A Policymaker's Guide to Rural Broadband Infrastructure

BY DOUG BRAKE | APRIL 2017

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For over a century, universal service has been an explicit, foundational objective of telecommunications policy. The underlying technology and the industry structure have changed dramatically since Theodore Vail, then president of the American Telephone & Telegraph Company, called for goal of "one policy, one system, universal service."[1] In turn, the appropriate tools for expanding communications infrastructure to rural areas have changed as well. But the goal remains the same: access to modern communications at a reasonable price for all U.S. residents. With discussion of a potential infrastructure package at some point in the Trump administration that many rightfully hope will include rural broadband, it is worth examining previous attempts to spur rural broadband service, revisiting the basic policies used to encourage broadband deployment in those geographies where the economics do not support competitive delivery, and distilling guidance for any new attempts at the same.

Ensuring digital opportunity throughout the country is good politics for good reason: Broadband access is necessary to participate in the 21st-century economy. It's also good policy as well: Broadband boosts social opportunity and economic growth. Broadband infrastructure understandably sees bipartisan appeal, and expanding the geographic footprint of the nation's digital infrastructure should be a significant part of any infrastructure plan.[2] Investment in broadband, as well as other "smart infrastructures," will

result in considerably greater economic returns to the national economy than simply throwing money at concrete.[3]

The existing private-investment framework for broadband has seen tremendous achievement, attracting capital expenditures that make U.S. broadband an international success story.[4] That said, the gap between rural and urban broadband performance is real, if not necessarily as large an inhibitor to economic growth as it is sometimes made out to be, especially compared with other factors like broadband adoption. Prior programs attempting to address rural broadband have faced accountability challenges and, in some cases, wasted money on duplicative infrastructure. Before investing significant public funds, it is worth taking stock of existing programs, refining the problems policy should address, and defining principles for effective rural broadband infrastructure policies.

The Information Technology and Innovation Foundation (ITIF) believes that any broadband infrastructure package should be guided by the following key principles:

- Both tax credits and direct grants or loans can be appropriate, but tax credits are not likely to be enough to move the needle in truly high-cost areas; for those areas, targeted support is appropriate.
- Jurisdictions should not be eligible for grants if they have not taken adequate steps to first remove barriers to deployment, including making fees to access rights-of-way cost-based and competitively neutral.
- For any direct funding program, reverse procurement auctions, like those administered by the FCC's Connect America Fund (CAF) program, should be employed.
- Given limited funds, the focus of any grant program should first be on the lowest-cost one percent of areas without fixed broadband of any speed. If additional funding is available, it should be targeted to the next one percent, until costs grow unreasonable.
- Support should be made available for both fixed and mobile broadband. Fixed support should be made on a technologically neutral basis, designed to achieve specific, reasonable performance goals, allowing for different access technologies.
- Download speed targets should be tied to reasonable expectations of application demand and cost to ensure money is effectively used to maximize the number of additional users added to the network.
- Ideally, subsidies would focus on those areas that only require up-front capital support, rather than funding ongoing support for operating expenses. Carefully structured one-time subsidies would be more effective at reaching a targeted level of network performance than piecemeal advances over a longer period of time.
- Subsidies should focus first on supplying a single network for unserved populations before supporting upgraded speeds of existing slower networks.

In summary, Congress should take the opportunity to support a major infrastructure package by designating a portion of the funds for broadband deployment to rural and less-densely populated areas. But to do this effectively, any program should be designed to follow the principles articulated in this report.

This report first lays out an overview of infrastructure policy more generally, then examines how those high-level principles should apply in the broadband context. Next, it discusses existing rural broadband programs with an eye toward their successes and shortcomings. It then discusses some available policy tools on the table for a future push for rural broadband deployment before offering concluding principles that should guide any future broadband infrastructure legislation.

INTRODUCTION TO INFRASTRUCTURE INVESTMENT

Innovation and investment are best supported when broadband infrastructure is led by the private sector, but there are circumstances where the government should intervene.

One of the core questions regarding any infrastructure system or project is the appropriate mix of public and private involvement. Some projects are designed, built, owned, and managed by government, others by the private sector. Most involve a mix. While it is not possible to say a priori which is better—public or private ownership—all else being equal, private-sector ownership and operation brings several advantages, including a greater incentive for efficiency and innovation.[5]

Public ownership or operation of infrastructure makes the most sense for true public goods: resources that are both non-excludable (meaning it's difficult to prevent access to those who have not paid) and non-rivalrous (meaning consumption by one doesn't prevent simultaneous use by another). It is often difficult to price public goods on the basis of use, so there is little to no incentive for the private sector to provide these services, justifying government intervention. The following chart gives a rough sense of how these concepts, rivalry and excludability, can clarify the economics of infrastructure investment.

	Excludable	Non-excludable
Rivalrous	Private Goods (food, computers, broadband access, toll roads)	Common-pool resources (fish stocks, unlicensed spectrum)
Non-rivalrous	Club Goods (private parks, satellite television)	Public goods (lighthouses, broadcast television)

Of course, the distinctions are not so rigid in practice, and can change over time through advances in technology. For example, consider limited access highways. Some would consider a highway system as a public good: It is open to any to use, and can provide service just as well for each additional car added to the road—to a point. It is non-rivalrous until traffic becomes congested. It is also not entirely non-excludable. But a variety of mechanisms, such as toll transponders or vehicle miles-traveled payment systems can price

access to the system, allowing private provision and excludability.[6] Telecommunications in general, as well as broadband, has largely been provided privately precisely because the technology allows for excludability (you are not supposed to let your neighbor use your Wi-Fi) and payment from users.

