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**Mindfully Wasteful Spending:
The Definition of Broadband**

by

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I. Introduction and Summary

Definitions matter. Especially in policy. For example, in antitrust suits, the outcome generally comes down to how one defines the market in question. A narrowly defined market will include fewer market participants and more easily prompt concerns regarding excessive concentration. A broadly defined market will encompass more competitors, making it more likely that marketplace forces are deemed sufficient to protect both consumers and competition.

Definitions matter with respect to the broadband market too: as seemingly all of government mobilizes to ensure that every household in America has access to an adequate high-speed Internet connection, the extent of the problem – and the scope of the solution, inevitably expressed in the expenditure of taxpayer dollars – hinges on the specific metrics that determine what it means for a location to be "served" by having access to broadband.

The Federal Communications Commission definition of broadband service is any Internet access service above a minimum speed threshold. Initially that threshold was a minimum download

speed of 200 kilobits per second (0.2 Megabits per second (Mbps)). In 2010, the threshold was raised to 4 Mbps download and 1 Mbps upload. In 2015, the threshold jumped to 25 Mbps download and 3 Mbps upload. There is now pressure for the FCC to raise the threshold to 100 Mbps/20 Mbps.

Consumers' usage needs do not justify this moving target. The highest download speed requirement I have found for an Internet application is 15 Mbps, and the highest upload speed requirement is 6 Mbps. Higher speeds allow for more devices and applications to run simultaneously. For example, a household with four people can simultaneously participate in four Zoom video calls with 50 Mbps download speeds without creating congestion.¹

The FCC's definition is supposed to represent the *minimum threshold* for service to officially count as broadband service. It is not supposed to represent the minimum needed for a household with five gamers, two live streamers, and two grandparents streaming to two ultra-high-definition 4K TVs 24 hours a day. Nor should it.

Extremely high speeds are not necessary for every household, and this is not how one should define a *minimum threshold* for a technology – especially when that minimum threshold will dictate the size and existence of presumed digital divides, how much federal money will be spent to close them, precisely where that money will go, and the extent to which it will be used to subject existing, privately financed networks to government-subsidized competition. A car is a car whether it is a Kia, a Honda, or a Lamborghini. Even if the Honda Accord is the most popular car in the U.S., does that mean any car that is not as in demand as a Honda Accord cannot be called a car?

In the background of the broadband definitional issue there has always been pressure to exclude satellite broadband services from national measures regarding the availability of broadband services. While concerns over speed and latency were at least part of the justification historically for excluding satellite service, a driving factor behind this choice seemingly has been the desire of certain FCC commissioners and others to maximize measures of unserved households.

The first satellites to offer broadband service were geostationary (GSO). They could reach 99.9% of U.S. households but were slower than fixed broadband and, due to their orbit at a distance of 36,000 km, had latency issues which made their service less than ideal for certain applications like VoIP, video conferencing, online gaming, etc. Over time, though, GSO satellite broadband service speeds increased. Each time those speeds began rivaling the existing minimum threshold defined by the FCC, that threshold was officially increased.

Average satellite speeds are now once again above the current FCC minimum threshold. Moreover, since 2021 low earth orbit (LEO) satellites have been providing service at high speeds and without latency issues since they are only 400 to 2,000 km above the earth. Still, funding programs to increase broadband deployment continue to define served areas based only on access to fixed broadband and fixed wireless (but only if it uses licensed spectrum) and embrace

¹ As of December 2022, Move.org suggests that "25 Mbps [is] good for about 2 people and up to five devices," "50 Mbps [is] good for 2-4 people with 5-7 devices [and] can handle 2-3 video streams plus some extra online activity," and 100 Mbps is "good for 4-6 people and up to 10 devices." See <https://www.move.org/how-much-internet-speed/>.

deployment criteria that explicitly or implicitly favor giving government subsidies to fiber over all other possible technologies. This is despite the fact that LEO satellite service, as well as fixed wireless using unlicensed spectrum, often can provide adequate broadband service (in terms of both speed and latency) and can be deployed more quickly and at far lower cost than fiber in rural or geographically challenging areas which are the areas that most suffer from lack of access.

