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Broadband Myth Series: Do We Need Symmetrical Upload and Download Speeds?

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Assertions that symmetrical broadband is a national imperative are not well grounded in application demand or actual use of networks. Requiring symmetry in an infrastructure support program would drive up costs, reduce flexibility, and likely result in subsidies for redundant infrastructure in already served areas.

KEY TAKEAWAYS

- Calling for "symmetry" is often a neutral-sounding way of calling for fiber. Proponents sound as if they are not picking a particular winner for subsidies, but a symmetry requirement would automatically exclude several options.
- Current applications do not require symmetrical speeds. While the actual use of upload bandwidth is growing, download traffic is growing too. It is highly unlikely actual use of networks will ever approach symmetry.
- No single broadband technology holds all the advantages. With finite resources and widely varying topography, we need a flexible combination of all available access technologies to bridge the digital divide—not just symmetrical ones.
- If subsidies are limited, then policymakers must confront trade-offs. Putting more resources toward gold-plating symmetrical broadband in one location means fewer locations can be served with more cost-effective tools.
- If we try to subsidize fiber everywhere, overbuilding will crowd out private investment. A targeted approach that doesn't require "future-proofing" will better complement areas that can support competition with private investment alone.
- The FCC should be able to design future auctions in a way that accounts for the ability to scale up network speeds. Legislators should preserve flexibility for different technologies that can best serve different areas of the country.

INTRODUCTION

Calls for symmetrical broadband speeds (the same speeds for uploads as downloads) have circulated in telecom policy circles for over a decade.[1] Early support for broadband symmetry was largely ideological in nature, based on the belief that individuals could play a bigger role in generating content, and symmetry was necessary to put production on equal footing with consumption of content. Recent efforts to promote symmetrical networks, however, appear aimed at shaping a potential infrastructure subsidy program. Establishing an expectation of symmetry would set an unreasonably high bar for subsidies, meaning areas of the country with more than adequate broadband today would be eligible for subsidized overbuilding tomorrow.

Advocates claim that symmetrical speeds are needed for new applications that require faster upload speeds.[2] While it is true that the demand for faster upload speeds is increasing, downloaded content still greatly outweighs uploaded, and likely always will. Modifying the Federal Communications Commission's (FCC's) definition of broadband (currently 25 Mbps/3 Mbps) to symmetrical speeds (some advocates propose 100 Mbps/100 Mbps) would misrepresent foreseeable demand, increase costs, and risk excluding low-cost technologies that already help connect rural areas.[3]

The baseline standard of what is considered broadband informs how rural networks are subsidized, so a reasonable expectation of application demand on last-mile networks is crucial for a well-designed infrastructure subsidy program. Setting the baseline threshold for what speeds count as unserved (and thus deserving of subsidies) has profound implications for the ultimate cost of the program, especially if ungrounded requirements for high-speed, symmetrical service force wide-scale and expensive rebuilding of our nation's existing broadband networks.

Assuming funds are not unlimited, symmetrical requirements would ultimately mean either fewer high-cost locations are served or less money is available to address affordability, digital literacy, and other impediments to adoption. Extreme changes to the broadband standard may even increase the digital divide, as many providers would likely spend subsidies in relatively low-cost areas already covered under the previous definition of broadband, simply using funding to upgrade networks where economic return is easier, rather than deploying new networks to truly unserved areas.

Symmetrical requirements would ultimately mean fewer high-cost locations are served or less money is available to address affordability, digital literacy, and other impediments to adoption.

However, the definition of "broadband" should be updated to reflect reasonable expectations of future demand, which likely means increasing baseline upload speeds from 3 Mbps, even though doing so would make coordinating with existing subsidy programs more difficult. Broadband should be defined such that subsidies go toward the deployment and operation of robust networks that enable meaningful participation in online activities, not to ensure subsidized networks can support any and all conceivable high-speed technologies, especially if the higher speeds only enable marginally higher-quality entertainment (e.g., allowing livestreaming in ultra-HD rather than HD) or marginally faster file transfers that take place in the background.