If we continue under the high-level principle that innovation and investment are best supported when infrastructure deployment is led by the private sector where it is possible to make a profit, there are circumstances other than public goods where the government should intervene: put simply, where it is impossible to turn a profit because costs are too high. As discussed below, this is extremely relevant in the rural broadband context, where the cost-per-home passed are usually higher than in more-densely populated urban areas and where revenues from customers don't make up for costs (operating and capital).

There are also circumstances where the benefits of infrastructure projects exceed the costs, but those benefits cannot be adequately captured by private providers. This can occur when potential customers, for whatever reason, are unwilling or unable to pay an amount for service that would see an acceptable return on investment. This can also occur where there are significant positive externalities—benefits to a third party or society from the transaction. Again, as discussed below, this has significant import in the broadband context where, because of network externalities, the benefits of bringing more users onto broadband networks benefits the broader economy, not just the individual users. That does not mean that all potential users should obtain subsidized broadband. In many cases, such as very remote households, the combined private and public benefit of connectivity do not necessarily exceed the very high costs of connection.

THE BROADBAND CONTEXT

Unlike many areas of digital infrastructure, which have historically been associated with a government role—like highways or water systems—U.S. telecommunications infrastructure since the invention of the telegraph has largely been provided by private-sector companies in a regulated context. That said, in areas where a provider's revenue base is widely dispersed, and costs-per-customer are extremely high, that provisioning breaks down in a classic market failure. While disruptive technology can always come by surprise, one can chart the expected trajectory of broadband market expansion, and what areas can be cost-effectively served, by examining existing technology.

The Economics

Broadband is a private good with large pubic spillovers. It is both rivalrous and excludable: Users are gated through a subscription model, and high-bandwidth uses can overwhelm capacity, especially when aggregated within the network. Some activists dream of turning broadband into a ubiquitous, free, publicly provided service like roads, but this is, no pun intended, a pipe dream.[7]

Broadband is also competitively supplied in the vast majority of markets. Thanks to technological convergence in the telecommunications sphere, whereby different existing communications plants, most notably cable television and the wireline telephone system,

have evolved to provide a similar bundle of services over a common platform based on the Internet Protocol, the United States enjoys some of the most robust intermodal broadband competition in the world. Because broadband is not a monopoly in the United States and many other nations with extensive cable and telephony broadband infrastructure, these nations have for the most party rightly relied on private-sector competition to drive progress and evolution of broadband networks.

Even though the U.S. regulatory system depends on intermodal competition to drive innovation in new communications technologies and business models, the reality remains that deployment of physical infrastructure is highly dependent on the underlying economics. A key element of the ability to recoup investment in network infrastructure is the economies of geographic population density.

Spectrum is a type of infrastructure: Congressional desire to expand broadband deployment should include efforts to provide additional spectrum for commercial uses through a variety of license types.

When subscribers are bunched close together—like in a high-rise apartment building—costs per subscriber are much lower, and it is far easier to build a sustainable business, for revenue is largely invariant based on density, but costs are not. Population density can give a rough indication of this key factor in the cost of building, upgrading, and operating a given network. At a national level, it is really the density within cities, suburbs, and towns themselves that makes the largest difference in the cost of a network (top-line population density can be deceptive, as you don't have to serve broadband to areas that have no population). To get a rough sense of how dramatically different the cost structure is between rural and urban areas, consider a common measure of anticipated return on a network—the number of customers per mile of fiber; in rural areas, the metric is often flipped, instead measuring the number of miles of fiber per customer.[8]

Beyond the economies of density, two other economic considerations define the success of a broadband system: network effects and economies of scale.[9] The network effect of a system refers to how the value of a network to its users increases as each additional user joins. In the broadband context, with its robust system of interconnection on the Internet Protocol (IP) platform, this consideration is important more on a system-wide scale. As a greater percentage of the population uses broadband, society can organize itself with the assumption that citizens use broadband, unlocking tremendous efficiencies. To take a simple example, an application like e-government is more valuable if a greater share of the population can access it on broadband networks.[10]

Economies of scale, a similar concept, measures how the costs of providing a network go down with additional users. Broadband networks have tremendous up-front costs that cannot be transferred to other uses—the actual deployment of infrastructure. But once the network is built and the wires strung, the marginal costs off adding new customers are relatively low. This means, especially in rural areas where the up-front costs are highest and take-up rates might be somewhat lower, it is far more efficient for one, large network to serve a given area, rather than multiple smaller networks, or even worse, multiple overlapping networks.

The basic lessons of broadband economics are: (1) It is important to get most, but not all households online; (2) a single bigger network is better than smaller or duplicative ones; and (3) private investment without public assistance is likely not sufficient in rural, high-cost areas.

The Technology

Wired

Over the last 15 years or so, communications networks have transformed from discrete technologies for separate services to always on, high-speed digital networks. There are three general technologies for mass-market fixed broadband: various flavors of Digital Subscriber Line (DSL), cable modem, and optical fiber. DSL relies on the so-called "twisted pair" copper wires of the legacy telephone network, whereas coaxial cable was deployed to deliver cable television.

Although these networks were developed for different uses, innovations have allowed them to be repurposed for broadband Internet access. In reality, both cable and copper networks are hybrids, with the core of the network and some "tendrils" to the edge having been replaced by newer fiber optic technology. Especially compared with DSL, fiber offers significant advantages, including higher, symmetrical data rates with lower operating expense, so new networks are generally built with fiber, and older networks are being replaced (or extended with fiber) where it is cost effective.