The consequence of using such a limited (and limiting) definition is mislabeling "served" areas as "unserved," and, importantly, mislabeling areas that have no need for subsidization as "underserved." This allows funding intended to reduce digital divides to be redirected away from truly unserved areas and towards more economically attractive areas that are being mislabeled as "unserved" or "underserved" simply due to the entirely artificial constraints embodied in such a definition of broadband service.

The Rural Digital Opportunity Fund (RDOF) auction provides a good illustration of the problem with this non-technology neutral definition to identify unserved locations. Locations to be auctioned were defined as explained above and ignored all existing satellite service. Consequently, 11.6% of the 786,952 locations auctioned in RDOF were already receiving service as of December 2021 from Starlink (SpaceX's LEO satellite service).²

However, based on the auction rules, LEO satellite providers were allowed to participate in the auction to receive funding to provide service to these "unserved" locations. Bids were weighted by proposed speeds, monthly usage allowance and latency, and heavily favored fiber. Still, Starlink won the auction for almost 114,000 locations.

Then, in the second Long Form Application review (after the auction), the FCC declared Starlink ineligible for RDOF funding. The stated reason for this decision was that the current speeds being offered through Starlink were decreasing as more subscribers joined and that it was therefore unclear that Starlink would be able to provide the level of service at which it had bid. It is true that median speeds were decreasing as subscribers increased because of capacity constraints. However, the observed median speeds remained above 60 Mbps.³ Moreover, with continuing satellite launches capacity constraints can be reduced.

The FCC decision to deny SpaceX's long-form application may have come from a renewed desire to favor fiber or fixed wireless service using licensed spectrum. If so, this is another example of how altering the definition of broadband in ways that are divorced from consumer usage expectations and demand impacts regulatory policy – and often in ways that lead to mindfully wasteful spending of taxpayer dollars.

² I thank Rio Asaka for his excellent research assistance in pulling these data.

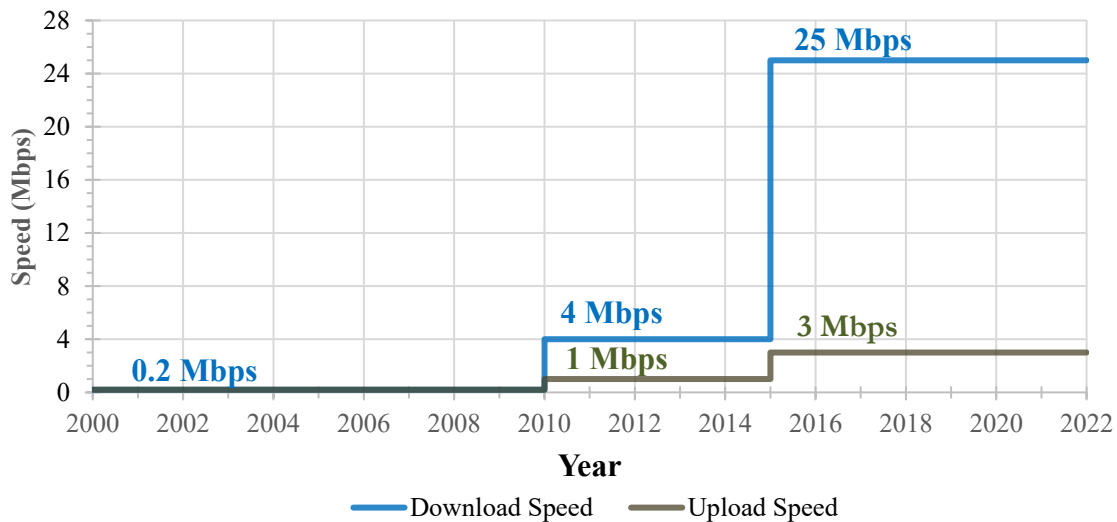
³ Ookla Speedtest data as reported by Scott Wallsten, "How Should Satellite Broadband Be Included in Universal Service Subsidy Programs?" working paper, February 2023.

II. Minimum Broadband Speeds Should Be Based on Consumer Usage Needs

When I first joined the Federal Communications Commission as Chief Economist in 2006, the FCC defined broadband service as any Internet access service with a minimum download speed of 200 Kbps (i.e., 0.2 Mbps). I remember looking that up on the Internet the morning of my interview with the FCC Chairman. During my second appointment to the FCC there was discussion of raising the minimum required speeds to 4 Mbps down and 1 Mbps up. While technology and speed offerings were increasing, it was not exactly clear why the minimum speed required for Internet access *to qualify* as broadband had to be raised.

