February 4, 2022

National Telecommunications and Information Administration
U.S. Department of Commerce
1401 Constitution Avenue NW
Washington, DC 20230

Re: Infrastructure Investment and Jobs Act Implementation - Notice, Request for Comment
Docket No. 220105-0002, RIN 0660-ZA33

The Electronic Frontier Foundation (EFF)[1] submits the following comment to the National Telecommunications and Information Administration (NTIA).

About the EFF

The EFF is the leading nonprofit organization defending civil liberties in the digital world. Founded in 1990, EFF champions user privacy, free expression, and innovation through impact litigation, policy analysis, grassroots activism, and technology development. With over 38,000 dues-paying members (with several thousand California members) and well over 1 million followers on social networks, we focus on promoting policies that benefit both creators and users of technology. EFF has been at the forefront of studying the future of broadband access in the high-speed market and has conducted in-depth research and produced both legal and technical publications on the issue. EFF's goal in broadband access is the deployment of universally available, affordable, and competitive high-speed networks. EFF focuses on fiber because it is the only data transmission medium capable of low latency and speed upgrades for generations to come that far exceed alternative last-mile options and a necessary component for ubiquitous 5G coverage and successor technologies.

[1] These comments were organized by EFF staff Legislative Associate Chao Jun Liu, Staff Technologist Bennett Cyphers, Legal Intern Emma Hagemann, and Senior Legislative Counsel Ernesto Falcon.

Responses to Questions

1. ***What are the most important steps NTIA can take to ensure that the Bipartisan Infrastructure Law's broadband programs meet their goals with respect to access, adoption, affordability, digital equity, and digital inclusion?***

EFF believes the most important steps the NTIA can take in implementing the Bipartisan Infrastructure Law are to provide objective technical guidance to the states on what type of infrastructure projects fulfill the goals of the statute as well as guidance on effective infrastructure models. In specific, the law establishes that "priority broadband project[s]" mean infrastructure capable of achieving the following goals:

1) *broadband service that meets speed, latency, reliability, consistency in quality of service, and related criteria*

2) *ensure that the network built by the project can easily scale speeds over time to*
   a. *meet the evolving connectivity needs of households and businesses and*
   b. *support the deployment of 5G, successor wireless technologies, and other advanced services.*

EFF's technical research[2] drives the organization to forcefully conclude the only existing ***transmission medium*** capable of fulfilling the above objectives is fiber optics. EFF has compared all existing last mile options and can only find that fiber pushed into homes or as close as possible delivers the future-proof capacity potential that meets the laws objectives without a comparable alternative.[3] It is the only fixed broadband connection that has an economically and technically feasible path towards a multi-gigabit broadband access future well past even the fastest speeds today. Indeed, scientists have been able to push 100 terabits per second down a single fiber[4] in laboratory conditions, indicating that real world utilization has ample room for growth. This is not true for 5G wireless broadband, DOCSIS cable systems, or the newest

[2] See Bennett Cyphers, *The Case for Fiber to the Home, Today: Why Fiber is a Superior Medium for 21st Century Broadband*, Electronic Frontier Foundation (Oct 11, 2019), https://www.eff.org/files/2019/10/15/why_fiber_is_a_superior_medium_for_21st_century_broadband.pdf (for a more detailed explanation as to why different transmission mediums have different inherent capacities baked in physics).
[3] *Id*.
[4] *Id*. at Page 22

proposed satellite broadband systems. Each of these other systems have concrete barriers that fiber based systems do not contend with at all.[5]

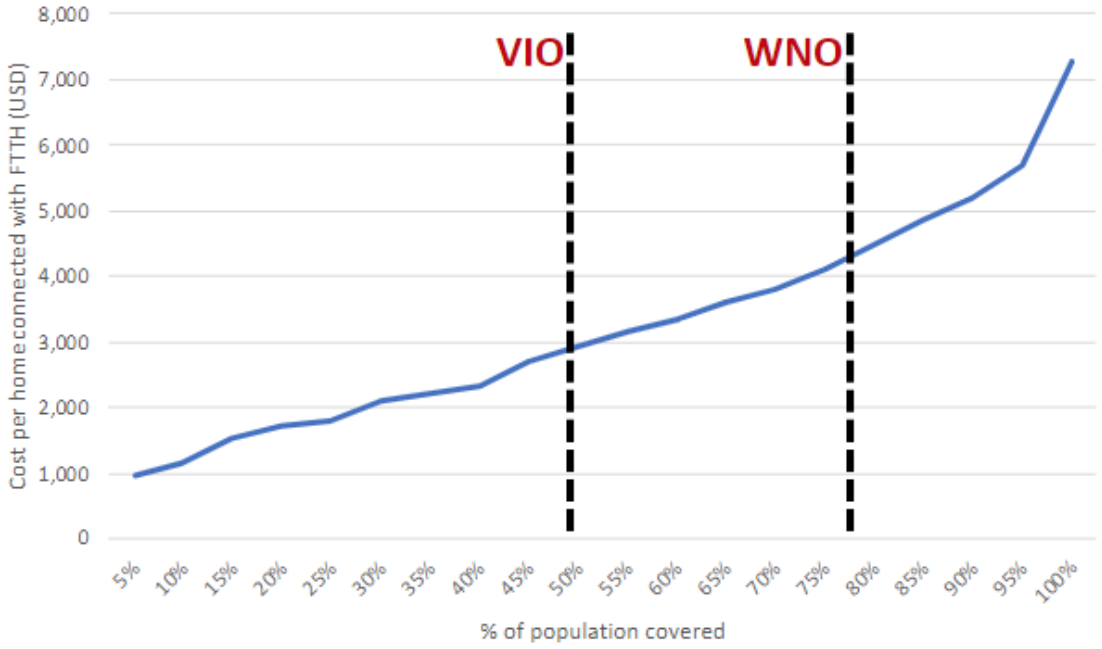
In regard to infrastructure models, EFF strongly recommends the NTIA dedicate a portion of the grant funding exclusively toward the deployment of open access fiber networks in order to stretch the federal dollars as far as possible. While the nearly $45 billion that will go towards the states is an enormous sum of money, and certainly some states with their own ambitious infrastructure funding efforts coupled with federal dollars will deliver universal fiber,[6] the NTIA funding alone will not cover the entire "unserved" population absent supporting self-sustaining, self-perpetuating, and cost-efficient infrastructure models. EFF's cost model study[7] demonstrates conclusively that structurally separated wholesale network operators (WNOs) focused solely on the delivery of fiber infrastructure, but does not directly engage in the sale of broadband service, can reach 10s of millions of more Americans than traditional vertically integrated operators (VIOs) long before subsidies are even required (see chart below and attached cost model study).

[5] *Id*. at Page 21

[6] Jon Brodkin, *California's Ambitious Fiber-Internet Plan Unanimously Approved by Legislature*, ARSTECHNICA (Jul. 16, 2021), available at https://arstechnica.com/tech-policy/2021/07/california-passes-historic-plan-for-statewide-open-access-fiber-network.

[7] Benoit Felten & Thomas Langer, *Wholesale Fiber is the Key to Broad US FTTP Coverage*, DIFFRACTION ANALYSIS (Oct. 27, 2021), available at https://www.eff.org/document/wholesale-fiber-key-broad-us-fttp-coverage.

Exhibit 1: Profitable FTTP coverage based on wholesale vs. vertically integrated model



Ensuring a portion of the funds is dedicated towards seeding a WNO in every state will effectively plant a seed in every state that can continuously expand in the years that follow, at a substantially lower subsidy cost, than solely subsidizing VIOs. This will ensure the most efficient use of limited federal dollars because the infrastructure will be capable of leveraging further investments from local needs to finance its future growth sustainably while simultaneously delivering on the goals of the statute.