Copper wires are somewhat limited, in that the rate at which they can transmit information drops quickly over distance—in rural areas, this problem is particularly acute. The United States is fortunate that the goal of universal service in the telephone era enabled an extensive copper build-out, and today networks that grew out of telephony serve 37.5 percent of the broadband market.[11] In some urban areas telco providers have upgraded to an all-fiber network, but in most rural areas they rely on DSL technology over copper infrastructure for at least the last section to the home. These copper networks were designed for narrow-band voice communication, not broadband data delivery. Our copper loops are among the longest in the world, and the longest in the Organization for Economic Cooperation and Development (OECD).[12] This means that, while rural coverage with copper networks is extensive, speeds can remain slow and upgrade paths are relatively expensive.

Cable networks have more bandwidth available to be dedicated to data traffic. While it can be expensive to execute the node splits needed to see significantly higher speed offerings, cable can generally achieve higher speed at a lower upgrade cost compared with copper. Again, the United States enjoys some of the most extensive cable network deployment in the world, with high-speed cable Internet available to 93 percent of U.S. households (exceeded only by densely populated Belgium).[13]

Wireless

In addition to wired access technologies, where a physical connection runs all the way to the premises, consumers and businesses increasingly access the Internet through wireless

connections. Wireless is a crucial component to the broadband ecosystem, but also is growing to touch more verticals of the economy than simply consumer-facing broadband through the Internet of Things. There are several different wireless technologies relevant to rural infrastructure.

Broadband provided through mobile industry standards, such as 4G LTE and future 5G technologies, supplements and can even replace a traditional wired connection for many uses. Mobile access can be provided somewhat cheaper than wired connections, as the last several hundred feet of the network is over the air, but it is still costly, requiring siting for equipment, towers, and backhaul. And wireless systems usually have pricing plans related to the amount of bandwidth consumed. 5G research is focused on technologies that will dramatically improve capacity and speeds, but is expected to require significantly more infrastructure investment due to smaller, more numerous cells, and therefore will likely first be deployed in urban areas where it is easier to recoup the high costs.[14] However, the same technologies can be used for highly directional fixed wireless links, which may play a key role in some rural areas.

The ultimate policy goal is not just deployment, but adoption and use. In many cases, it is the demand for broadband—not the supply—driving the rural gap.

Unlicensed spectrum also plays a key role in rural broadband access. With fewer people vying for limited spectrum resources in rural areas (e.g., such as over-the-air TV signals), wireless ISPs or "WISPS" can offer cost-effective service using unlicensed or lightly-licensed spectrum. Spectrum is in a sense a type of infrastructure: Congressional desire to expand broadband deployment should include efforts to provide additional spectrum for commercial uses through a variety of license types.

Satellite

Satellite broadband access has the benefit of blanketing large swaths of the globe but has long been thought of as a fallback offering for the most rural, high-cost areas. It has long been thought of as something of an imperfect substitute, as the long trip up to the satellite and back down to earth made for long delays in navigating the Internet. While the FCC attempts to keep its Universal Service Fund (USF) support "technology neutral," its restrictions on latency requirements have historically excluded satellite from consideration. But this may be changing.

Existing satellite broadband offerings are made using satellites in geostationary orbit (GEO), that orbit at the same speed the earth rotates, so sit at a constant position on the horizon. GEO satellites have the advantage of simplicity and cost effectiveness compared with other constellations. To be sure, satellite broadband does not perform as well as wired broadband, but in many cases, the speeds and even latency are adequate for many or most broadband applications, and it has been given short shrift as an adequate, cost-effective solution for providing connectivity the highest-cost areas.[15]

There is renewed interest in what are called "Low Earth Orbit," or LEO satellites, that operate significantly closer to users, allowing for lower latency than satellites in more distant orbit.[16] These types of offerings are being explored—at least to some extent—by a wide array of companies, such as Google, Facebook, Boeing, SpaceX, and Virgin.

Interest in LEO satellites is driven by a desire to see a cost-effective means to connect developing countries, but the capital expenditure functionally covers the globe. Rural users in the United States would benefit from these same endeavors.

DEFINING THE DIVIDE

Before diving into existing and past programs, it's important to define the problem we would look to address with broadband infrastructure legislation.

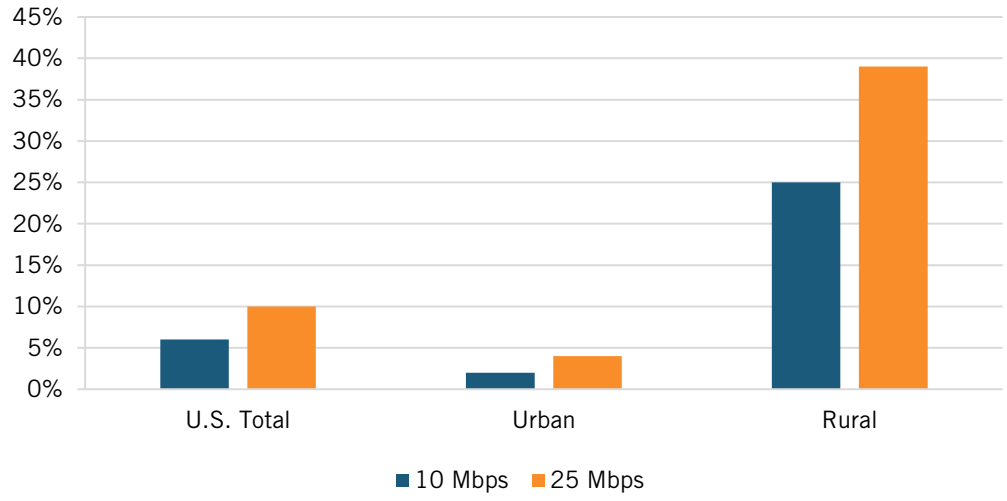
Deployment

Much has been made of the lack of broadband in rural versus urban areas, but the disparity, while definitely real, is not as dramatic as one might think.