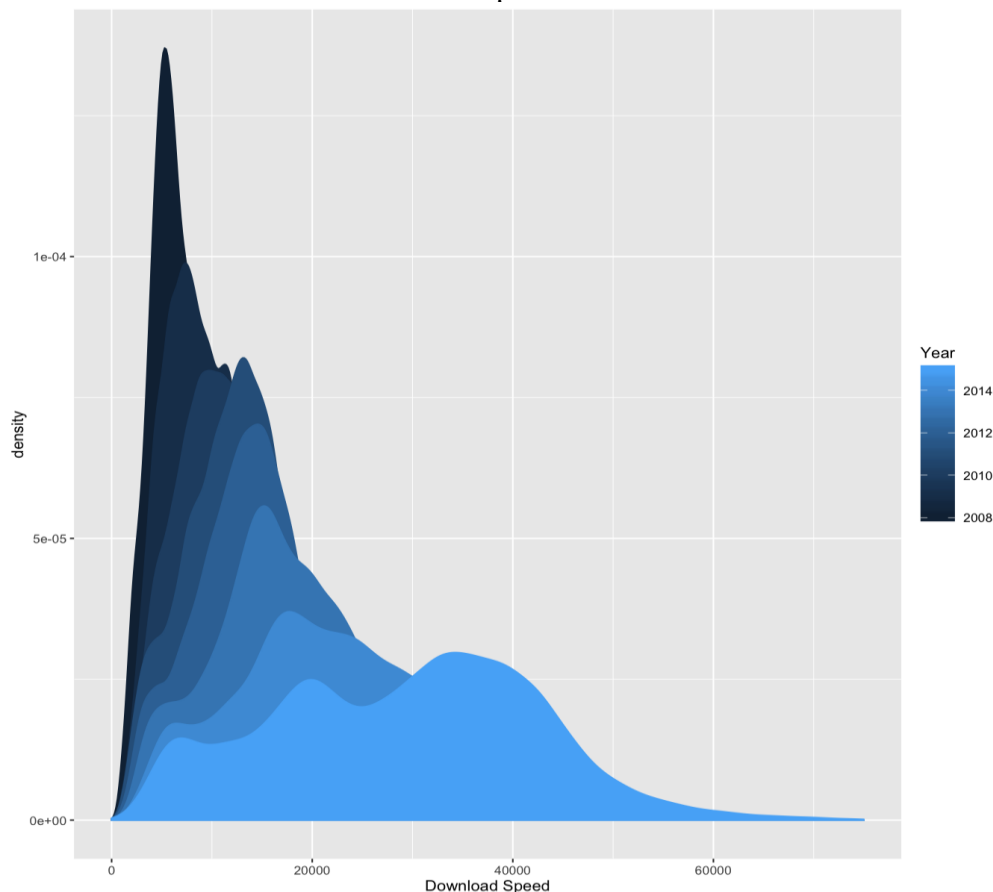
Interestingly, at the time, geostationary orbit satellite operators were starting to offer higher speeds and, strictly on that basis, might have begun to count as broadband service under the original speed definition. Proponents of excluding satellite service from broadband definitions argued that, regardless of speed, GSO satellite service had latency issues and was therefore not suited to some types of applications such as VoIP, online gaming, video conferencing, etc. In 2015, the FCC increased the minimum download speed roughly eight-fold to 25 Mbps and the minimum upload speed three-fold to 3 Mbps (see Figure 1). Currently, there is pressure to push the definition *to qualify* as broadband to 100 Mbps down and 20 Mbps up.

Figure 1. FCC Minimum Speed Requirements for Broadband



It is worth noting that applying the new 25 Mbps down/3 Mbps up threshold meant that perhaps the U.S. did not actually have broadband service in 2012. Figure 2 shows actual download speeds collected by OOKLA speed tests for the U.S. from 2008-2014. Applying the new 2015 minimum speed thresholds, a majority of the 2013 broadband market and almost all broadband service before 2013 disappears.

Figure 2. Did the U.S. Have Broadband Service in 2012?
Recorded Download Speeds in U.S. 2008-2015



Source: [Connolly, Sa, Zaman, Roark and Trivedi \(2018\)](#), Data from OOKLA

Why did this definitional change happen? There was no new blockbuster technology or Internet application specifically introduced in 2014 that suddenly made it impossible to access the Internet and do most everything you wanted unless you had 25 Mbps download speed.