3. ***Transparency and public accountability are critical to the success of the Bipartisan Infrastructure Law's broadband programs. What types of data should NTIA require funding recipients to collect and maintain to facilitate assessment of the Bipartisan Infrastructure Law programs' impact, evaluate targets, promote accountability, and/or coordinate with other federal and state programs? Are there existing data collection processes or templates that could be used as a model? How should this information be reported and analyzed, and what standards, if any, should NTIA, grant recipients, and/or sub-grantees apply in determining whether funds are being used lawfully and effectively?***

The NTIA must ensure that objective technical analysis as well as vetting of finances is applied to all projects seeking grant funding prior to approval in order to avoid mistakes made in past federal policy. For example, the evidence shows that the less rigorous scrutiny that occurred

under the Federal Communications Commission (FCC) Rural Development Opportunity Fund (RDOF) resulted in the equivalent of technology grifting where unproven means of delivering last mile broadband access were approved for funding[8] or enormous sums of federal dollars went towards capacity constrained deployments with unproven financial viability.[9] Such outcomes are avoidable if we simply rely on engineering and economic analysis to guide the grants towards long term viable infrastructure rooted in proven models.

Undoubtedly some commentors will suggest that dismissing alternatives will make delivering on the infrastructure goals financially unviable. Here is the good news: Fiber to the Home (FTTH) is already economically feasible in a ***super-majority*** of American communities if the right policies and government efforts are in place to facilitate fiber deployment. A study[10] by the Fiber Broadband Association found that FTTH is commercially feasible up to the 90th percentile of density (chart below). This coincides with EFF's own cost model research.[11] Even for the remaining 10 percent, we are seeing models led by the public sector and rural cooperatives on long-term debt financed capital investments as opposed to huge infusions of grant financing. For example, a rural cooperative in Missouri today can deliver fiber gigabit service that achieves all of the goals of the statute at $100 a month at a population density of ***2.4 people per square mile***.[12]

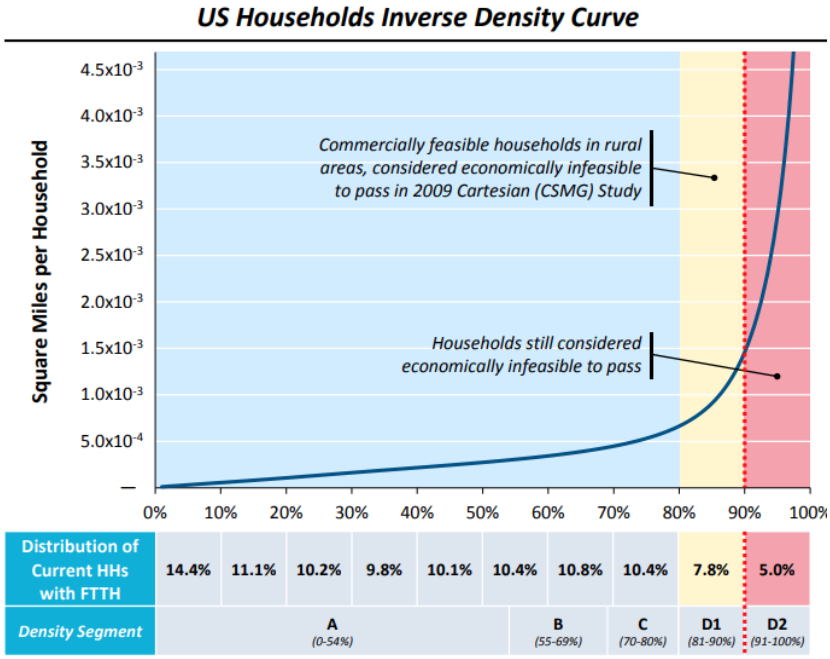
[8] *See* Doug Dawson, *Fixing the RDOF*, POTS AND PANS (Feb. 3, 2021), available at https://potsandpansbyccg.com/2021/02/03/fixing-the-rdof (noting that projects delivering "gigabit fixed wireless" technology in rural markets that do not exist); *See Also* Christopher Mitchell, *RDOF Auction Ends by Confusion and Corruption May Just Be Beginning*, COMMUNITY NETWORKS, (Dec. 9, 2020), available at https://muninetworks.org/content/rdof-auction-ends-confusion-and-corruption-may-just-be-beginning.

[9] Tim Farrar, *Starlink's Reach Won't Be Enough to Solve Rural Broadband Dilemma*, FIERCE WIRELESS (Jan. 13, 2022), available at https://www.fiercewireless.com/tech/starlinks-reach-wont-be-enough-solve-rural-broadband-dilemma-farrar; See Also Bernie Arnason, *Musk Hints at SpaceX Bankruptcy Possibility, Not the Best News for Starlink RDOF Vetting*, TELECOMPETITOR (Dec. 1, 2021), available at https://www.telecompetitor.com/musk-hints-at-spacex-bankruptcy-possibility-not-the-best-news-for-starlink-rdof-vetting.

[10] Fiber Broadband Association, *New Study Finds All-Fiber Deployments to 90% of Households Achievable in Next Decade* (Sep. 10, 2019), available at https://www.cartesian.com/fiber-broadband-association-new-study-finds-all-fiber-deployments-to-90-of-households-achievable-in-next-decade.

[11] Benoit Felten & Thomas Langer, *Wholesale Fiber is the Key to Broad US FTTP Coverage*, DIFFRACTION ANALYSIS (Oct. 27, 2021), available at https://www.eff.org/document/wholesale-fiber-key-broad-us-fttp-coverage.

[12] Christopher Mitchell, *United Fiber Tackles Missouri's Most Rural-Community*, BROADBAND BIT PODCAST (Feb. 14, 2017), available at https://muninetworks.org/content/united-fiber-tackles-missouris-most-rural-community-broadband-bits-podcast-240.



5. ***In implementing the Bipartisan Infrastructure Law's programs, NTIA will offer technical assistance to states, localities, prospective sub-grantees, and other interested parties. What kinds of technical assistance would be most valuable? How might technical assistance evolve over the duration of the grant program implementation?***

Borrowing the lessons from the rural electrification of the 1930s and 40s,[13] NTIA should form tight partnerships with local entities and offer technical assistance to those entities. This technical assistance should include, at a minimum, 1) assistance with accessing grant funds and 2) training on building future-proof fiber networks. More generally, EFF recommends that NTIA establish a franchise-like model of broadband deployment, with NTIA lending its expertise to motivated local partners in exchange for local partners developing and maintaining fiber-optic broadband networks that serve their communities in compliance with the Bipartisan Infrastructure Law.

[13] Following the passage of the Rural Electrification Act of 1936, the newly established Rural Electrification Administration (today, the Rural Utilities Service) distributed low-interest loans to rural areas, hired engineers to help develop rural power structures, and helped local entities obtain the supplies necessary to build grids, among other things. *See* Tim Sablik, *Electrifying Rural America*, Econ Focus, https://www.richmondfed.org/publications/research/econ_focus/2020/q1/economic_history (last accessed Jan. 31, 2022) [hereinafter *Sablik's Electrifying Rural America*]; *see also* https://www.rd.usda.gov/programs-services/electric-programs.

1. NTIA Should Provide Technical Assistance to Help Local Partners Access Grants

Local partners willing to tackle what will effectively be 30-to-40-year financial commitments to deliver 21st century infrastructure to serve their communities may not have experience with the process of accessing federal funds. Nevertheless, cultivating their participation will be key to the success of the program as many for-profit national ISPs operate under tight return on investment formulas that are ill-suited for long term infrastructure investment plans in rural areas. These local partners may need assistance with writing a grant proposal, conducting feasibility studies to support a grant proposal, or with other funding-related issues. Accordingly, NTIA assistance should take many forms, since local partners will have a variety of needs and levels of expertise. NTIA should be responsive and flexible to the needs of local partners in coordination with the states.

The following list of proposals is not designed to be comprehensive but to provide some examples for consideration.

Online Information

- NTIA should post guides to writing a successful broadband grant that include clear lists of what the grant proposals must include and what NTIA will be looking for.
- NTIA should post a Frequently Asked Questions page geared towards grant-writing and the grant application process. This page should be updated regularly as NTIA learns what questions and assistance local partners require.

Live Assistance

- NTIA should establish a telephone hotline dedicated towards answering questions local partners may have about the grant-writing and grant application process.
- NTIA should conduct workshops, online or in-person, that target local partners and provide information about the process of accessing Bipartisan Infrastructure Law's funds.