Calls for symmetrical networks are especially pernicious because of the way symmetry requirements would increase costs and reduce the flexibility in technology that can be used to bridge the rural infrastructure divide. Today, symmetrical speeds are only realistically achievable by fiber and some updated cable systems. By setting the baseline standard as symmetrical, much of the country that today has highly functioning broadband would be opened to subsidies. If the target goal for subsidized networks to achieve is symmetry, then the flexibility for fixed wireless solutions to help bridge the digital divide will also be greatly reduced .

The thinking of symmetry advocates would be understandable if money were no object. Either a bottomless government purse paid for by unlimited debt or the supposedly "deep pockets" of broadband providers could pay for this gold-plated system. But in the real world, resources are scare and wasting money on infrastructure people are unlikely to need means either higher prices or higher taxes—or even both.

THE CASE FOR SYMMETRY

Calls for symmetry focus on the need for 100 Mbps/100 Mbps specifically, often without providing adequate, or sometimes any, evidence for why 100 Mbps upload speeds are needed. Qualitative statements are made in the place of quantitative data: "[A]t a minimum, people need symmetrical broadband speeds to ensure that they can connect with family, friends, employers, educators, and healthcare professionals," or "[t]o engage in all of these activities at once requires symmetrical broadband speeds."[4] These arguments lack a clear quantitative assessment to demonstrate why the FCC needs to require symmetric speeds, and why specifically 100 Mbps/100 Mbps. Why not 75/75? Or 150/150? Or even 150/75? Instead of selecting a random target, any change in the FCC's definition of broadband should be grounded in use-based facts and reasonable anticipation of future demand. Upload traffic has increased over the years, but not dramatically. Actual Internet traffic is still wildly asymmetric.

Advocates for symmetric speeds also focus on the potential impact to U.S. global competitiveness, claiming that a "low standard undermines larger policy goals for widespread, high-speed connectivity and stifles our competitiveness in the global broadband marketplace."[5] Such statements are misleading. The FCC's definition of broadband does not stop the private sector from developing and deploying faster broadband. It simply provides a reference point for how to determine whether an area is served with the baseline requirement for broadband, and in no way restricts the advancements of broadband or what may be deployed in subsidized areas. In fact, by some advocates' own admission, "61 percent of all broadband subscribers have connections of 100 Mbps or faster," and there has been an almost 100 percent increase in "the median advertised download speed" since 2017.[6] It is reasonable to demand faster upload speeds, at least to a degree. Evidence shows that more than 3 Mbps would help support growth in real-time interactive applications. But there is no indication that requiring symmetrical or far higher upload speeds for subsidized networks is needed to remain globally competitive.

So why do advocates continue to push for symmetry? Often, calling for symmetry means calling for specific technologies, namely fiber. Notably, cable provides a reasonable alternative to fiber with similar performance—yet it has not been widely deployed (likely due to a lack of demand). Requiring symmetry as a technical standard allows for a workaround to the argument that such a requirement is actually a way of picking a particular winner for rural subsidies, when in reality, it automatically excludes several options.

If the policy debate is about moving toward specific technologies, such policy considerations should be discussed in the open, not shrouded in proxy debates. There may well be arguments in favor of wide-scale deployment of fiber. However, debating the use of specific technologies under the guise of self-restricting standards leads to ineffective and inefficient policy debates. Increasing the transparency of the discussion allows policymakers to understand the important trade-offs associated with demanding specific technologies.

For some activists, calls for symmetry are grounded in an ideological view that the Internet should be a "democratized" system wherein users rule; Therefore, uploaded content being equally or more important than downloaded content drives a "need" for symmetrical systems. This stance overlaps with a general distaste for the current U.S. broadband system, wherein access is largely provided through private companies. If advocates can make nonsymmetrical systems look inferior to symmetrical ones, then they can make the case that some private companies are not providing adequate broadband services. In their view, only government-owned networks that are unconcerned with the cost of providing symmetry would ever provide "real" broadband, even though many municipal systems also provide asymmetrical systems.[7]

THERE IS LITTLE REASON TO THINK SYMMETRICAL SPEEDS ARE NEEDED

Current evidence does not demonstrate a need for symmetrical speeds. In fact, over the last decade, the average down-to-up ratio has grown from 3:1 to over 14:1.[8] Even during the pandemic, when most Americans have switched from in-person work and schooling to virtual experiences, Comcast reported: "Traffic patterns remained highly asymmetrical, as downstream traffic volumes were 14x higher than upstream traffic volumes."[9]

Over the past decade-plus that advocates have claimed a need for symmetry, there has yet to be a significant increase in the demand for upload speeds from consumers or applications.[10] While the actual use of upload bandwidth is growing, so too is that of download—and there is little expectation for these growth lines to converge. Most users are still largely consumers, with streaming video taking up the bulk of Internet traffic.