According to the FCC's 2016 Broadband Progress Report, there are approximately 34 million U.S. citizens (10 percent) without home access to a fixed terrestrial service of at least 25 Mbps down and 3 Mbps up as of December 2014.[17] Note, this is down from approximately 55 million (17 percent of the population) just a year before that.[18] And only 6 percent of Americans lack access to fixed terrestrial service at 10 Mbps, and 5 percent lack access to such services at 4 Mbps.[19] To put that in perspective, a 10 Mbps connection would allow two household members to independently and concurrently stream a Netflix video. The difference between a 10 and a 25 Mbps connection is marginal, affecting how long a large download may take or how many concurrent high-definition streams a household can run.

Rural does face a divide in terms of broadband availability, with a quarter of rural residents without access to terrestrial fixed-broadband networks (excluding satellite) of at least 10 Mbps download, according to FCC data.[20]

Figure 1: Americans Without Access to Fixed Terrestrial Broadband by Download Speed[21]



Paul de Sa, former chief of the FCC's Office of Strategic Planning and Policy Analysis, put out a paper arguing that the a goal of federal broadband infrastructure policy "should be to increase and accelerate profitable, incremental private-sector investment to achieve at least

98 percent nationwide deployment of future-proofed, fixed broadband networks."[22] Using the FCC's cost models, de Sa says this increase of four percentage points can be achieved for about $40 billion.[23] Achieving the last two percent—going from 98 percent to 100 percent—would double the cost.[24]

De Sa defines "future-proofed fixed broadband networks" as either cable or fiber to the premise, arguing that these technologies have a sustainable upgrade path to low-latency, multi-gigabit networks. The term "future-proofed" should give any policymaker pause, especially when it is defined as specific, existing technologies. Instead of one-off spending to achieve installation of specific technology, policymakers should provide support that can cost effectively achieve adequate broadband speeds of the kind needed today (i.e., at least 10 Mbps). Investing more scarce public resources to install so-called "future-proof" networks today means that fewer households will get any broadband at all.

There is a misperception that the economic benefits of broadband require significantly higher speed networks. Susan Crawford is perhaps the chief mythmaker in this regard, repeatedly insisting that supposedly "future-proof" gigabit fiber networks are a national imperative. This is simply not true. Study after study repeatedly show that the economic benefits of broadband are greatest when adding additional users at lower speeds, not upgrading networks to supposedly "future-proofed" technologies.[25] There is a clear and extremely large diminishing marginal utility to additional network speed.[26]

This is not to say we will never need super high-speed networks, such as gigabit networks that have now been deployed in numerous cities throughout the United States and indeed the world, but no "killer app" requiring this amount of speed has emerged.[27] Nor have gigabit networks magically sprouted thriving entrepreneurial hubs.[28] If there is a "chicken and egg" to seeing a growing need for gigabit applications, any restriction is not on the network side, but rather on the application side. For areas with challenging cost structures, policymakers should look to technology-neutral, cost-effective means to bring people online, rather than more expensive future-proofing.

This is also not to say that in some cases when provisioning new infrastructure that very high speeds can be constructed for the same costs, given that it makes sense to provision any new network with the most up-to-date electronics. But in many cases, extending fiber deeper into the network will be cheaper than extending it all the way to the home.

If policymakers want to have the largest impact when subsidizing infrastructure investment, the research is clear: Focus first on those populations without any connection at all rather than improving speeds. For example, a study in preparation for an infrastructure-subsidy program in the United Kingdom examined the relative effectiveness of each euro of subsidy and estimated a consumer surplus of €2.25 for each euro invested to achieve 100 percent coverage of 15 Mbps—a significant gain beyond what the market would otherwise bear for each subsidy dollar.[29] This €2.25 was compared with a €0.72 surplus per euro spent for 50 Mbps to 92 percent of the country, and a €0.34 surplus per euro spent for speeds over 50 Mbps for 64 percent coverage.

These economic trade-offs are complicated, depending on variables such as the marginal externality to faster speeds, geographic cost structures, and existing infrastructure. But a focus on broadening coverage to truly unserved populations is clearly the most cost-effective improvement.