Technical Assistance Grants

- NTIA should provide technical assistance grants, which would help local partners fund endeavors such as feasibility studies, market studies, and/or infrastructure plans, which would in turn support further grant proposals for broadband development. This approach is modeled on California's fiber infrastructure law, which sets aside funds for local

agency technical assistance grants.[14] California also has a pre-existing tribal technical assistance grant program which allows tribes to apply for this type of funding.[15]

2. NTIA Should Provide Technical Assistance to Help Local Partners Build Fiber

As discussed in detail throughout this comment and in the attached documents, fiber is the only medium that can meet the future scalability requirements of the Bipartisan Infrastructure Law. No other infrastructure is capable of meeting growing demands for broadband. As such, NTIA must teach local partners how to build and maintain their own fiber infrastructure.

In addition to providing online resources about building fiber (like those described above for grant assistance), NTIA should send technicians to conduct live workshops with local entities looking to develop broadband in their communities.[16] These workshops will be especially appropriate in areas where local partners are motivated to tackle the long-term infrastructure challenges but lack the training. This model draws from the rural electrification of the 1930s and 40s, in which the Rural Electrification Administration sent electricians and engineers around the country to help local co-operatives build power grids and connect to power.[17] Hundreds of these electrical co-operatives are still operating these same rural electrical grids today.[18] Notably, many of them have already begun planning and/or building fiber broadband networks for their constituents.[19]

Because different communities will be at different stages in their planning, NTIA should also make technicians generally available for troubleshooting or other assistance. This system could be modeled on the system used by the Rural Utilities Service, which maintains a staff of

[14] Ernesto Falcon, *How California's Broadband Infrastructure Law Promotes Local Choice*, https://www.eff.org/deeplinks/2021/09/how-californias-broadband-infrastructure-law-promotes-local-choice (Sep. 17, 2021).
[15] California Public Utilities Commission, Tribal Technical Assistance Grant Program, https://www.cpuc.ca.gov/industries-and-topics/internet-and-phone/california-advanced-services-fund/tribal-technical-assistance.
[16] Workshops like these are already happening, with great success, in unserved regions of the country. *See, e.g.*, Christopher Mitchell, *Building Connections and Capacity in Indian Country at the First Tribal Wireless Bootcamp*, https://muninetworks.org/content/building-connections-and-capacity-indian-country-first-tribal-wireless-bootcamp (Sep. 21, 2021).
[17] *See Sablik's Electrifying Rural America*, note 12, *supra*.
[18] *See* https://www.electric.coop/our-organization/history.
[19] For helpful and informative testimonials about rural broadband development, see https://conexon.us/case-studies/groundbreakers/.

field representatives stationed throughout the country who provide and connect local entities to assistance on an as-requested basis.[20]

Conclusion

Ultimately, different local partners from the public and private sector will have different technical needs; therefore, NTIA should prioritize being prepared to offer a wide variety of technical assistance (from workshops, to telephonic troubleshooting, to grant-writing assistance, and everything in between) to ensure local entities can successfully develop fiber broadband networks.

As with rural electrification, the up-front effort of teaching local entities to build networks and assisting in network development will pay handsome dividends for decades to come. Local entities have the necessary incentive to connect their communities to the best broadband network available. NTIA can best fulfill its mandate by providing these entities regular support today, so that these entities can maintain their own networks tomorrow.

6. ***The Bipartisan Infrastructure Law requires states and territories to competitively select subgrantees to deploy broadband, carry out digital equity programs, and accomplish other tasks. How should NTIA assess a particular state or territory's subgrant award process? What criteria, if any, should NTIA apply to evaluate such processes? What process steps, if any, should NTIA require (e.g., Request for Proposal)? Are there specific types of competitive subgrant processes that should be presumed eligible (e.g., publicly released requests for proposals and reverse auctions)?***

The NTIA should assess the award process in a manner that looks firmly toward future needs as opposed to playing catch up with past definitions of service. While the grant monies are meant to provide broadband to unserved communities, defined as lacking the current federal standard of service of 25 Mbps downstream and 3 Mbps upstream (25/3), and underserved communities, defined as lacking 100 Mbps downstream and 20 Mbps upstream (100/20), all of these speeds are inadequate for current needs, let alone the needs of the future. Average internet

[20] https://www.rd.usda.gov/programs-services/electric-programs

use as of Q2 of 2021 was already about 207 Mbps downstream and 16 Mbps upstream.[21] Those numbers will only go up.

When assessing awards then, the NTIA should both establish a projected demand curve for broadband speeds and then prioritize proposals that can meet constantly higher future needs. Such bandwidth projections by the NTIA are necessary to fulfill the goals of the statute that emphasizes ***easily*** scalable networks that meet evolving community needs. In fact, this is standard practice for accessing infrastructure needs of a community in water usage, electricity consumption, housing needs against population growth estimates, and road construction. Data capacity needs are no different as an essential component of infrastructure planning.

During the assessment process, the NTIA should make sure that the process is transparent, accountable, and rigorous. As noted throughout the comment, awardees must be thoroughly vetted to ensure that they in fact have not only the technical capability to deploy and deliver the services they are committed to providing, but the financial, managerial, operational, and other necessary resources to do so. As part of the process, we urge the NTIA to be as publicly transparent as possible with their reviews, and allow opportunities for additional input if necessary. A similar request was made of the FCC by a large bipartisan number of Members of Congress and should be expected of the NTIA program.[22] After awards are given, there must also be a means by which the NTIA can ensure funds are used effectively and toward their stated purposes. There must be due diligence to ensure the funds are properly spent on services that do in fact serve Americans today and into the future given the challenge of recovering funds once encumbered.

The above advice comes from watching the errors made during the FCC's process with the Rural Digital Opportunity Fund (RDOF); the NTIA should learn from the RDOF process and endeavor to not repeat those mistakes. In the course of the RDOF, more than $9bn in the form of a 10-year subsidy was dispersed in a reverse auction process to companies that promised to deliver everything from 25/3 to gigabit service, defined as 1Gbps upstream and 500 Mbps downstream. One of the largest winning bidders was LTD Broadband, a wireless internet service

[21] Ernesto Falcon and Katharine Trendacosta, *The Future Is In Symmetrical, High-Speed Internet Speeds,* Electronic Frontier Foundation (July 2, 2021), https://www.eff.org/deeplinks/2021/07/future-symmetrical-high-speed-internet-speeds

[22] *Congressional Letter to FCC on Rural Digital Opportunity Fund,* Underground Construction (January 13, 2021), https://ucononline.com/news/2021/january/congressional-letter-to-fcc-on-rural-digital-opportunity-fund

provider that, in exchange for $1.3bn, promised to provide gigabit service to more than 500,000 locations.[23] A major problem is that the purported gigabit wireless technology does not currently exist in rural markets.[24] Wireless technology, on an engineering level, depends wholly on excess capacity from underlying wireline infrastructure. It is impossible to deliver gigabit wireless without an excess of multi-gigabit capacity in the underlying wires, i.e., fiber optics. LTD Broadband, a wireless internet service provider, should have been vetted on its ability to deploy what is essentially a FTTH network as opposed to a network heavily dependent on wireless delivery.[25]

A less egregious and more realistic failure scenario is SpaceX, who won a bid for $885 million to use Low Earth Orbiting Satellites (LEOs) to deliver 100/20 to about 640,000 locations.[26] In even the best case scenario where SpaceX's Starlink Fleet is at full size, has the maximum stated throughput capacity, and only serves RDOF locations, more than half of RDOF subscribers are predicted to have congested services by 2028.[27] Taking into account how SpaceX's LEOs would likely also serve non-RDOF subscribers and may not reach full fleet size or maximum stated throughput capacity, less than promised service would likely occur before then. These were not hidden secrets of industry, but required in-depth scrutiny of unproven deployments that should have been compared against proven deployments that are happening in similar markets with cooperative, municipal and local rural private fiber to the home.

In both cases, lack of vetting meant more than $2bn in RDOF monies went to companies that potentially will fail to deliver future proof networks and will either undervalue or fail to deliver upon promised service ready for the future. It is imperative that the NTIA have proper, transparent, and rigorous vetting to ensure award process monies are used in a way that continues to yield value into the future.