Application Use Is Strongly Asymmetric

Broadband use remains asymmetrical and will likely remain so long into the future. While there is a growing demand for bandwidth (to support both upstream and downstream traffic), heavy upstream use is often limited to a small group of applications and users—and not representative of average user demand.

When it comes to broad measurements in Internet traffic, a large portion of uploads is attributable to a small number of heavy file sharers. The actual use of network capacity is not evenly distributed, with only a very small number of users responsible for much of the upload traffic on any given network. For example, a 2013 study of a Dutch Internet service provider's (ISP) network found "about 2% of the users [were] responsible for 60% of all upstream traffic."[11] It notes the asymmetric nature of downstream to upstream traffic, and predicts this trend will continue, even though the ratio may narrow in the future.

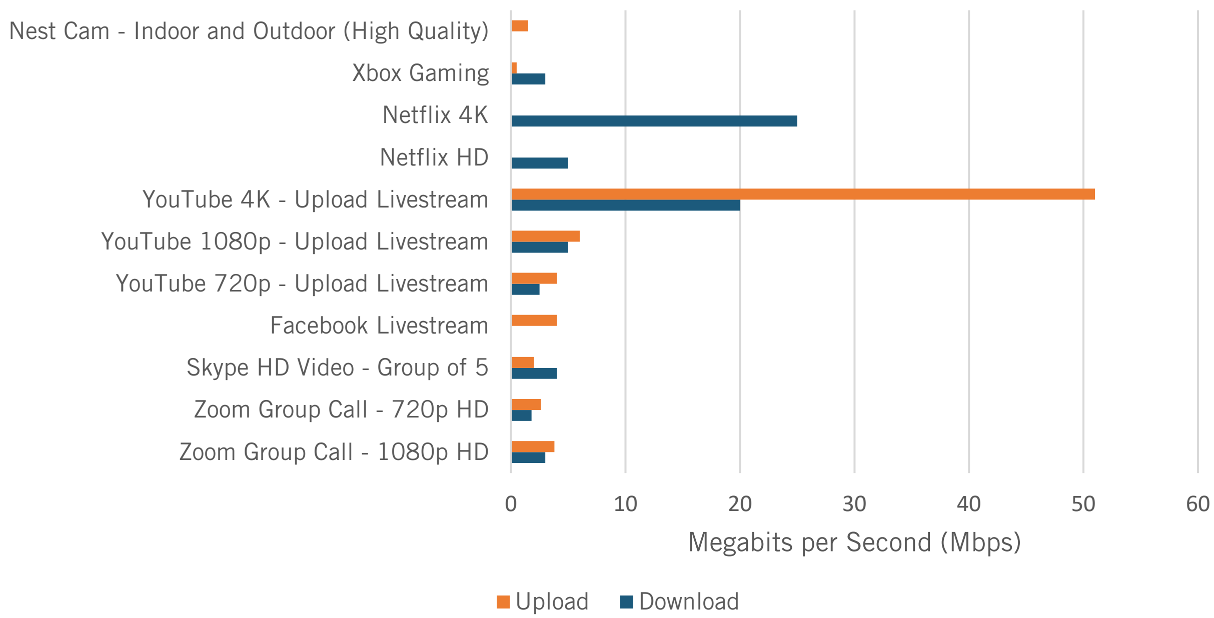
Often much of this upload traffic is from file sharing applications such as BitTorrent. One report finds that file-sharing accounts for 4.2 percent of global downstream and 30.2 percent of upstream traffic.[12] In late 2019, Sandvine published measurements of applications' share of

American upload traffic.[13] BitTorrent was the second-largest uploader behind IPTV (Internet Protocol television) services, which consistently track where users are in a given video. The third-heaviest uploading application was VPN (virtual private network) services, which are often used to disguise file sharing.[14] The publication noted upload traffic spiked during the release of popular U.S. content, such as the HBO series *Game of Thrones*.[15] File sharing would likely be the application that would benefit the most from a large increase in U.S. broadband upload speeds.