Average service speeds had increased tremendously, but the FCC definition is supposed to indicate the minimum speed required for service *to qualify* as broadband. That should be based on usage needs determined through a rigorous, evidence-based assessment. If a service providing access to the Internet meets speed and latency needs for Internet usage, it should count as broadband service, regardless of technology type, even if providers competing for customers offer speeds that exceed that minimum threshold.

Table 1 shows minimum speed requirements for current Internet applications. They are surprisingly low relative to common perception. The highest required download speed I have found is 15 Mbps for Netflix if you have a 4K ultra-high-definition television. The highest required upload speed is 6 Mbps for live video game streaming. Even a Zoom meeting with 49 participants using gallery view only requires 4 Mbps down and up.

Table 1. Minimum Broadband Speeds for Internet Applications

		Min Download	Min Upload	Max Latency
Email, Web Browsing		0.2 Mbps		
Netflix ¹	High Definition (HD)	3 Mbps		
	Full High Definition (FHD)	5 Mbps		
	4K/Ultra HD (UHD)	15 Mbps		
Zoom ²	Group Video Calling			
	720p HD	1.8 Mbps	2.6 Mbps	
	1080p HD	3 Mbps	3.8 Mbps	
	Gallery View Receiving – 49 views	4 Mbps	4 Mbps	
Gaming ³	Xbox ⁴	3 Mbps	0.5 Mbps	150 milliseconds
	Nintendo Switch ⁵	3 Mbps	1 Mbps	
	PlayStation ⁶	Recommend 5 Mbps		
Live Video Game Streaming ⁷	Twitch (resolution 720p-1080p)		3 Mbps – 6 Mbps	
	YouTube Live (resolution 720p-1080p)		2.2 Mbps – 3 Mbps	

More devices running more applications at the same time within a household can create congestion. Additional speed/bandwidth reduces the risk of congestion within a household. Still, observed performance is impacted by a multitude of factors beyond the speed of your service. Observed performance problems are often attributed to slow Internet service but are often driven by other factors. Peak hours can create congestion beyond your household. Within your household, the capabilities of your ethernet connection, your modem, and your Wi-Fi router affect performance. For example, the maximum capabilities of your Wi-Fi router will limit your speed, latency, and experience, no matter what speeds your Internet service provides. Similarly, since Wi-Fi relies on sending signals over the air, it is susceptible to interference. For example, if you take your laptop to the kitchen and the refrigerator stands between the Wi-Fi router and your laptop, your service quality will decrease.

So, what are the minimum usage needs for broadband speed? For any single application, the highest required download speed is 15 Mbps and 6 Mbps upload speed (if you are live video game streaming). Still, multiple devices and many applications may be running simultaneously within a household. For a large household with many devices running simultaneously and one or two gamers, the speed they will want will be much higher than a single-person household that mainly uses the Internet for Netflix and Zoom, much as the larger household would be more likely to prefer a minivan than the single person.