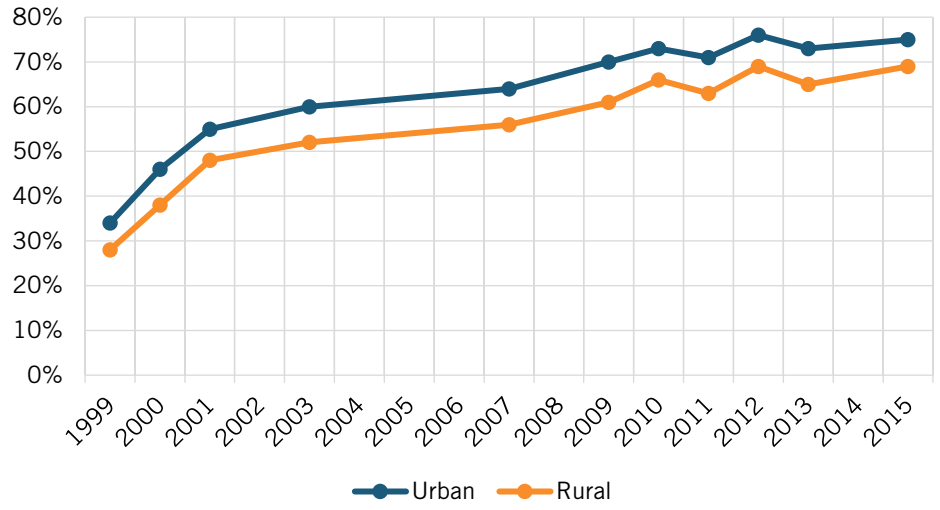
Adoption

At a high level, the ultimate policy goal is not just deployment, but adoption and use. We want to encourage the transition to all-digital communications systems, where various social institutions—such as communications and distribution to information—and economic functions—such as banking or health care—can be either provided entirely or dramatically improved through access to robust broadband. This requires both that broadband networks be available, and that people take advantage of the broadband networks that exist.

In addition to being intuitive, more and more evidence indicates it is the adoption of broadband that matters far more than the simple existence of network infrastructure. A regression analysis of data from 2008 to 2011 found that "simply obtaining increases in broadband availability (not adoption) over this time has no statistical impact on either jobs or income."[30] A similar analysis of economic measurements and data from the National Broadband Map led researchers to concluded that "broadband adoption in rural areas positively (and potentially causally) impacted income growth," but "[b]roadband availability measures (as opposed to adoption) demonstrate only limited impacts, suggesting that future broadband policies should be more demand-oriented."[31]

In a follow-up study, the same academics analyzed data on adoption rates of rural and urban users, finding that a lack of interest was the dominant reason for non-adoption, and surfaced more often in rural areas than urban.[32] This survey gave the authors "some preliminary evidence that it is the demand for broadband (and not supply) that is driving the gap."[33]

Figure 2: Internet Use by Population Density, Percent of Americans Ages 3+[34]



The broadband adoption gap between urban and rural broadband use has been relatively steady, at approximately 10 to 13 percent difference in adoption.[35] It is encouraging that the rural-urban adoption gap is steady, and not growing, even if rural communities face higher adoption barriers, most notably a higher lack of perceived relevance or interest in broadband.[36]

Like other infrastructure, broadband is only valuable to the extent it is put to use. Any spending package should consider ways to improve digital literacy and broadband adoption, as lagging adoption is a significant limitation in seeing the economic gains even from existing infrastructure.

CURRENT AND FORMER GOVERNMENT PROGRAMS

The U.S. federal government already oversees several programs designed to address rural broadband infrastructure, some more successfully than others. Some of these programs, such as the latest iteration, the Connect America Fund, were carefully designed after a long history of trial and error. Other programs are lamentably wasteful, funneling money to entrenched, inefficient rural ISPs or propping up small networks that cherry-pick the lowest-cost, highest-return multi-dwelling units.

The FCC: Connect America Fund

The Connect America Fund (CAF) is the Federal Communications Commission's (FCC's) primary subsidy mechanism for rural, high-cost areas. At $4.5 billion per year, CAF is the largest component of the Universal Service Fund (USF), which also includes support for low-income consumers under the Lifeline program, schools and libraries under E-Rate, and rural health facilities under the Rural Health Care Program. Overall USF disbursements fluctuate year to year, but are typically around $8 billion per year or more.

CAF is paid for through a fee on voice telecommunications services, and provides support for both voice and broadband in high-cost areas. Since its landmark rulemaking in 2011 that began the transition to support broadband in the high-cost program, the FCC has been in the process of updating and refining the program.[37] The commission first took steps to transition support from legacy telephone service to networks that also offer broadband. It conducted several rural broadband experiments, finally settling on a multi-stage system, including a sophisticated reverse-auction mechanism for the most recent round of support, known as CAF phase II.[38]

The CAF support is awarded through two different stages. First, incumbent "price cap" carriers, existing networks that would upgrade to a higher speed, were given essentially a right of first refusal to either accept or decline an offer to hit specific performance and deployment obligations developed through cost models by the commission. Where those offers were declined, the FCC is moving on to a competitive bidding process open to cable operators, fixed wireless companies, and competing telco providers.[39]

This auction process should be a focus for policymakers considering additional future rural broadband support. Targeted, well-defined objectives can be achieved through relatively efficient auction mechanisms. This reverse auction tool can be weighted to encourage different performance characteristics and would be an effective way to accelerate improvements to high-cost, rural infrastructure.

Note, there is a separate support mechanism within CAF for what are called "rate-of-return" carriers, but this mechanism should be of less interest to forward-looking policymakers. The terms "price cap" and "rate-of-return" come from the type of regulation historically imposed on monopoly utility networks. As one might expect, these regulations place restrictions on the prices charged to end users and the rate at which costs are recouped, respectively, both of which are usually indexed to inflation and expected gains to improved operation.

RUS grants and loans often get funneled into cherry-picking arbitrageurs that overbuild lower-cost areas that are already served by existing networks.

The FCC also offers support specific to mobile broadband under the Mobility Fund. The most recent phase of the Mobility Fund will also be awarded by auction and is set to distribute $4.53 billion in support for mobile broadband over the next decade.

One of the long-term challenges of the CAF is its contribution base. The fund is paid for through a fee on telecommunication services, specifically voice services. The voice contribution base is shrinking, and Econ 101 would suggest against leveeing this fee on broadband: Supporting a service that we hope to see more use of through what is functionally a tax on that same service is not good policy.[40] A shot of infrastructure funds into the CAF would help reduce anxiety over this support mechanism as a longer-term financing arrangement is developed.