There is far more data for a user to consume than produce.

A look at common OTP (over-the-top) applications (see figure 1) illustrates the still low amount of upload bandwidth required to participate with common applications (with the exception of 4K livestreaming).

Figure 1: Bitrates of common "high-upload speed" applications[16]



Extremely high-quality livestreaming does require substantial bandwidth, but the average user still spends far more bandwidth on consuming rather than producing content. YouTube's anticipated bitrate for 4K streaming is the obvious outlier, recommending the highest upload requirement of the applications above by a considerable margin.

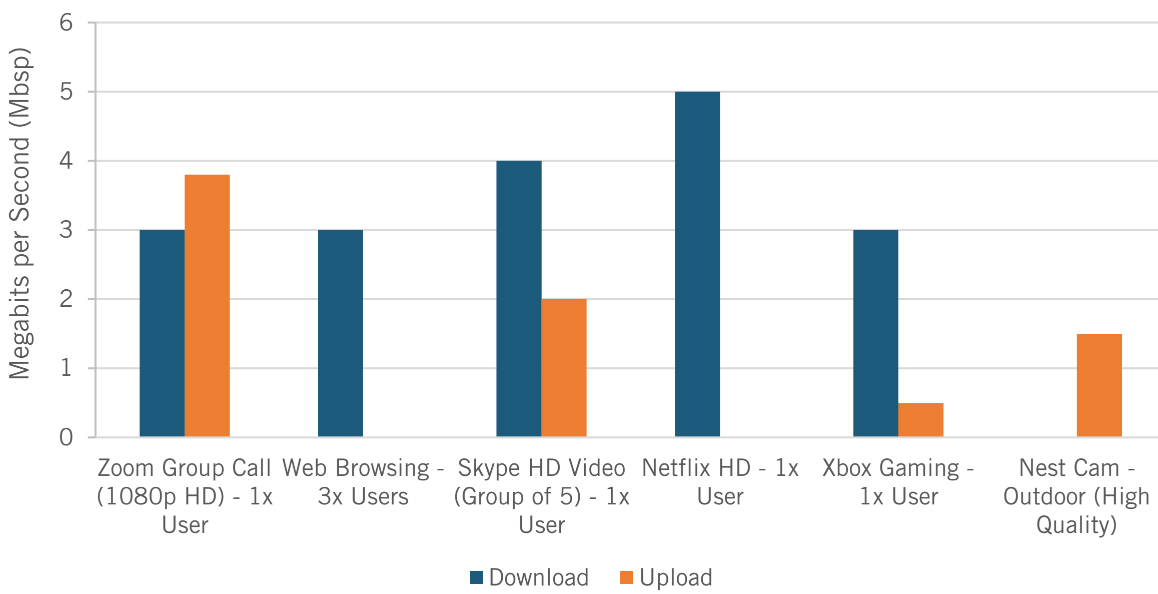
YouTube notes asymmetrical demand across its users. While "people are uploading 500 hours of video to the platform every minute"— equal to 720,000 hours a day—"[p]eople watch more than a billion hours of video on YouTube every day."[17] That is an almost 1,400:1 ratio of consumption to production. "And while video conferencing was growing anywhere from 300-700% over its pre-[pandemic] levels, that traffic still accounts for less than 5% of overall network traffic."[18]

To make this aspect of the symmetry debate more concrete, the question is how many tens of billions of dollars should be spent to ensure those who can stream content in 1080p high definition today are able to do so in 4K ultra-high definition tomorrow. As an analogy, this would be like asking how many billions of dollars we'd want to spend to make sure the nation's highways are just a tad smoother. It is about enabling not new applications, but slightly better entertainment and faster file transfers.