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[23] Christopher Mitchell, *RDOF Auction Ends But Confusion and Corruption May Just Be Beginning,* Community Networks (December 9, 2020), https://muninetworks.org/content/rdof-auction-ends-confusion-and-corruption-may-just-be-beginning

[24] Doug Dawson, *Fixing the RDOF,* Pots and Pans by CCG (February 3, 2021), https://potsandpansbyccg.com/2021/02/03/fixing-the-rdof/

[25] Presentation, *Week 2: Why Fiber is the Only Future Ready Broadband (January 12, 2022),* Fiber Broadband Association's Fiber for Breakfast (January 12, 2022), https://www.fiberbroadband.org/page/fiber-for-breakfast

[26] Mike Dano, *Here Are All the Winners of the FCC's $9.2B RDOF Auction,* Light Reading (December 7, 2020), https://www.lightreading.com/opticalip/here-are-all-winners-of-fccs-$92b-rdof-auction/d/d-id/765937

[27] Cartesian, *Starlink RDOF Assessment Final Report,* Cartesian (February 8, 2021), https://ecfsapi.fcc.gov/file/10208168836021/FBA_LEO_RDOF_Assessment_Final_Report_20210208.pdf

Separately, when assessing grants, states and territories that can already meet or have already met the needs of their ***unserved*** communities should not be precluded from immediately spending received funding to addressing the needs of their ***underserved*** population. Put another way, a state already addressing the unserved should not be penalized for using received monies to address the underserved. They should be able to move on to the next phase of deployment.

Some commenters might argue that the NTIA should exclusively address the unserved first, but a 'first worst' strategy fundamentally misunderstands that future-proofed sustainable broadband networks cut across communities that are currently a mix of unserved, underserved, and even the served.[28] A future sustainable network needs to aggregate the demand of multiple communities to cross-subsidize deployment to the most difficult and expensive areas, thereby tying together areas that would otherwise be considered underserved or even served. If the first phase of NTIA funding can only address unserved served projects, defined as projects in which 80% or more of the locations have less than 25/3, it will impede efforts by states proactively tackling their unserved communities and stall the deployment of future-proof broadband networks across wide swaths of America.

For example, last year California created the largest fiber infrastructure program in the country that made available an estimated $7.5 billion available to close the digital divide, with more than $2 billion in grants to finance the construction of broadband networks to unserved communities and an additional $700 million that can be leveraged into $7 billion in long term financing.[29] Proactivity on California's part, or of any state, should be taken into recognition. They and similarly situated proactive actors should be allowed to receive NTIA funding and move on to provisioning the underserved without penalty.

7. NTIA views the participation of a variety of provider types as important to achieving the overall goals of the Bipartisan Infrastructure Law broadband programs. How can NTIA ensure that all potential subrecipients, including small and medium providers, cooperatives, non-profits, municipalities, electric utilities, and larger for-profit

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[28] *See Reply Comments of the Electronic Frontier Foundation in Response to the Request for Additional Comments As Part of Middle-Mile Data Collection* (filed October 15, 2021) at 3.D. (asserting the [California Public Utilities Commission] should avoid recommending a "first worst" strategy as opposed to a universal 21st century access strategy), available at, https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M415/K275/415275380.PDF

[29] Ernesto Falcon, *How California's Broadband Infrastructure Law Promotes Local Choice,* Electronic Frontier Foundation (September 17, 2021), https://www.eff.org/deeplinks/2021/09/how-californias-broadband-infrastructure-law-promotes-local-choice

companies alike have meaningful and robust opportunities to partner and compete for funding under the programs?

NTIA should take several steps, outlined below, to ensure widespread, equitable access to funding through the following means.

Give Special Consideration Towards Applicants Utilizing Long Term Financing

Building fiber networks in difficult to serve markets requires long-term, low-interest financing. This is because the high up-front construction costs must be spread over an extended period of time in order to unlock the promise of low-cost, high-speed broadband to consumers. California's broadband infrastructure law recognized this and created a "loan loss reserve fund," specifically for local municipalities, county governments, nonprofit organizations, tribes, school districts, and other public and non-profit entities to support local fiber development.[30] The approach is logical in that many of these deployments will have to be done at-cost without any profit over an extended period of time. In fact, the provisioning of specially tailored long-term low-interest financing designed for public entities in California has led to the creation of a multi-county government entity explicitly dedicated towards the construction of open access fiber to all rural Californians.[31] NTIA can leverage the creation of existing long term infrastructure focused entities by prioritizing funding towards assisting their expansion plans.

NTIA should require applicants to disclose any long-term debt obligations as a means to assess the level of existing commitment to a local community. This will ensure that NTIA distributes funds to entities that have already agreed to invest in communities for the long run, as is necessary to fulfill the goals of the law. These entities are likely to be highly motivated to serve their communities, such as municipalities, co-operatives, tribes, local rural private providers, or school districts.

NTIA Should Condition Middle-Mile Grant Money on Provisioning the Middle-Mile Open-Access and At-Cost

[30] S.B. 156, § 8. *See* California Public Utilities Commission, Last-Mile Broadband Fact Sheet, https://www.cpuc.ca.gov/-/media/cpuc-website/industries-and-topics/documents/telecommunications/broadband--fact-sheet_083021.pdf (last accessed Jan. 31, 2022)
[31] GOLDEN STATE CONNECT AUTHORITY, *available at* https://www.goldenstateconnect.org.

A way to ensure the long-term affordability and capacity to communities from federally funded middle mile is to require that access to middle-mile infrastructure is offered on an open and at-cost basis. This will enable the most efficient and lowest cost way to reach the most people with fiber connections.[32] Planning for development of this shared infrastructure is already underway in Utah, California,[33] and many other states[34] that give the NTIA existing projects to expand upon with its middle mile funding. An open-access regime is particularly important for rural markets, which are uniquely difficult to serve and rely on affordable access to middle-mile infrastructure.

NTIA should therefore condition middle mile grants funds to require entities to operate only as open, at-cost access to middle-mile infrastructure. Middle-mile providers that receive NTIA funding should be required to grant at least 30-year, at-cost licenses to last-mile providers to ensure these providers do not lose affordable middle-mile access midway through their development of sustainable fiber networks.

Conduct Multiple Phases of Granting

The NTIA should outline a means of ensuring that communities in the early stages of thinking about developing their own last-mile solution are given adequate time to become grant applicants as well as utilizers of any existing middle-mile infrastructure. EFF theorizes that certain communities are ready today to utilize NTIA's infrastructure program, while others may need potentially more than a year to be fully ready to apply for funds. Planning multiple phases

[32] *See generally*, Benoît Felten and Thomas Langer, *Wholesale Fiber is the Key to Broad US FTTP Coverage*, https://www.eff.org/document/wholesale-fiber-key-broad-us-fttp-coverage (study commissioned by EFF).
[33] *See* https://www.utopiafiber.com/*; see also* Ernesto Falcon, *Every State Has a Chance to Deliver a "Fiber for All" Broadband Future: 2021 In Review*, https://www.eff.org/deeplinks/2021/12/every-state-has-chance-deliver-fiber-all-broadband-future-2021-review (Dec. 30, 2021).
[34] For additional state examples see the Illinois Century Network https://www2.illinois.gov/icn/about/network/Pages/default.aspx, Kentucky Communications Network Authority https://kentuckywired.ky.gov/Pages/index.aspx, Massachusetts Broadband Institute https://broadband.masstech.org/middle-mile-network, Michigan's Merit https://www.merit.edu/about, Missouri's Sho-Me Power Electric Cooperative https://www.shometech.com/media/1139/map-layout-151-printable-blue-w-pop-list.pdf, North Carolina MCNC https://www.mcnc.org/our-solutions/connectivity/fiber, Ohio Middle Mile Consortium https://www2.ntia.doc.gov/files/grantees/comnet_infrastructure_application_attachment_part5_redacted.pdf, Virginia's MBC https://mbc-va.com/network, and Washington's NOANET https://www.noanet.net/network-map.

that give early bidders and late comers equal opportunities will be important to ensure that NTIA's program is successful and that grants are given to the most efficient recipients.