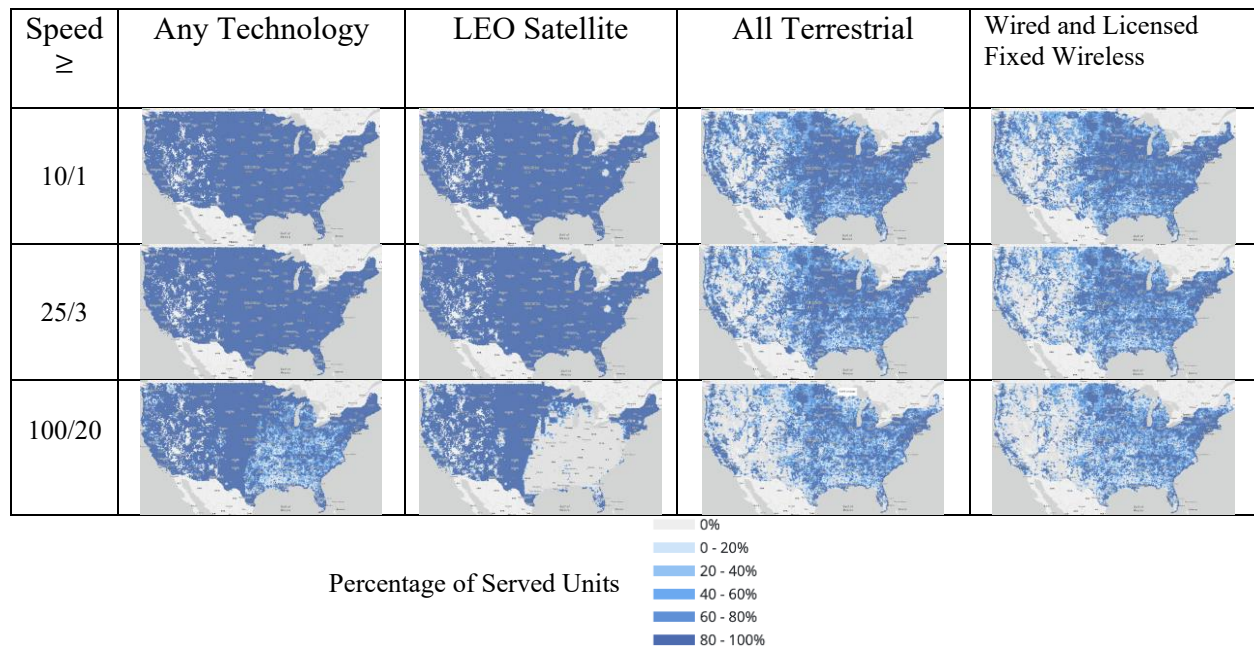
III. Inflated Speed Requirements Lead to Wasteful Government Spending

One clear consequence of endlessly increasing minimum speed definitions for fixed broadband is that the percentage of "unserved" and "underserved" households jumps with each definitional change. In 2015, when the FCC implemented the new 25/3 threshold, the 2015 Broadband

Report stated that as of 2013, 4% of Americans lacked access of at least 3 Mbps/768 kbps. However, 17% lacked access at 25 Mbps/3 Mbps. In rural areas, 20% lacked access of at least 3 Mbps/768 kbps as opposed to 53% at 25 Mbps/3 Mbps.⁴

Based on the FCC National Broadband Map released in November 2022, Table 2 shows the impact of technology and minimum speed thresholds on observed unserved areas. The top left image shows how few locations are unserved if one uses the 10/1 threshold and ignores latency issues (meaning that GSO satellite is also included). At the other extreme, the bottom right image suggests that there are many parts of the U.S. that are "unserved" if the minimum speed threshold is raised to 100/20 and all satellite (including LEO) and fixed wireless (using unlicensed spectrum) service is excluded.

Table 2. Residential Fixed Broadband Service
June 30, 2022



Source: FCC National Broadband Map, <https://broadbandmap.fcc.gov/home>

Why does it matter if the definition of broadband is a moving target? It matters because areas with adequate service are being lumped in with areas without adequate service and can receive funding for broadband deployment on an equal basis with truly unserved areas. Given that truly unserved areas are generally the least economically attractive areas, providers will be far more likely to choose to provide an overlay service in an area that currently has service below 25/3 Mbps speeds over providing new service to an area that has never had service. Similarly, defining areas as "underserved" if they have less than 100/20 Mbps speeds again redirects funding from truly unserved areas to areas that absolutely have broadband service – just not fiber.

⁴ 2015 Broadband Report, FCC-15-10A1, Table 7, p.49.

NTIA's BEAD Program Notice of Funding Opportunity (NOFO) further pushes for symmetric 100 Mbps up and down for community anchor institutions. Symmetric up and down speeds can not be provided by any service using spectrum. This is another example, even beyond the NTIA's official prioritization of fiber, of defining service based on specifications that can only be satisfied by a particular technology. Moreover, NTIA's NOFO for the BEAD Program states that funding can be distributed to "underserved" areas as long as there is a "plan" in place to deploy to unserved areas. If the plan to deploy in unserved areas fails, the rest of the money will already have been disbursed to provide overlay services in "underserved" areas. This further exacerbates the redirection of funding to provide overlay services in more economically attractive locations.