Based on sheer numbers, there is far more data available to be downloaded for a user to consume—be it movies, videos, emails, news, etc.—than there is for a user to produce. While a user can draw data from millions of sources, they can only produce from one source (itself). Thus, the average user is likely pulling more data downstream, requiring more download bandwidth, than they are pushing upstream.

Even in a multi-person household, download-speed requirements more often than not outweigh upload-speed requirements (see figure 2). In a hypothetical example of a typical family, four people are surfing the Internet: Two of them are simultaneously making video calls (Zoom and Skype), one is watching an HD movie on Netflix, and the fourth person is playing games on Xbox. There is also a family nest camera outside continuously streaming footage. In this scenario, the family would leverage 18 Mbps for downstream traffic and 7.8 Mbps for upstream traffic, demonstrating a clear demand for download bandwidth over upload bandwidth, even with multiple, concurrent video calls.

Figure 2: Bandwidth usage at one time for hypothetical family of four[19]



With cloud migration and increased simultaneous backups to cloud servers, the average user may increase their need for upstream bandwidth. However, with advancements in artificial intelligence (AI), machine learning (ML), and cloud service applications, companies are constantly seeking methods to compress this data stream, thereby reducing the bandwidth required to upload data to the cloud and for other applications. For example, Oracle allows its cloud service users to compress their data before delivery to the cloud.[20] Moreover, NVIDIA recently announced its Maxine platform, which leverages AI to substantially decrease video bandwidth requirements.[21] Similarly, Google has capitalized on ML to pursue its own compression techniques, developing a codec called Lyra that "makes voice communication available even on the slowest networks."[22] As bandwidth demands continue to increase, companies are having to innovate in order to reduce bandwidth requirements.

Network Access Technologies Have Different Advantages and Disadvantages

Separate from applications that together may both dictate the aggregate demand for upload and guide investments, it is worth considering network access technologies and their own set of trade-offs (such as cost, quality, scalability, and performance). Requiring high-speed symmetrical networks eliminates the ability to use certain access technologies, notably fixed wireless and Digital Subscriber Line (DSL) with longer loop lengths. A brief overview of the main network technologies demonstrates the various advantages and disadvantages associated with each technology, highlighting the importance of allowing for a robust combination of technologies when establishing broadband standards.

Leveraging existing telephone copper lines, DSL encompasses a range of network delivery options to include asymmetric DSL (ADSL), very high data rate DSL (VDSL), and symmetric DSL (SDSL).[23] One of the key benefits of DSL is its near-ubiquitous coverage, a result of historical infrastructure decisions that pushed telephone access out to the corners of the country.[24] However, the infrastructure, while cheap, offers only a limited capacity to transmit data (particularly over longer distances) compared with other broadband delivery networks.

Fixed wireless provides a critical advantage in hard-to-reach areas where terrain may limit the ability to construct Internet infrastructure. However, wireless networks are generally not built to deliver symmetrical speeds, due to actual demand and limitations on consumer-device form factors and power. Thus, a requirement demanding symmetry would eliminate the ability of providers to deploy wireless networks. This is especially important as fixed wireless is often well suited to serving rural areas. Wherever there are fewer people, there is generally a lower demand for spectrum—rural areas have abundant spectrum that can be used with lower risk of interference compared with urban areas. Wireless networks are also less costly, as the labor costs for installing a single device are far lower than for trenching miles of fiber.

Satellite Internet access has seen new life with such big-name players as SpaceX achieving higher performance than traditional offerings. While old satellite broadband suffered from latency issues, low-orbit satellites are helping to rapidly improve performance.[25] Similar to fixed wireless, satellite offers an affordable way to reach the hardest-to-connect—and therefore costliest-to-serve—areas that have a mix of undeveloped geographic terrains. However, asymmetric speeds are uncommon, and prices remain relatively high for consumers.[26]

Hybrid Fiber-Coaxial (HFC) is one of the most common network access technologies employed across the United States. HFC offerings, as they are deployed today, remain primarily asymmetric. However, with advancements in technology, the ability to provide near symmetric or fully symmetric speeds is becoming a reality. Research at CableLabs has enabled full duplex systems that will allow both upstream and downstream traffic to use the same blocks of spectrum within the cable network.[27]

Largely considered the gold standard for delivering broadband, fiber-optic cable is able to offer super-fast and symmetrical speeds. However, the deployment of fiber cables to rural areas is expensive and often unrealistic without large subsidies. Fiber does not have an existing last-mile of deployment, as cable and copper do, and thus requires the labor-intensive deployment of wholly new networks, rather than mere extensions or upgrades. As a result, the universal deployment of fiber would come with an exorbitant price tag.