Department of Agriculture: Rural Utilities Service Programs

The Rural Utilities Service of the Department of Agriculture oversees a number of loan and loan guarantee programs that are, at least in theory, designed to increase broadband penetration and adoption, primarily in rural areas. The largest programs, at $3.4 billion, is called the Broadband Initiatives Program or BIP.

One long-standing and serious problem of the Rural Utilities Service program is that a sizable portion of its grants don't end up supporting unserved rural areas, and often get funneled into cherry-picking arbitrageurs that overbuild lower-cost areas that are already served (as this is where it is easiest to recoup the outlays of the loan), making it one of the most criticized U.S. broadband support programs.

As summarized by Tony Romm in his investigative report on the RUS program for *Politico*,

> Sometimes, RUS funded high-speed Internet in well-wired population centers. Sometimes, it chose not to make any loans at all. Sometimes, RUS broadband projects stumbled, or failed for want of proper management; loans went delinquent and some borrowers defaulted. Yet despite years of costly missteps that left millions of Americans stranded on the wrong side of the digital divide, a stable

> of friendly lawmakers swallowed their doubts about RUS and made sure the politically protected agency wasn't cut out of the historic stimulus effort.[41]

A 2014 GAO report of BIP was also quite critical, particularly of the reporting and tracking of the program's performance, writing in its conclusion, "RUS has not shown how the approximately $3 billion in funds awarded to BIP projects have affected broadband availability."[42] A 2017 Congressional Research Service report on the various RUS loan and grant programs examined a slew of problems with the program, including loans going to communities with existing providers and loans being repaid overwhelmingly by USF ongoing support.[43]

Another study looked to see whether the RUS loan program had measurable positive impacts on economic impacts. It noted that the economic effects of earlier pilot programs appeared to be occurring only in metro areas, not in rural areas the program was designed for.[44] As for the RUS loans authorized under the American Recovery and Reinvestment Act, the authors stated "we find no evidence that loans received as part of the current Broadband Loan Program have had a measurable positive impact on recipient communities," though the authors note this may be because not enough time had elapsed.[45]

Yet another study examining three case studies under RUS concluded that "millions of dollars in grants and loans have been made in areas where a significant majority of households already have broadband coverage," and the "BIP program creates strong disincentives to private broadband investment in the long run, as potential future investors will discount expected returns for the possibility that the government may step in, ex post, to subsidize a competitor."[46] Many of the RUS programs stem not from bureaucratic management failures but from the congressional design of the program, which limits the ability of the program to fund broadband in higher-cost areas. But to be clear, funding a second or even third broadband provider in rural communities is a waste of money.

NTIA: Broadband Technology Opportunities Program

The National Telecommunications and Information Administration (NTIA) administered another grant program authorized by the American Recovery and Reinvestment Act. Known as the Broadband Technology Opportunities Program (BTOP), this $3.5 billion fund was designed to promote deployment and adoption of broadband throughout the country, particularly in unserved and underserved areas. Much of BTOP funding focused on middle-mile broadband infrastructure projects that connected to community anchor institutions, such as community colleges.

BTOP does appear to have been better administered than the RUS BIP program, leading one economist to write "the NTIA is a paragon of transparency and responsibility compared to the Rural Utilities Service."[47] A study performed for NTIA by ASR Analytics claimed that the grants saw broadband penetration increase by 2 percentage points in their geographies, which it extrapolated to an estimated long-term increase of $5.7 billion or

more in economic output.[48] That said, BTOP, as well as that very report detailing its impact, is not without its criticisms.[49]

Most criticisms of the program are leveled not at the competence of the administrators but the technocratic model of awarding grants itself. As the program was being developed, a list of 71 respected economists wrote to the administration explaining that the traditional grant-making application review process was not up to the task of efficiently allocating the stimulus money.[50] Instead, they called for procurement (or reverse) auctions, arguing that such an approach is more efficient, flexible, and fair to allocate grants, and offering a comprehensive framework for structuring such procurement auctions.[51] These recommendations unfortunately were not implemented.

THE TOOLKIT: HOW TO EFFECTIVELY SPUR HIGH-COST DEPLOYMENT

There are several different tools that can be leveraged to spur further broadband deployment. This section briefly summarizes and evaluates some of the more promising opportunities.

More cooperation at the local level would greatly assist in streamlining cost-effective deployment of next-gen broadband systems, especially in the wireless arena.

Local Barriers to Investment

To deploy or upgrade existing broadband infrastructure, firms, whether subsidized or not, must interact with local governments and utility-pole owners to gain access to rights of way, conduit, or poles. Some municipalities and electric utilities can be locked into old-fashioned thinking, continuing to rely on policies that grew out of franchise agreements for the building of television networks.

More cooperation at the local level would greatly assist in streamlining cost-effective deployment of next-gen broadband systems, especially in the wireless arena. Local governments should view broadband build-out as a partnership goal that will not only assist citizens in their daily lives, but also help cities provide better government services. These efforts should not be like franchise agreements of the past, which cities viewed as a cash cow, but cooperative endeavors.

Spurring broadband infrastructure deployment is in the best interest of municipalities. Obviously, citizens benefit: Civic Internet of Things applications have the potential to greatly increase the efficiency of municipal services.[52] A recent study by Accenture Strategy, focused on wireless infrastructure, estimated that the next generation of wireless technology is "expected to create 3 million new jobs and boost annual GDP by $500 billion," but highlighted that before these benefits are seen, operators must navigate local permitting and regulations, and fee structures designed for a macro cell world.[53] Many of the benefits envisioned flow from smart-city applications, ultimately helping cities provide better services, and citizens live better lives.

