 0.78 seconds versus 0.02 seconds for Quantile 1).

Such poor internet has consequences. Nearly half of quantile 5 users report they have significant in-home rationing such as asking other family members to stay off the internet during business video conference calls. Further, quantile 5 users report an amazing average of 11 lost hours per week waiting for applications to load, etc. Other reports include double paying for backup Internet service just to maintain constant availability.

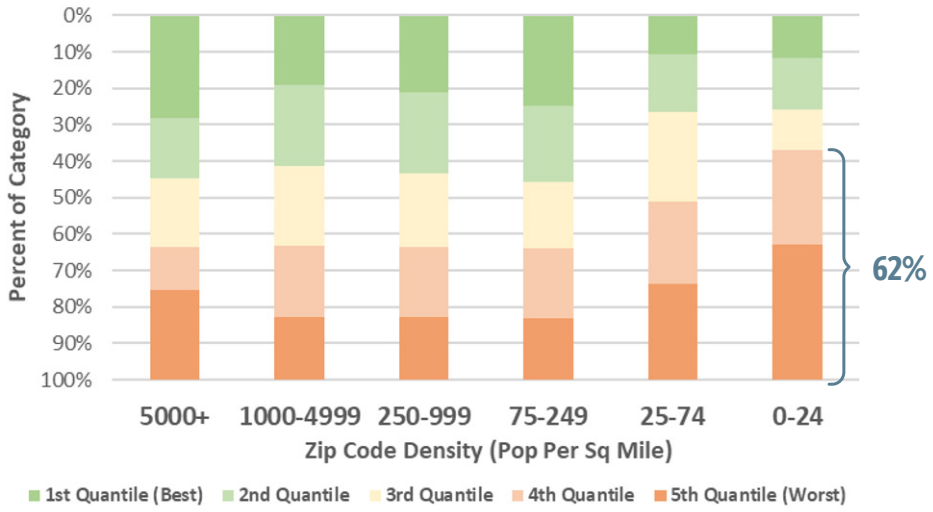
FIGURE 5
AVERAGE BLENDED BROADBAND SPEEDS VARY BY LIVING DENSITY



Source: RVA Consumer Study Speed Tests

FIGURE 6

THE DIGITAL DIVIDE IS EVIDENT:
REPRESENTATION OF INTERNET SPEED QUANTITIES BY ZIP CODE DENSITY 2020



		Speed Quantile 1 (Top 20%)	Speed Quantile 2 (Second 20%)	Speed Quantile 3 (Third 20%)	Speed Quantile 4 (Fourth 20%)	Speed Quantile 5 (Lowest 20%)
Download speed (Mbps)	*Higher is better*	261	103	49	23	4
Upload speed (Mbps)	*Higher is better*	47	21	14	5	1
Latency (ms)	*Lower is better*	23	29	36	45	783

Source: RVA, LLC

Table 1 indicates the lost hours per week may seem small for the upper quantiles, but the effects significantly impact work from home and learning productivity.

TABLE 1

Speed Quantile	Download Mbps	Upload Mbps	Latency (ms)	Additional Hours Lost per person per Week	Additional Hours Lost per person per Year
1	261	47	23	0	0
2	103	21	29	0.3	15
3	49	14	36	0.6	30
4	23	5	45	1.8	90
5	4	1	783	6.0	300

D. What Is the Solution to Eliminating The Rural Digital Divide?

To eliminate the rural digital divide, the following is required:

1. Focus attention on the most effective rural broadband infrastructure.

Various broadband technologies can be helpful in the short term and private service providers are certainly free to use any solution: DSL, HFC cable, wireless, current fixed satellites, upcoming low orbit satellites, possible floating blimps, Wi-Fi hotspots near schools for students and so on. Private investment to make any improvements to rural broadband would be welcome, but it should be understood, however, that all of rural North America ultimately needs the best sustainable solution – perhaps even more so than does suburban and urban North America. That superior solution is clearly fiber optic cable directly to the residence. This statement can be made definitively because:

- Without exception, there is simply no communications medium nearly as effective or "future proof" as fiber optics. Once fiber is in place, the transmission capacity can be increased almost infinitely as needed to supply whatever bandwidth is needed. Fiber optics are immune to electrical interference and require far fewer powered nodes, enabling fiber to provide the most consistent and reliable technology.
    - A copper wire such as DSL or Coaxial Cable cannot compete. There is a huge trans mission loss for every foot an electrical signal passes through copper.
    - Wireless cannot compete - it spreads its energy in the air. Even the most effective wireless solutions, the type of high-band narrow-beam "5G" wireless using millimeter waves cannot fully compete in terms of capacity. Also, this type of 5G has a very short range, must be carefully aimed, requires a completely clear line of site to the receiving antenna, and still needs fiber to the transmitting antenna. (Further, high band 5G will not likely be economically viable for most rural settings.)
    - Low orbit satellites cannot compete – while they will be superior to current high altitude synchronous satellites, they require complicated tracking antennas and have limited capacity (especially on the upload side) and higher latency (communication delays).

Fiber-Optic broadband to the rural home is the clearly the ultimate solution to solve the rural digital divide.

The current advantages of fiber versus other methods are easily demonstrated. As shown in Figure 7, based on end user experiences on the actual performance of various types of broadband, in speed, latency, reliability, and satisfaction, FTTH clearly has the best performance.[12]

FIGURE 7

FIBER PROVIDES A SUPERIOR EXPERIENCE OVER OTHER BROADBAND TYPES: BROADBAND EXPERIENCE INDEX 2019

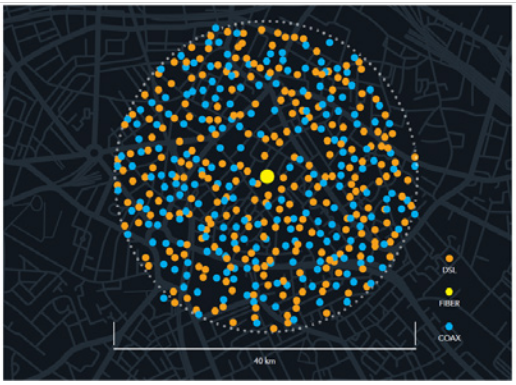
	FTTH	Cable	Wireless	DSL/FTTN	Satellite
2019 BEI	98%	65%	38%	38%	1%
2019 ALTERNATIVE BEI	99%	69%	47%	45%	14%

Source: RVA, LLC

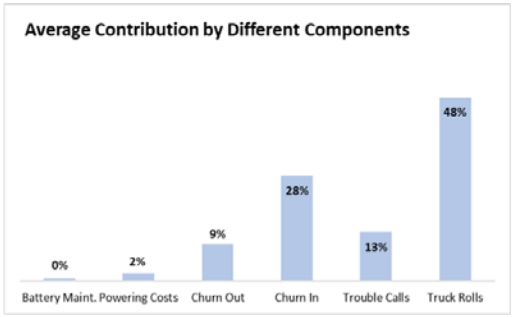
Based on a detailed engineering review of the cost to operate a fiber to the home system versus other broadband methods, fiber clearly has the lowest operational costs. Shown in Figure 8, these FTTH Opex cost savings can amount to $91 per year, or $910 over a 10-year period.[13]

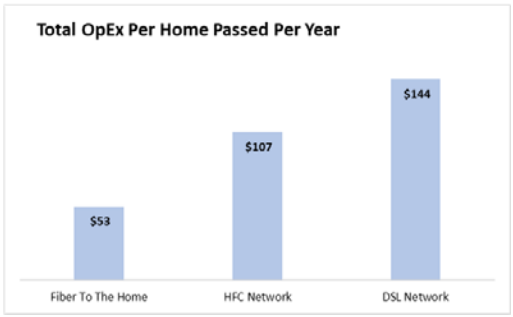
FIGURE 8

FTTH HAS A DISTINCT OPEX ADVANTAGE OVER OTHER METHODS



Typical powered equipment in a 40 Km area by provider type. FTTH has one powered point versus hundreds for other methods. The primary impact of this complexity is less reliability.