No single broadband technology holds all the advantages. There are a series of trade-offs that must be considered when selecting one technology over another in any given geographic area. With finite resources and widely varying challenges around terrain, a flexible combination of these technologies is needed to help connect America and bridge the divide.

CHANGING THE DEFINITION OF BROADBAND HAS TRADE-OFFS

If symmetrical speeds could be achieved at no additional cost, then adopting symmetrical networks certainly wouldn't hurt. However, as capacity and money are both finite resources, trade-offs must be confronted. The key priority should be getting as many people online as possible at a reasonable cost. Any resources used to build "highest-quality" broadband in one location is funding that cannot be put toward connecting other locations or for promoting adoption through low-income subsidies and digital literacy and training efforts. If only 5 percent more funding were needed to achieve 100 Mbps/100 Mbps speeds, then perhaps it would be worth it to invest the extra funding. But if it will actually cost 30–40 percent more, then it would likely not be worth it to direct critical funds away from low-income users in an effort to ensure only certain areas of the country receive "high-quality" speeds. No matter the exact amount Congress chooses to allocate to rural broadband, what's important is how many locations will be connected, and ensuring that it is done cost effectively.[28]

While upgrades are a worthwhile endeavor, funding directed toward upgrading networks is funding directed away from other broadband needs, such as helping to subsidize costs for low-income individuals and families.

Risks of Overbuilding

Changing the definition of broadband introduces the risk of subsidized overbuilding, which already remains a substantial concern in broadband funding programs.[29] Densely populated areas are often more attractive places to build than high-cost areas with fewer people—even if already existing networks mean lower take rates. If the broadband target is shifted to favor higher symmetrical speeds, many areas that were previously considered served will be deemed underserved or perhaps even unserved.

During future subsidy procurement auctions, companies may focus their resources on densely populated "underserved" areas where they already have or can easily tap into existing infrastructure. In effect, auctions could easily shift from building out broadband in unserved areas to upgrading already high-performance networks that can be supported by private investment alone. While upgrades are a worthwhile endeavor, funding directed toward upgrading networks is funding directed away from other broadband needs, such as helping to subsidize costs for low-income individuals and families. If the primary concern is closing the digital divide and ensuring that everyone can get online in some fashion, then policy decisions should be geared toward increasing the numbers of individuals and households that get connected.

At the very least, policymakers should institute a clear order of operations. First, policy should be laser-focused on connecting areas that truly lack infrastructure. Achieving 98 or 99 percent coverage with whatever technology can efficiently provide access to high-cost areas should be the primary goal. If this cannot be achieved with significant amounts of money remaining, then reasonable upgrades of existing infrastructure to improve upload or download speeds make sense, to an extent. Upgrading from 25 Mbps/3 Mbps to 100 Mbps/10 Mbps is a meaningful upgrade, but dramatic investments for symmetric gigabit networks would be extremely expensive with relatively little gain. Instead, remaining funds should go to improving the financial health of the Universal Service Fund (USF) to help cover the ongoing operating expenses of extremely high-cost areas, support nonprofits that promote digital literacy and adoption, and subsidizing low-income subscriptions to ensure broadband is affordable for every American.

Attempting to subsidize fiber everywhere all at once would lead to significant overbuilding that would crowd out private investment. A more targeted approach that doesn't insist on "future-proofing" everywhere would better complement those areas that can support competition with private investment alone.

PROCUREMENT AUCTIONS CAN SUPPORT HIGHER UPLOAD SPEED NETWORKS

Instead of using legislation to bake in hard limitations on speeds and thereby decrease the number of possible participants in any future subsidy program, the FCC's auction mechanism could be relied on to ensure upgrades do not simply meet a bare minimum.