In a recent blog post, FCC Chairman Pai described these challenges as faced by a start-up rural broadband company, Rocket Fiber:

> The company's executive team… discuss[ed] regulatory roadblocks. They had to get signoffs from multiple city agencies, none of which seemed to think that time

was of the essence. And they had to get access to a large number of poles at a reasonable cost, which wasn't easy; the city at first sought a very high price for pole access (using as a benchmark the high rate charged to another broadband provider for access to just three poles).[54]

So-called "dig once" policies, that would see installation of conduit along highways during roadwork, can play a similar, important role. Having easily available conduit, as well as accessible information on where that conduit is located, can go a long way in reducing the high cost of deploying broadband infrastructure by eliminating the need to dig up city streets.

Proposed legislation has looked to make dig once installation of conduit a required component of projects funded with federal highway dollars, but Congress could go further, making receipt of any federal infrastructure funds contingent on adoption of a model municipal code. This model code would be designed to streamline access to rights of way and other municipal infrastructure such as utility or light poles. The FCC can also play a role with existing statutory authority.[55]

Getting reasonably quick access to poles, conduit, and other city infrastructure at reasonable, competitively neutral rates can effectively push out the curve of areas where it is cost effective to deploy or upgrade broadband. These should be policies that municipalities adopt on their own initiative, and will be a crucial component of any infrastructure package.

Tax Policy

Tax policy has always been an important tool in encouraging additional private-sector investment in broadband infrastructure, a tool that every nation with leading broadband networks has relied on.[56] One of the most straightforward tax incentives is accelerated depreciation. Depreciation can be accelerated at different rates, or even immediate deduction of investment costs, functionally allowing businesses to recover the cost of expenditures sooner. Credits can also be offered for specific types of investments. There is potential for the cost of tax credits to be offset against a repatriation tax on overseas retained earnings.[57]

Tax incentives have the benefit of allowing private-sector firms, with experience in the field, to ultimately make the decision of where to invest. They do not require micromanaging or analysis of the viability of different proposals, and allow decentralized actors to make decisions based on their own local knowledge.

These investment decisions are made on the margin, so tax incentives can effectively push out the curve of areas worth investing in, and should be a component of any comprehensive strategy to expand rural infrastructure. On the other side of the coin, tax incentives can also reward investments that make would make economic sense regardless, and won't be able to incent operators out to the highest-cost areas. While tax policies

aimed at encouraging infrastructure investments are a useful tool, they should not be the only tool in the toolkit.[58]

Direct Subsidies

Direct subsidies will continue to be necessary to assist with the high capital costs of deploying and upgrading rural broadband infrastructure.

There are certainly parts of the country with high costs and low potential for return where commercial service is not feasible without a subsidy to cover the initial investment. Even further out on the cost curve, portions of the country cannot be served without an ongoing subsidy to cover operating expenses and maintenance. But subsidies should be targeted to those areas that are legitimately unserved by existing networks.

The most recent iteration of the Connect America Fund paves the way in terms of best practice, and it's possible an infrastructure package could funnel spending directly to this program.

To help ensure that subsides aren't spent wastefully, where a market cannot be competitively served, there should at least be "competition for the market," as put by Mark Jamison, director of Gunter Professor of the Public Utility Research Center at the University of Florida, and member of President Trump's telecommunications transition team.[59] Once areas legitimately in need are identified, the regulatory authority can then auction the subsidy to the bidder able to provide service at the lowest cost.

Here the most recent iteration of the Connect America Fund paves the way in terms of best practice, and it's possible an infrastructure package could funnel spending directly to this program.

Chairman Pai's Digital Empowerment Agenda

Last September, then commissioner, now chairman, Ajit Pai put forward his own plan to help close the infrastructure divide, which he calls "Digital Empowerment Agenda."[60] Pai's plan would focus on specific steps to remove regulatory barriers to broadband deployment through modifications to the commission's pole-attachment rules, and limitations on unreasonable fees imposed by municipalities; and support dig once policies, streamlined deployment, and siting on federal lands.[61] He also plans to continue and extend FCC support for mobile broadband through the Mobility Fund under CAF.[62]

Existing Legislative Efforts

There are several legislative efforts on these issues. Representative Anna Eshoo (D-CA), honorary co-chair of ITIF, has focused on the dig once issue, and has recently reintroduced a discussion draft of a bill to provide for the inclusion of broadband conduit installation in highway construction projects.[63] The House communications subcommittee also has a discussion draft examining the opportunity to develop an inventory of, and streamline the access and approval process to, federal assets that are of potential use for infrastructure deployment.[64] The MOBILE NOW Act also calls for state transportation departments to establish coordinated access to federal rights of way.[65] Spectrum is also an important component to providing mobile connection, so the MOBILE NOW act's goal of freeing spectrum for mobile broadband will assist in the overall effort to make it less costly to provide broadband.

RECOMMENDATIONS AND PRINCIPLES FOR EFFECTIVE GOVERNMENT SUPPORT OF BROADBAND INFRASTRUCTURE

When looking at any program to promote broadband infrastructure, policymakers need to consider the following key questions:

1. Is it sufficient to simply remove barriers to deployment, or is a subsidy justified?
2. If a subsidy is justified, what form should it take (tax credit or direct grant)?
3. If direct funding is justified, under what mechanism should it be awarded (proposal submissions or reverse auction)?
4. If a subsidy is provided, what size and what level of coverage should be expected (do we need 100 percent coverage, or more modest expectations considering the cost curve related to density)?
5. What type of technology should government support, and how is that defined (fixed or mobile or both; speed; latency requirements)?
6. What speed targets should be set for new networks, future-proof gigabit networks, or more modest speeds of the sort currently in place for most Americans?
7. Should government fund the up-front capital expenditure or provide ongoing support for operating expenses or both?
8. Where is it reasonable for a program to invest:
    a. Focus only on legitimately unserved populations or also on upgrading speed of existing slower networks?
    b. Support an additional competitor in an area that already has fixed broadband or support only the first one?