Condition Grant Money on Universal Deployment

Communities should be given clear guidance that they must include the unserved in their delivery of network access, but not to the exclusion of also connecting their underserved population. This is because a network needs to aggregate all of the demand in order to cross-subsidize the most difficult and expensive places to connect with the underserved and even the served.

New last-mile providers, particularly in rural markets, need to invest in their entire community to transition themselves into fiber but likely deal with existing legacy deployments that favored the most lucrative portions of the community. Applicants need the flexibility to approach projects from a comprehensive standpoint to upgrade everyone through cross-subsidizing the costs between their high-end users with higher-cost users. Core tenants, usually anchor institutions or local businesses, can often provide the revenues to make the entire deployment financially feasible on its own.[35]

Prioritize Local Entities with Smaller Grants

Rather than dole out a few large grants, NTIA should err on the side of providing many smaller grants, distributed among many entities. This will help ensure that broadband development occurs in unserved communities all over the country, as required by law, rather than potentially favoring large corporate ISPs that disfavor long term return on investments. For example, in rural areas, local electric co-operatives are typically best placed to develop FTTH

[35] See, for example, Chattanooga. Only a fraction of Chattanooga's population was necessary to cover the costs of providing FTTH to the community—revenues outpaced the costs of adding new customers year after year. Chattanooga's public ISP is so revenue-heavy that it could provide free 100/100 mbps broadband to 28,000 students for 10 years at an at-cost basis of barely $2.50 per month per student—serving all its low-income families with students attending public school. *See* Taelor Bentley, *Hamilton County Schools and EPB Team Up to Provide Internet Access to Students*, AMERICAN PUBLIC POWER ASSOCIATION (Aug. 17, 2020), available at https://www.publicpower.org/periodical/article/hamilton-county-schools-and-epb-team-provide-internet-access-students; *See also* Press Release, ELECTRIC POWER BOARD OF CHATTANOOGA, *State of Tennessee Helps Bridge Digital Divide for Students in Chattanooga and Hamilton County* (Sep. 30, 2020), *available at* https://epb.com/about/news/state-of-tennessee-helps-bridge-digital-divide-for-students-in-chattanooga-and-hamilton-county.

networks.[36] Distributing smaller grants to a wider number of local institutions like co-operatives will be the most efficient way to fulfill the law's mandate of providing high-quality broadband service to currently unserved areas.

8. States and regions across the country face a variety of barriers to achieving the goal of universal, affordable, reliable, high-speed broadband and broadband needs, which vary from place to place. These challenges range from economic and financial circumstances to unique geographic conditions, topologies, or other challenges that will impact the likelihood of success of this program. In implementing the Bipartisan Infrastructure Law's broadband programs, how can NTIA best address such circumstances?

The pandemic has dramatically shifted the importance of broadband in people's lives where now 76% of the American public view broadband access to be on par with water and electricity.[37] At the same time, many Americans simply lack the income to use the internet, which will be alleviated partially with the Affordable Connectivity Program (ACP). In other words, even if we build the infrastructure, some Americans will not be able to use it if it comes with a fee. However, we can bake into our infrastructure policy the delivery of free or near free access to the internet, which is feasible with sufficiently high-capacity fiber infrastructure that can be leveraged throughout a community.

Notably, fiber optics is unique among broadband technologies in that its capacity will grow while the cost per megabit will rapidly drop, potentially at an exponential level,[38] allowing for enormous flexibility in fiber infrastructure to deliver free access. As is noted in this comment, Chattanooga's delivery of free 100/100 mbps at an extremely lost at-cost basis per month per connection is the proof that fiber can meet affordability goals and make the cost of delivery future-proof along with the speeds. EFF believes more EPB style delivery of free high-speed access are achievable if currently existing fiber, for example existing E-rate financed fiber infrastructure under modernized rules from the FCC, can be connected with subsidy support

[36] For testimonials concerning the deployment of fiber networks in rural areas, see https://conexon.us/case-studies/groundbreakers/.

[37] Consumer Reports, *Broadband in the U.S.: Consumer Reports' New Survey Reveals Challenges for Consumers*, Aug. 3, 2021, *available at* https://www.consumerreports.org/media-room/press-releases/2021/08/broadband-in-the-us-consumer-reports-new-survey-reveals-challenges-for-consumers.

[38] See Bennett Cyphers, *The Case for Fiber to the Home, Today: Why Fiber is a Superior Medium for 21st Century Broadband*, Electronic Frontier Foundation (Oct 11, 2019), https://www.eff.org/files/2019/10/15/why_fiber_is_a_superior_medium_for_21st_century_broadband.pdf

programs such as the ACP and NTIA's grant program to extend the reach of existing fiber and ultimately free access.

To facilitate these outcomes, NTIA can condition its low cost offering on having to be able to not just offer sufficient speeds for today, but to also be easily scalable and price stable to match the ACP subsidy of $30 a month. If matched with a predicted growth in data needs from the NTIA, states will understand that infrastructure projects they finance will have to be capable of delivering future proof low-cost access rather than decouple it from the underlying infrastructure. Given that EPB's at cost basis is a mere $2.50 a month for a mature fiber network, there should be little challenge for applicants to design $30 a month low cost offerings that deliver high-speed access.

13. NTIA is committed to ensuring that networks built using taxpayer funds are capable of meeting Americans' evolving digital needs, including broadband speeds and other essential network features. What guidance or requirements, if any, should NTIA consider with respect to network reliability and availability, cybersecurity, resiliency, latency, or other service quality features and metrics? What criteria should NTIA establish to assess grant recipients' plans to ensure that service providers maintain and/or exceed thresholds for reliability, quality of service, sustainability, upgradability and other required service characteristics?

The NTIA should encourage the development of last-mile broadband infrastructure that can serve the needs of Americans who are more dependent than ever on reliable, high-speed broadband. It must consider not only the needs of today - which are pressing - but the trends that are likely to dominate the next several decades of network development. EFF suggests identifying a few key metrics by which different proposals for broadband deployment should be assessed: bandwidth, latency, capacity for symmetrical service, and upgradability.

Accordingly, we recommend the NTIA specifically seek to fund the construction of networks capable of meeting these metrics in fulfillment of the statute's stated goals of easily scalable infrastructure able to meet evolving community needs. From EFF's technical analysis, the answer is conclusively new fiber-optic infrastructure, especially plans that deploy "fiber-to-the-home" meet the terms Congress set out in its priority broadband projects. Fiber-optic Internet service is low-latency, high-bandwidth, and extremely reliable. Furthermore, fiber-optic cables that are laid now can be upgraded to achieve much higher performance for decades to come without significant changes to the cables themselves.

"Bandwidth" is the common term encompassing upload and download data rates, the primary metrics that consumers use to assess broadband speeds today. Bandwidth dictates how quickly users can transfer large quantities of data across the network: at 100 megabits per second, a user can transfer a 1 gigabyte (8 gigabit) file in 80 seconds. Demand for bandwidth has increased steadily and exponentially since the dawn of the Web, and millions of Americans depend on high-bandwidth connections in order to work, study, and participate in an increasingly remote society.

Internet service providers (ISPs) can provide relatively high-bandwidth connections using several different kinds of infrastructure. "Wireline" broadband connections are the most common, including DOCSIS over coaxial cable, DSL over phone lines, and fiber. Other emerging broadband technologies include 5G wireless and satellite internet. All of the technologies listed are capable of providing broadband Internet at speeds over 100 megabits per second.