There are lessons to be learned from previous high-cost subsidy auctions, in particular the Rural Digital Opportunity Fund (RDOF).[30] During the most recent RDOF, the FCC leveraged a weighting system that gave an advantage to bids that could provide faster speeds (see table 1).[31] Through this weighted process, the FCC was able to better determine not only the best value among the bids (not necessarily based on pure cost), but also the "quality" of each subsidy dollar spent.

Table 1: RDOF performance weighting[32]

Performance Tier	Speed	Monthly Usage Allowance	Weight (Penalty)
Minimum	≥ 25 Mbps/3 Mbps	≥ 250 gigabytes (GB) or U.S. average (whichever is higher)	50
Baseline	≥ 50 Mbps/5 Mbps	≥ 250 GB or U.S. average (whichever is higher)	35
Above Baseline	≥ 100 Mbps/20 Mbps	≥ 2 terabytes (TB)	20
Gigabit	≥ 1 Gbps/500 Mbps	≥ 2 TB	0
Latency	**Requirement**		**Weight (Penalty)**
Low	≤ 100 milliseconds (ms)		0
High	≤ 750 ms and Median Opinion Score ≥ 4		40

The FCC should continue to tap into the benefits of a weighted auction, which allows for competition to self-select and encourages the most competitive bids (based on cost and quality).

Using a weighted system, FCC auction experts can continue to tweak and refine the bidding process to ensure efficiency without being limited by only one, narrow definition of broadband.

It is reasonable to desire scalability and ability for infrastructure to be upgraded over time. Some seem to want symmetry incorporated into a subsidy requirement as a roundabout way of ensuring only the future-proof scalable technologies such as cable or fiber are able to participate. Rather than making this a hard-and-fast requirement, experts at the FCC could determine a modest weight for bids that could reasonably be expected to provide easily upgradable infrastructure.

Scalability or upgradability could be considered an independent metric when weighting and evaluating bids.[33] If a provider's bid has the ability to both scale up and out to provide better future service and to a larger range of individuals, a weighting system in the bidding process could help ensure these benefits are fairly considered. As such, the auction not only would help connect users in the short term but also enable future growth. But as it is unlikely a "scalable" solution would be cost-effective everywhere throughout the varied geography of the United States, legislators should preserve flexibility in a procurement auction.

Continuing to leverage adjustable and market-based mechanisms, such as a weighted system, allows for flexibility and adaptability to match current and future demand for any particular geographic area. In some far reaches of Alaska, or in rugged mountainous terrain, for example, either satellite or 25 Mbps/3 Mbps would be a reasonable solution. If a network is being extended just a few miles down the highway to the next farm town, then fiber or HFC may well be the best solution. But those decisions should be made on an area-by-area basis depending on what market participants anticipate they can provide—not mandated through legislation at whatever the cost.

CONCLUSION

The pandemic has shown our increased reliance on two-way video streaming, whether it be to connect with a doctor for a virtual health visit, or to celebrate holidays with family members we are unable to connect with in person. While more money should be spent and baseline speed requirements should be increased, it is important to recognize there are also quickly diminishing returns, as dramatically faster speeds likely are not worth the exorbitant investment.

Policymakers should carefully consider the trade-offs associated with increasing the speeds associated with the definition of broadband. Shifting the definition of the baseline for broadband from 25 Mbps/3 Mbps to 50 Mbps/50 Mbps or 100 Mbps/100 Mbps does not match the evidence of what applications are expected to require in the near future. Forcing providers to offer symmetrical speeds in order to qualify for auctions or other subsidies not only cuts out providers with the ability to deploy reasonable broadband technologies in high-cost, hard-to-reach areas, but it also risks increasing the amount of overbuilding that might occur in subsidized areas, leading in an inefficient distribution of funds, a crowding out of private capital, and the potential diminishment of dynamic competition. Instead, policymakers should focus on mechanisms that encourage innovation while remaining technology neutral. Leveraging lessons learned from the recent RDOF, both in the auction's weighting system and in the long-form process, FCC experts should be able to design future auctions in a way that increases efficiency. In doing so, federal funds will be better used to maximize connectivity and help ensure broadband for all.

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