There is not necessarily a one-size-fits-all answer to each question for every country. Different industry histories and organization, different cost structures, and tolerance for public investment will lead to different answers. That said, we have a general idea of where U.S. policymakers should come down on these questions.

1. Is it sufficient to simply remove barriers to deployment, or is a subsidy justified?

A lot of work remains to be done to lower the cost of deployment or upgrade by streamlining access to public rights of way and utility poles. By making fees reasonably cost-based and competitively neutral, jurisdictions can help expand the area where it makes economic sense for private providers to invest. This is certainly good policy for every geography, but for high-cost areas it is not enough—a subsidy is required.

2. If a subsidy is justified, what form should it take (tax credit or direct grant)?

Both tax credit and direct grants or loans are appropriate. Tax credits have advantages of being relatively easy to implement, broad-based, and responsive to decision-makers closer to the ground. Tax credits are not necessarily enough to move the needle in truly high-cost

areas; for those areas, targeted grants are appropriate. However, jurisdictions should not be eligible for grants if they have not taken adequate steps to first remove barriers to deployment, including making fees cost-based and competitively neutral.

3. If direct funding is justified, under what mechanism should it be awarded (proposal submissions or reverse auction)?

A reverse or procurement auction, like those administered as a part of the FCC's CAF program, should be preferred for new networks in unserved areas, as it helps ensure subsidy dollars are most effective in maximizing the additional users brought online. As for improving existing networks, again the CAF model leads the way: Policymakers should offer a subsidy based on the expected upgrade cost to hit reasonable performance metrics, before turning to a reverse auction if the offer is declined.

Support for fixed networks should be made on a technologically neutral basis, designed to achieve specific, reasonable performance goals.

4. If a subsidy is provided, what size and what level of coverage should be expected (do we need 100 percent coverage, or more modest expectations considering the cost curve related to density)?

The cost curve is too dramatic and the last few percent too costly to expect 100 percent coverage with terrestrial networks. Satellite Internet provides adequate access for those last few percent most-costly U.S. residents. With limited funds, the focus should be on the first lowest-cost one percent of areas without fixed broadband and if additional funding is available it should be targeted to the next one percent, etc.

5. What type of technology should government support, and how is that defined (fixed or mobile or both; latency requirements)?

Support for fixed networks should be made on a technologically neutral basis, designed to achieve specific, reasonable performance goals. Goals should be defined recognizing anticipated bandwidth needs, not necessarily future-proofing. Support should also be made for mobile broadband. Here, the predominance of a particular standard for the foreseeable future justifies subsidies specifically for LTE coverage. Additional efforts to promote availability of unlicensed or lightly licensed spectrum should be pursued as well.

6. What speed targets should be set for new networks? Do we need future-proof gigabit networks, or more modest speeds of the sort currently in use by most U.S. residents?

Download speed targets should be tied to reasonable expectations of application demand and cost to ensure money is effectively used to maximize the number of additional users to the network. The economic gains from broadband access have strong diminishing returns, so limited support funds should focus on achieving more modest speeds for the maximum number of people.

7. Should government fund the up-front capital expenditure or provide ongoing support for operating expenses or both?

Ideally, subsidies would focus on those areas that only require up-front capital support, rather than ongoing support for operating expenses. There is opportunity for a one-time rural broadband "acceleration fund," whereby auction winners would receive capital support on condition that participating projects would not receive future federal funding.[66] Such a program would be easier to implement, and avoid committing support to ineffective

projects long term. It would also provide stronger incentives for companies to manage ongoing broadband systems more efficiently.

8.a. Focus investment only on legitimately unserved populations or also on upgrading speed of existing slower networks?

Given that the benefits of going from no broadband to some is greater than going from some to more, the focus of any broadband infrastructure package should first be on legitimately unserved populations to see the largest impact of limited subsidy dollars. After that, subsidies should ensure that the performance of existing networks is up to par for realistic current and anticipated uses. For example, CAF targets of upgrading networks to 10 Mbps is reasonable.

Subsidies should only go to uneconomic areas and support at most one provider in any geography.

8.b. Support a second competitor or focus on only the first one?

As long as there are still significant numbers of Americans lacking access to fixed broadband networks, government support should not be available for areas that already have a broadband provider. Instead government should focus on areas cannot be served by market forces alone, and not artificially propping up redundant networks. Subsidies should only go to uneconomic areas and support at most one provider in any geography.

CONCLUSION

The existing private-investment framework for broadband has seen tremendous achievement, attracting capital expenditures that make U.S. broadband an international success story. That said, there are some particularly high-cost areas that remain unserved. One first step is in encouraging jurisdictions to help lower the cost of deploying or upgrading existing networks. Truly unserved areas are where government support for broadband infrastructure is most justified—any infrastructure package should focus on areas that are legitimately unserved rather than propping up duplicative networks. Subsidies should be directed to the CAF or a similar auction-based distribution mechanism, rather than following in the footsteps of flawed programs, such as the RUS loan program.

Congress should take the opportunity to support a major infrastructure package by designating a portion of the funds for broadband deployment to rural and less densely populated areas. But to do this effectively, any program should be designed to follow the principles identified above.

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