However, in terms of raw available bandwidth, fiber stands alone. Fiber-optic cables carry signals that are 10,000 to 100,000 times higher frequency than the highest RF bands that can be transmitted over copper wire or via cell tower. Signals carried over fiber optics can be modulated much more quickly, transmitting orders of magnitude more data per second than technologies that occupy lower frequency bands. A single fiber optic cable can transmit over 300 terabits per second over hundreds of miles today; in theory, it can carry even more. Once fiber has been laid to a building, exceptionally high bandwidth service can be provided relatively cheaply. Furthermore, because fiber-optic cables have so much spare capacity, multiple providers can share bandwidth on a single cable without interfering with one another. Fiber is capable of enabling open-access networks that can efficiently bring high-capacity internet service to underserved markets via a multiplicity of service providers.[39]

Another important factor to consider is network infrastructure's capacity to provide symmetrical speeds - that is, fast uploads as well as fast downloads. Traditionally, consumers have used much more bandwidth for downloading than they do for uploading, a consequence of the kind of traffic that web browsing generates. But recent trends, dramatically accelerated by the impact of COVID-19 pandemic, have changed that paradigm. The rise of remote work and

[39] Benoît Felten and Thomas Langer, "Wholesale Fiber is the Key to Broad US FTTP Coverage," 10/27/2021. https://www.eff.org/document/wholesale-fiber-key-broad-us-fttp-coverage

remote learning, which often require continuous streaming of live video, have helped drive a massive uptick in upstream traffic since the beginning of 2020. That year alone, total upstream traffic increased 63%, and average upstream traffic during business hours nearly doubled.[40] Technologies like DOCSIS and 5G, which must make efficient use of limited spectrum, tend to favor download capacity over upload speeds. As consumer needs continue to change, these technologies will take time to adapt, and symmetrical speeds may come at the expense of download bandwidth. In contrast, widely deployed protocols for networking over fiber already support symmetrical speeds to millions of households.

Grants should not just aim to fill the needs of today; they should be used to fund infrastructure that will continue to be useful for decades to come, and that can be upgraded at low cost. Fiber-to-the-home deployments which provide symmetrical gigabit speeds have not even scratched the surface of the medium's capacity. And future improvements to fiber networks will not require changes to the fiber itself. The limiting factor on a fiber network is the hardware that transmits and receives signals.

In contrast, cable internet (using the DOCSIS standard) is already approaching the physical limit of how much information coaxial cables can transmit. As a result, cable companies operate with slimmer margins of error and less room for improvement. It's simply not possible to keep squeezing more capacity out of aging copper cables. Future gains in upload and download speeds over coaxial networks will require laying fiber closer and closer to subscriber's homes.

Similarly, although wireless broadband has improved rapidly over the past decade, the technology is beginning to run up against its own set of physical limitations. 5G makes use of the much-touted "mmWave" spectrum at frequencies of 26 GHz and above. This spectrum is capable of transmitting data at rates of up to 10Gb/s under optimal conditions, but that comes with several caveats: mmWave signals are more susceptible to disruption by buildings, foliage, and weather, and they disperse over shorter distances than lower-frequency signals do. As a result, high-bandwidth 5G towers must necessarily serve smaller areas than previous generations of wireless broadband. It seems unlikely that long-range wireless broadband will be able to provide bandwidth that competes with wireline systems in the decades to come.

[40] Dan O'Shea, "Pandemic drove upstream broadband traffic boom: OpenVault," 4/1/2021 https://www.fiercetelecom.com/telecom/pandemic-drove-upstream-broadband-traffic-boom-openvault

Another important metric for differentiating last-mile solutions is latency. Latency is critical to the performance of real-time applications, including remote work and learning, online gaming, and emerging VR/XR apps.

An FCC study conducted in 2019 found that fiber connections had consistently lower latency than both DSL and cable wireline connections, averaging between 10 and 12 milliseconds compared to cable's 13 to 27 ms.[41] Wireless broadband has traditionally suffered from latency problems when compared with wireline alternatives. 4G, still the dominant technology in much of the country, has been tested at between 42 and 60ms.[42] The 5G standard is theoretically capable of latencies competitive with wireline broadband, but independent testing of currently-deployed 5G networks still measure average latencies above 30ms.[43]

Satellite internet lags behind the pack thanks to physical limitations. While 5G and other terrestrial wireless networks may eventually be able to compete with fiber at very low latencies, satellite networks require that a signal be sent from a subscriber to space and back before it can rendezvous with the rest of the Internet. Even at the speed of light, this takes time. For geostationary satellites, this means a minimum latency of approximately 240 ms, an unacceptable delay for real-time applications. For low-earth orbit satellites like those used in Starlink's constellation, the signal round trip is less costly, but still a factor. The distance and complexity involved mean that the earth-to-space hops will require at least 20-40 milliseconds, meaning they still can't compete with current wireline technology.

In conclusion, we recommend that the NTIA evaluate grant applications with a strong preference for symmetrical, high-capacity, low-latency connections that will be easy to upgrade for the next several decades. In a word, that means fiber. See our whitepaper for more details on the technical merits of fiber-to-the-home infrastructure, both now and in the future.[44]

14. NTIA is committed to ensuring that networks constructed using taxpayer funds are designed to provide robust and sustainable service at affordable prices over the long

[41] FCC, "Measuring Fixed Broadband - Tenth Report," 1/4/2021 .https://www.fcc.gov/reports-research/reports/measuring-broadband-america/measuring-fixed-broadband-tenth-report

[42] Tom's Guide, "5G speed: 5G vs. 4G performance compared," June 1, 2021 https://www.tomsguide.com/features/5g-vs-4g

[43] SpeedTest, "United States' Mobile and Fixed Broadband Internet Speeds," last updated December 2021 https://www.speedtest.net/global-index/united-states#market-analysis

[44] Bennett Cyphers, "The Case for Fiber to the Home, Today: Why Fiber is a Superior Medium for 21st Century Broadband," 10/16/2019 https://www.eff.org/wp/case-fiber-home-today-why-fiber-superior-medium-21st-century-broadband

term. What criteria should NTIA require states to consider to ensure that projects will provide sustainable service, will best serve unserved and underserved communities, will provide accessible and affordable broadband in historically disconnected communities, and will benefit from ongoing investment from the network provider over time?

The NTIA must set a high standard and require states to consider only projects that aim to meet projected future needs. From a technical analysis EFF has found that fiber optics lies at the core of all future proof infrastructure. Fiber provides sustainable, affordable, and accessible capacity in the long term when the assumption that people will always need more data in the years to come is baked in the analysis. It is also the only transmission medium that can provide greater service at lower costs with further advancement in hardware. The result being it benefits from the relatively inexpensive investment costs of hardware switching. This cheap upgrade process will also promote price stability with higher speeds at the same or lower prices going forward. This is especially true if the NTIA program is handling the most expensive part of the network, the one-time sunk costs of construction.

Other commentators might argue that fiber infrastructure is more expensive than just upgrading pre-existing cable infrastructure or favoring wireless connectivity, and that upgrading pre-existing cable infrastructure to meet today's needs is good enough. This is, after all, what the government has historically done as a matter of policy without much policy success.[45] It is precisely this backwards, short term, good-enough-for-now thinking that led to the proliferation of once connected communities rapidly becoming unserved as data demands advanced. The NTIA can get ahead of this problem by appropriately scoring the value of long term infrastructure over short term deployment strategies given that the capacity constrained slower networks will eventually become obsolete as needs grow.[46]

Fortunately, there are already several proofs of concept in America that the NTIA can draw upon to study both the viability of fiber as a future-proof network and how it compares to the cable model. The Electronic Power Board of Chattanooga (EPB) and United Fiber, a rural cooperative in Missouri, are two examples of how places we can reach with electricity can also

[45] Jonathan Chambers, *Sunk Costs: A Cautionary Tale,* Conexon (April 5, 2021), https://conexon.us/conexon-blog/sunk-costs-a-cautionary-tale/

[46] Ernesto Falcon, *Why Slow Networks Really Cost More Than Fiber,* Electronic Frontier Foundation (June 4, 2020), https://www.eff.org/deeplinks/2020/06/why-slow-networks-really-cost-more-fiber

be reached by fiber. Furthermore, future proof infrastructure yields the incredibly valuable benefit of extremely low cost but high quality access to fiber for low-income Americans.