Source: RVA, LLC

2. Encourage private (and local public) investment in rural fiber

All types of entities serving rural customers with Internet, whether private or municipal, enjoy many benefits from fiber deployment, and should be encouraged and educated as to the advantages of choosing fiber broadband to their business case.

Solving the rural digital divide will take the work of many types of service providers.

There are distinct advantages to fiber deployment for all types of service providers.

- Tier 2 and Tier 3 telephone companies as well as smaller cable companies have been switching to fiber broadband to serve their customers better, improve their revenue, reduce operations expenditures, and protect their market share.
- Wireless service providers have started hedging their bet and (as they continue to run wireless systems) and are starting to build out fiber broadband in many areas, understanding that eventually this will be the best way to serve their customers and protect their market share.
- Rural electric cooperatives are installing fiber broadband because of their history of serving customers, allowing better control and analysis of the electric grid including automated meter reading, and understanding that a fiber "grid" will likely be necessary after an electric grid becomes less necessary as residential solar and battery energy storage becomes more cost effective.
- Municipalities need fiber broadband to ensure their communities thrive, to serve their citizens, and to provide backbone for 5G and Smart City activities. Many municipalities are looking at broadband as critical infrastructure, much like roads, water systems etc. To meet this need, some communities are building and operating their own systems, some are building infrastructure partnering with private providers running the system, and some are simply encouraging private providers to build in their area.

States governments and related entities can also take action to invest in or encourage broadband. Brian Whitacre's academic research at Oklahoma State University has found that states with broadband committees or commissions positively impact broadband availability in that state.[14] Strategic broadband shareholders should work to educate all public government decision makers as to the position of their area's broadband versus their peers and encourage a sound understanding of broadband's current and future economic benefits.

3. Encourage public investment in rural fiber

We must encourage government investment in fiber broadband where appropriate. For very rural areas, fiber broadband often needs to be subsidized because despite good take-rates, the privately funded business case for very low-density areas is often inadequate and these areas may not have a middle mile fiber in place to connect to the national network. It should be noted that the same was true when rural areas of the U.S. were electrified using government support from 1935-1965.

Federal government Investment is important... but only for a permanent and lasting solution to the rural digital divide.

In the U.S., government funding happens at both the federal and state level. At the federal level, there are important funding programs for broadband deployments through the FCC, the USDA, and other agencies. The FCC has planned to fund $20.4 billion over 10 years to improve broadband in rural areas. However, $20 billion is just a starting point as it is estimated that $70 billion of additional private and/or public investment over that already planned is needed to make fiber available to 90% of US households.[15] On March 31, 2021, President Biden announced the "American Jobs Plan" that includes $100 billion to connect every American to high-speed broadband over the next 8 years. In addition, some states provide grants, and those states with knowledgeable broadband leadership are making the most effective use of public funding.

Meanwhile, the Canadian government is also investing in broadband. The CRTC Is expected to spend nearly $7 billion over the next ten years with additional investment from provincial programs.

The Fiber Broadband Association believes that the federal government should invest in future- proof networks offering 1000/1000 Mbps service, and at a minimum 100/100 Mbps vs today's 25/3 Mbps definition, as lower quality networks will either leave North Americans behind, or require costly upgrades over time to keep pace with growing bandwidth demand. In some cases, initial investments in slower networks may make future upgrades difficult because of prohibitions on multiple government investments in the same community. Prioritizing fiber networks facilitates a "Build it Once" policy that avoids the cost of periodic upgrades while giving consumers greater bandwidth and productivity from the start. Moreover, the installation of fiber networks facilitates 5G mobile service as well, as 5G networks are primarily fiber architectures that utilize antennae to deliver signals relatively short distances to the consumer at the end of the network. As speeds required for households to function productively will reach Gigabit levels in less than a decade, it has become clear that if it's not Fiber, it's not broadband.

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fiberbroadband.org 3050 K Street NW, Suite 400, Washington, DC 20007, USA

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