The contradiction of non-technology neutral definitions plus moving threshold targets is beautifully illustrated with the SpaceX experience in the FCC Rural Digital Opportunity Fund (RDOF) auction. The locations eligible for RDOF money were identified solely based on service provided by fixed broadband or fixed wireless that used licensed spectrum. GSO satellite service was not allowed to bid, but based on service performance including speed and latency, SpaceX's Starlink LEO service short-form application for eligibility was accepted.

Due to the heavy weighting of bids in favor of fiber, Starlink won only 3.5% of the locations upon which it bid. Likely for the same reason, only about 21% of the Starlink served RDOF locations were actually won by Starlink. The majority of locations won by Starlink were areas in which they did not already provide service. Still, almost 17% of Starlink winning bids were for locations it was already serving.

Table 3. RDOF Auction Outcomes

	RDOF Locations Auctioned	RDOF Locations Served by Starlink as of December 2021
Total	786,952	92,475 11.6% of RDOF locations
Not Won by Starlink	673,047	73,295 79.3% of Starlink served RDOF locations
Initially Won by Starlink	113,905	19,180 20.7% of Starlink served RDOF locations 16.8% of Starlink winning bids

After the auction, Starlink was declared ineligible during the second, long-form application review. The stated reason for this decision was that the speeds being offered by Starlink were decreasing as more subscribers joined and that it was therefore unclear that Starlink would be able to provide the level of service upon which it had bid. It is true that median speeds were decreasing as subscribers increased because of capacity constraints. However, the observed median speeds remained above 60 Mbps.⁵ Moreover, with continuing satellite launches capacity constraints can be reduced.

⁵ Ookla Speedtest data as reported by Scott Wallsten, "How Should Satellite Broadband Be Included in Universal Service Subsidy Programs?" working paper, February 2023.

The FCC decision to deny SpaceX's long-form application may have come from a renewed desire to favor fiber or fixed wireless service using licensed spectrum. It may, however, also have been due to the realization that at least some of the locations won by Starlink were areas in which it was already providing service.

IV. Conclusion

Everyone should have the opportunity to have broadband. But does closing digital divides require that every household in the U.S. have access to the highest tiers of Internet service? Should we be spending money to make sure that as many households as possible have the opportunity to buy a Lamborghini (even if that means leaving many without an opportunity to buy any car), or should we be spending money to make sure that as many households as possible have the opportunity to buy a working car that can take them from point A to B?

As a society we can spend money to ensure that everyone has access to broadband that satisfies basic usage needs or we can spend money to force deployment – and in many cases, overlay service – by particular technologies – namely, fiber – regardless of the time and cost of deployment.

Current programs explicitly and implicitly prioritize fiber networks regardless of relative cost – and blithely assume that the massive amounts of federal dollars available, literally hundreds of billions, will assure that, even with all of the overbuilding they encourage, enough of that spending actually helps unserved or underserved areas. This is worse than mindless spending. This is mindfully wasteful spending.

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¹<https://help.netflix.com/en/node/306#:~:text=A%20Standard%20or%20Premium%20Netflix,set%20to%20Auto%20or%20High>, retrieved April 30, 2023.

²[https://support.zoom.us/hc/en-us/articles/201362023-Zoom-system-requirements-Windows-macOS-Linux#:~:text=Bandwidth%20requirements,-The%20bandwidth%20used&text=For%201%3A1%20video%20calling,3.0Mbps%20\(up%2Fdown\)](https://support.zoom.us/hc/en-us/articles/201362023-Zoom-system-requirements-Windows-macOS-Linux#:~:text=Bandwidth%20requirements,-The%20bandwidth%20used&text=For%201%3A1%20video%20calling,3.0Mbps%20(up%2Fdown)), retrieved April 30, 2023.

³<https://www.gamedesigning.org/tech/internet-speed/>, May 30, 2022.

⁴<https://support.xbox.com/en-US/help/hardware-network/connect-network/xbox-one-connection-speed>, retrieved April 30, 2023.

⁵https://en-americas-support.nintendo.com/app/answers/detail/a_id/22400/~troubleshooting-slow-download-and-upload-speeds, retrieved April 30, 2023.

⁶ <https://www.playstation.com/en-us/ps-plus/getting-started/#:~:text=To%20stream%20games%20to%20your,connection%20of%20at%20least%2015Mbps>, retrieved April 30, 2023.

⁷ <https://www.highspeedinternet.com/resources/how-much-speed-do-you-need-for-live-video-game-streaming>, Dec 13, 2022.