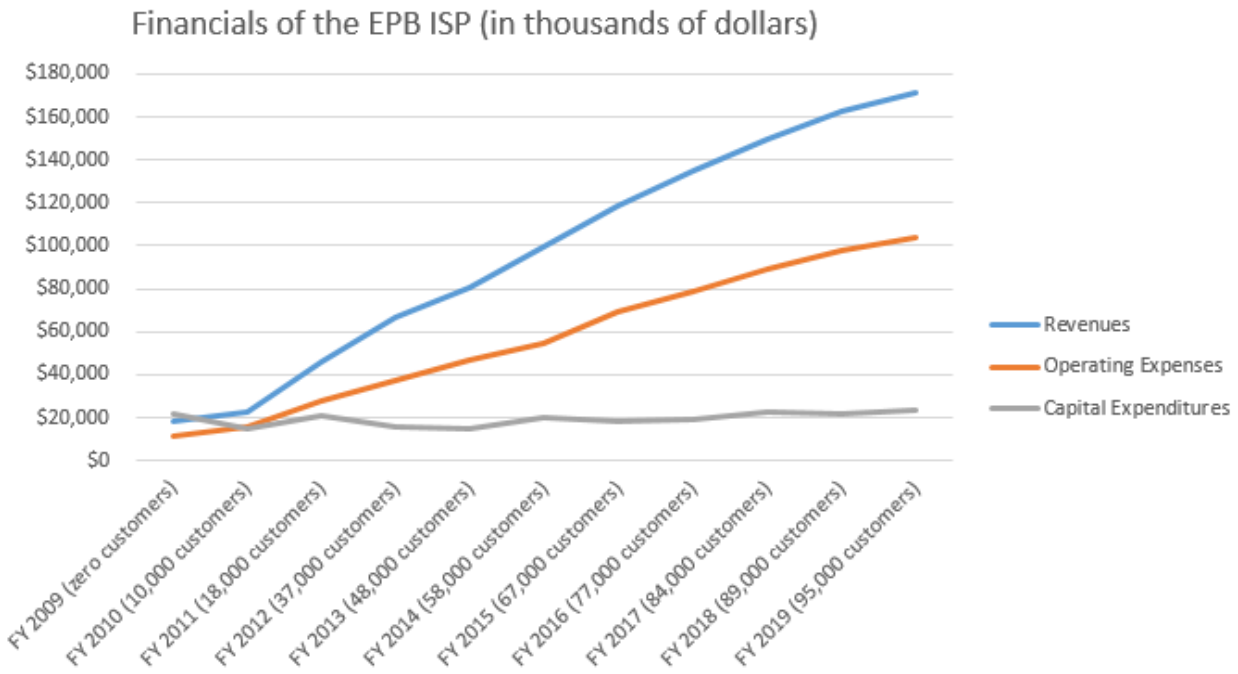
Consider the city of Chattanooga, Tennessee whose local public utility, the EPB, began building and servicing fiber a mere decade ago and is already so revenue-heavy that they can provide free 100/100 mbps service to 28,500 students for 10 years at an at-cost basis of barely $2.50 per month per student, which is substantially less than the $30 a month subsidy Congress authorized for five years under the Affordable Connect Program. Now EPB effectively provides service to every low-income family in Hamilton County schools, in response to the ongoing pandemic.[47] EPB began to build out fiber infrastructure in 2009 and provide internet service, becoming an ISP, in 2010.[48] By 2012 they were profitable and in 2015 they launched 10 gigabit downstream 10 gigabit upstream networks.[49] Cable providers did not transition to 1 gigabit downstream, with substantially slower upstream, a tenth of what Chattanooga began offering four years earlier, until 2019.[50] Notably, the cost for EPB to upgrade their network to 10 gigabits was fully financed by their user base and negligible in terms of capital investment expenditure. As previously noted, cable cannot upgrade as fast or as cheaply as fiber, but rather have to transition their coaxial lines into fiber. There is no reason to believe EPB's investment in fiber will cease to yield dividends, as a revenue heavy entity and more importantly as a network provider that can cheaply meet future demands and expand its services over time.

[47] Taelor Bentley, *Hamilton County Schools and EPB Team Up to Provide Internet Access to Students,* American Public Power Association (August 17, 2020), https://www.publicpower.org/periodical/article/hamilton-county-schools-and-epb-team-provide-internet-access-students; See also Press Release, *State of Tennessee helps bridge Digital Divide for Students in Chattanooga and Hamilton County,* Electronic Power Board (September 30, 2020), https://epb.com/about/news/state-of-tennessee-helps-bridge-digital-divide-for-students-in-chattanooga-and-hamilton-county/

[48] *HCS EdConnect: Connecting families at no-cost, high-speed internet in Chattanooga*, Results4America (January 12, 2022), https://catalog.results4america.org/program/broadband-access-initiatives/hcs-edconnect-chattanooga-tn

[49] Press Release, *Chattanooga Implements World's First Community-wide 10 Gigabit Internet Service,* Electronic Power Board of Chattanooga (October 15, 2015), https://epb.com/about/news/chattanooga-implements-world-s-first-community-wide-10-gigabit-internet-service/#:~:text=Chattanooga%2C%20TN%20

[50] Press Release, *America is Now a Gigabit Nation*, NCTA - The Internet and Television Association (January 18, 2019), https://www.ncta.com/whats-new/america-is-now-a-gigabit-nation



Meanwhile, United Fiber in Missouri can deliver gigabit service at $100 a month to rural locations with a population density of 2.4 people per square mile.[51] At $50 a month one can get 200 Mbps upstream 200 Mbps downstream.[52] These are areas where incumbents would never provision with adequate service due to a belief in lack of profitability, yet a fiber network has been built here on the rationale that long-term capital investment combined with fiber's inexpensive capital investment costs will ensure that the network can not only meet future needs, but also continue to provide up-to-date access to these otherwise difficult to provision areas.

There is no reason the NTIA cannot facilitate the successes of the EPB or United Fiber across the country and enable the downstream benefits of extremely low cost to free access to the internet for low-income Americans. However, fiber optics is the only transmission medium capable of meeting the needs of all Americans, urban and rural, in an accessible and affordable way both today and into the future. Anything less will squander taxpayer dollars on not future ready deployments.

[51] Christopher Mitchell, *United Fiber Tackles Missouri's Most Rural-Community,* Broadband Bit Podcast at Community Networks (February 14, 2017), https://muninetworks.org/content/united-fiber-tackles-missouris-most-rural-community-broadband-bits-podcast-240

[52] United Fiber, Internet Plans, https://unitedfiber.com/internet/

15. In its effort to ensure that BEAD funded networks can scale to meet Americans' evolving needs, and to ensure the public achieves the greatest benefit from the federal investment, NTIA seeks to understand reasonably foreseeable use cases for America's broadband infrastructure over the next five, ten, and twenty years. What sort of speeds, throughput, latencies, or other metrics will be required to fully connect all Americans to meaningful use over the next five, ten, and twenty years? How can the BEAD program meet our nation's broadband network connectivity needs in the future and what other benefits can Americans expect from this program and the networks it will help fund in other industries and across the economy? How can existing infrastructure be leveraged to facilitate and amplify these benefits? What are the best sources of evidence for these questions and for predicted future uses of broadband?

With regard to the speeds, latencies, and other metrics required to fully connect all Americans to meaningful use in the future, the NTIA should proceed with the core assumption that usage will always grow; usage in 2024 will be greater than 2022 and further, usage in 2032 greater than 2026. Since the 1980s, consumer usage of the internet has grown by 21% on average every year and that rate of growth has only shown signs of increasing, not decreasing.[53]

Using Openvault's finding that average use in 2021 was 207 Mbps downstream 16 Mbps upstream, applying a 21% annual growth places usage in 2026 as over 500 Mbps downstream and 40 Mbps upstream. By 2032, average use will be nearly 2 gigabits downstream.[54] Even conservative estimates for demand in rural areas predict the need for gigabit speeds by 2029.[55]

Crucially downstream and upstream growth are not equivalent, with consumer need for upstream data growing at an even faster pace. As the pandemic underscores, people are moving toward remote socializing, remote learning, remote work, telehealth, and various other services that require high upstream speed and capacity as well. In fact, services reported an increase of 56% in upstream traffic in 2020.[56] This is not an aberration; these are the new facts of life when

[53] Doug Dawson, *Why Fiber?,* CircleID (February 13, 2021), https://circleid.com/posts/20210213-why-fiber/
[54] Ernesto Falcon and Katharine Trendacosta, *The Future Is In Symmetrical, High-Speed Internet Speeds,* Electronic Frontier Foundation (July 2, 2021), https://www.eff.org/deeplinks/2021/07/future-symmetrical-high-speed-internet-speeds ; See also Presentation, *Week 2: Why Fiber is the Only Future Ready Broadband (January 12, 2022),* Fiber Broadband Association's Fiber for Breakfast (January 12, 2022), https://www.fiberbroadband.org/page/fiber-for-breakfast
[55] *The Rural Digital Divide: Fiber Broadband Can Eliminate The North American Rural Digital Divide*, Fiber Broadband Association (June 2021), https://www.fiberbroadband.org/p/cm/ld/fid=978
[56] Dan O'Shea, *Pandemic Drove Upstream Broadband Traffic Boom: Openvault,* Fierce Telecom (April 1, 2021), https://www.fiercetelecom.com/telecom/pandemic-drove-upstream-broadband-traffic-boom-openvault

it comes to the provisioning of broadband service and upstream limited infrastructure will be ill suited for the shift.

To contextualize the increase in average use, consider the many critical services that now require both high upstream and downstream capacity. At the start of the pandemic, the surge in home usage led to a massive degradation of service for capacity constrained networks. The cable networks operators and legacy telecoms dependent on copper wires for example were not ready to handle what we now consider normal volumes of data usage.[57]

While most businesses will not transition to a 100% remote workforce in the near future, nearly 80% of businesses now have work from home policies, signaling that remote work, and the demands it places on networks, is here to stay.[58] The white collar economy is no longer urban high rises, but suburbs, multi-tenant apartments, and Americans in rural areas who will all require a reliable, fast network to participate and contribute to the American economy.

Rural economies also increasingly require high quality, reliable broadband. Essential economic endeavors like agriculture, forestry, mining, and energy production are best suited to rural areas and, with increasing digitization, need greater speeds and capacity to remain competitive. Precision farming requires the use of ground sensors, drones, and satellite data to analyze the needs of the soil and monitor applications of water and nutrients on a foot-by-foot basis.[59]

Beyond what is necessary for the future of work, drastically higher upstream speeds to the point of requiring symmetrical usage will be necessary for the future of person-to-person communication (telehealth, videoconferencing, distance learning) and entertainment. All these services require high upload speeds to establish a reliable connection. AR/VR technology as

[57] Cecilia Kang, Davey Alba, and Adam Satariano, *Surging Traffic is Slowing Down Our Internet,* New York Times (May 20, 2020), https://www.nytimes.com/2020/03/26/business/coronavirus-internet-traffic-speed.html
[58] *The Future of Work: Analyzing Global Broadband Trends,* Fiber-To-The-Home Council Global Alliance (July 31, 2021), https://www.ftthcouncil.eu/knowledge-centre/all-publications-and-assets/233/the-future-of-work-analyzing-global-broadband-trends
[59] *The Rural Digital Divide: Fiber Broadband Can Eliminate The North American Rural Digital Divide*, Fiber Broadband Association (June 2021), https://www.fiberbroadband.org/p/cm/ld/fid=978

recreational entertainment and business uses will likely require higher upstream than downstream speeds to properly function.[60]

The discussed projections only calculated usage out 10 years and all findings unanimously point toward the need for, at the very least, a gigabit connection for each person. Because usage will always grow, twenty years from now user demand could conservatively be in the realm of 6 gigabit per second symmetrical speeds. It is incumbent upon the NTIA to provide guidance to the states and project those estimated needs going forward.

Lastly, as noted before, an open-access fiber network can reliably meet future connectivity needs across the whole of American society for a myriad of technologies. This is particularly true for the unserved and high-cost areas the BEAD program is designed to address. Furthermore, it is a model that can both economically and technically deliver multi-gigabit broadband access in the future but also promote competition from local private and public entities. In addition, open access fiber networks can be economically feasible and provide reliable future-proofed service in both urban and rural areas.[61] The fact that any provisioning of fixed wireless is wholly reliant on the excess capacity of underlying fiber lines, without fiber infrastructure there can be no 5G or any kind of good, future-proofed wireless service.[62]

With fiber being the only real option, existing infrastructure that can be leveraged to hasten deployment is existing dark fiber. It is entirely feasible that a local entity with sufficient technical knowledge can simply tap into existing dark fiber and run their own network in its entirety, thereby provisioning a previously unserved or underserved community.[63] Work may

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[60] *Cloud AR/VR Whitepaper,* GSMA Future Networks (April 26, 2019), https://www.gsma.com/futurenetworks/wiki/cloud-ar-vr-whitepaper/

[61] Benoit Felten & Thomas Langer, *Structurally Independent Broadband Infrastructure can Solve Perceived FTTH Coverage Issues*, DIFFRACTION ANALYSIS (Jun. 13, 2016), https://www.diffractionanalysis.com/services/white-papers/2016/06/structural-remedies-solve-rural-broadband-issue; see also Press Release, *New Study Finds All-Fiber Deployments to 90% of Households Achievable in Next Decade,* Fiber Broadband Association (September 10, 2019), https://www.fiberbroadband.org/blog/new-study-finds-all-fiber-deployments-to-90-of-households-achievable-in-next-decade; *see also The Rural Digital Divide: Fiber Broadband Can Eliminate The North American Rural Digital Divide*, Fiber Broadband Association (June 2021), https://www.fiberbroadband.org/p/cm/ld/fid=978

[62] Wireless Infrastructure Association, *Fiber: Inextricably Linked with 5G Connectivity*, available at https://wia.org/fiber-inextricably-linked-with-5g-connectivity.

[63] *See Comments of the Electronic Frontier Foundation in Response to the Request for Additional Comments As Part of Middle-Mile Data Collection* (filed October 01, 2021) at 5.C., available at, https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M411/K741/411741844.PDF

need to be done finding the locations of existing dark fiber lines that are available at an affordable rate, but if the infrastructure is already built then putting it to use can reduce costs.

Where the lack of adequate broadband connectivity has already been tied to lower productivity, lagging educational attainment, declining economic development opportunities, and poorer health outcomes, successful implementation of a fiber network will remedy all these social maladies in the long term.[64] In areas without a proper connection, Americans could not go to school or properly participate in today's economy, exacerbating the struggle of what are often low-income communities of color.[65] Additionally, fiber infrastructure serves as the basis for reliable public wireless service as well as smart city applications including early warning fire detection and air quality monitoring. The benefits of reliable, high-quality fiber will have a real economic benefit in the creation of jobs, increased economic opportunity, and prevention of outages and other disruptions of economic services. There is also preliminary research that finds fiber adds to home value.[66]

In conclusion, fiber optics have already proven to be the transmission medium available today that is economically feasible in both densely populated areas and most rural locations. And fiber is the only medium with the inherent spectrum capacity that allows cheap hardware advances to improve its speed and costs overtime, which can be leveraged for a myriad of other purposes. Financing the construction of this transmission medium to all people, and ensuring its accessibility through open-access obligations can ensure all Americans can partake in the 21st century internet.

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[64] *The Rural Digital Divide: Fiber Broadband Can Eliminate The North American Rural Digital Divide*, Fiber Broadband Association (June 2021), https://www.fiberbroadband.org/p/cm/ld/fid=978

[65] Vinhcent Le and Gissela Moya, *On the Wrong Side of the Digital Divide: Life Without Internet Access, and Why We Must Fix It in the Age of COVID-19,* The Greenlining Institute (June 2, 2020), https://greenlining.org/publications/online-resources/2020/on-the-wrong-side-of-the-digital-divide/; Galperin, H., Bar, F., Kim, A.M., Le, T.V., Daum, K., *Who Gets Access to Fast Broadband? Evidence from Los Angeles County, Spatial Analysis Lab at USC Price,* Annenberg School for Communication (September 2019), https://arnicusc.org/wp-content/uploads/2019/10/Policy-Brief-4-final.pdf

[66] *The Rural Digital Divide: Fiber Broadband Can Eliminate The North American Rural Digital Divide*, Fiber Broadband Association (June 2021), https://www.fiberbroadband.org/p/cm/ld/fid=978