PERSPECTIVES

PHOENIX CENTER FOR ADVANCED LEGAL & ECONOMIC PUBLIC POLICY STUDIES

Speed-Tests: Substitute for, or Complement to, Broadband Maps?

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The Federal Communications Commission's ("FCC") existing broadband availability maps have been heavily criticized as inaccurate, especially for the purpose of distributing billions in subsidy dollars to extend broadband networks to unserved areas.[1] Responding to these concerns, the first iteration of new broadband availability maps using the "fabric" approach are forthcoming in November-2022.[2] This release will be the first to use the FCC's new approach, which seeks to overlay provider footprints with serviceable locations. Given the complexity of this task, it is reasonable to expect some inaccuracy in early versions.[3] A challenge process to help correct the data will render improved versions, and the expectation is that a map the National Telecommunications and Information Administration ("NTIA") can use to allocate the Infrastructure Investment and Jobs Act of 2021's Broadband Equity, Access, and Deployment ("BEAD") program subsidy dollars will be available by mid-2023.[4]

In a rush to distribute subsidy dollars, a few states have initiated their own mapping efforts and some advocates have proposed alternative mapping means using speed-test data to identify areas that lack adequate broadband.[5] As for the latter, the usefulness of speed-test results to identify unserved or underserved areas has not been evaluated, and there are several reasons to doubt their utility: (1) speed-tests reflect what speed tiers consumers buy rather than what is available; (2) tests are convenience samples; and (3) testing is often used for troubleshooting, which biases the results downward. An important question, therefore, is whether speed-test data provide a reasonable measure of broadband deployment? I search for answers to this question in this PERSPECTIVE.

To do so, I merge location-specific broadband availability data from Iowa's Broadband Map (Version 5) with Ookla speed-tests results, the most respected source for such data. I use Iowa data because the state has developed a broadband availability map at the location level.

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Other findings may also be of interest. For example, in areas where 1 Gbps or better is available, the average download speed is just under 200 Mbps. In fact, the correlation coefficient between maximum available speed and average speed-test results is only 0.07, despite some aggregation of the data (which tends to increase correlations). Aside from highlighting the fault in using speed-tests to infer deployment, this finding shows that while many Internet Service Providers ("ISPs") offer gigabit service to consumers who want it, apparently most consumers see no use for very high-speed connections and are thus unwilling to pay for them.

Taken together, these results offer strong guidance as to whether governments should rely on speed-test-based maps to identify unserved areas for the purpose of distributing deployment funding. The evidence is clear: speed-tests are poor substitutes for a careful mapping effort such as the one Congress has required the FCC to undertake.

Data

Data on maximum speeds (*M*) available at each location is obtained from Iowa's broadband map. Ookla's Open Data Program provides measured broadband speeds. Ookla's data are presented as averages for rectangular areas of varying sizes. For the data in Ookla's Open Data Initiative, the fixed speed-test data are obtained from Android and iOS mobile devices (permitting better location accuracy) using the Speedtest application, so all tested devices connect via a Wi-Fi connection.[6] For each tile, the Ookla data include the averages of download speed, upload speed, and latency, and include the number of tests and devices used to compute these averages. Using the latitude and longitude data from the Iowa data, each location is placed within one of Ookla's geographic tiles.

The Iowa data provide maximum-available speeds for 1,500,660 locations. Of these, 1,065,644 (71%) of locations fall within one of Ookla's 19,699 geographic tiles in the state (the tiles do not cover the entire geography of a state). Each tile can have multiple maximum speeds, a consequence of the data being aggregated to tiles, but 17,044 tiles (86.5%) have a single maximum-available speed.

For locations not assigned to a tile, I note that there is evidence of a selection bias. For locations that are unmatched to a tile, the average maximum-available download speed is 572 Mbps, but 1.12 Gbps in matched locations. Still, there is substantial variation in speeds within tiles matched to locations, so the data are useful.

… speed-test data are also not a good proxy for available speeds. In areas where the speed-test data indicate average speeds below the threshold, large shares of the locations have maximum-available speeds above the threshold.

Analysis

Broadband providers typically offer an array of services that differ in speed and price, with faster services having a higher price. Presumably, consumers maximize their utility by choosing speed/price combinations that best meet their needs, so the services purchased are likely to be below the maximum available speed. While observing the actual speeds consumers experience may be useful for a host of purposes, broadband subsidies are based on what speeds are available but *not* purchased, so using speed-test data for subsidy allocation is questionable. If consumers choose to buy a 100 Mbps service when a 1 Gbps service is available, then subsidizing additional broadband network construction does not offer much, if anything, to consumers.[7]

To better understand the problems with using speed-test data to identify unserved or underserved areas, consider a set of geographic areas g. In each area, we observe the average of speed-test results (S_g) and the maximum-available download speeds (M_g). Let T be the threshold that defines the desired minimum speed desired by the government. Area g qualifies for a subsidy if $M_g < T$. Using speed-test data as a proxy for M_g depends instead on $S_g < T$. Plainly, the two approaches produce the same results only when $M_g = S_g$, which seems unlikely to hold. However, if the difference is small, then the speed-test may serve some useful purpose, especially if quality maps cannot be constructed in a reasonable timeframe.

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A useful approach to evaluate the validity of speed-test data for subsidy distribution is whether the share of locations for which the maximum-available speed falls below the threshold in areas where the average download speeds (by speed-tests) is below the threshold. Or, is the identification of subsidy-eligible areas based on $S_g < T$ reasonably close to those identified using $M_g < T$?

Using the Ookla data, I set the variable s_g equal to 1 if the download/upload speeds fall below the threshold T (0 otherwise) in area g. I set the variable m_g equal to 1 if the maximum available speed is above the threshold. The mean of m_g within areas where $s_g = 1$ is a measure of similarity between the two approaches. Table 1 summarizes the results for both the simple mean and device-weighted mean of $m_g \geq T$. The thresholds are either 25/3 Mbps or 100/20 Mbps, which are commonly used.

Table 1. Error in Using Speed-test Data

Threshold (T)	$m_g \geq T$	$m_g \geq T$ †	*Obs.*
25/3 Mbps	80.2%	81.9%	18,692
100/20 Mbps	86.0%	91.5%	137,189

† Device Weighted Mean

We see in Table 1 that the speed-test data are also not a good proxy for available speeds. In areas where the speed-test data indicate average speeds below the threshold, large shares of the locations have maximum-available speeds above the threshold. At the 25/3 Mbps threshold, about 81% of locations meet the availability threshold. For the 100/20 Mbps threshold, about 89% of locations have maximum-available speeds above the threshold. Using speed-test data to identify areas for subsidization is a poor substitute for actual broadband availability.

Table 2. Error in Using Speed-test Data
(Single Maximum-Available Download Speed in Tile)

Threshold (T)	$m_g \geq T$	$m_g \geq T$ †	*Obs.*
25/3 Mbps	84.7%	87.3%	13,527
100/20 Mbps	91.6%	95.9%	111,406

† Device Weighted Mean

In Table 2, I restrict the tiles to those that have a single maximum-available download speed (86.5% of tiles). The error is a bit larger here: in areas where speed-test data indicate a lack of adequate service, about 86% of locations have broadband available at the 25/3 Mbps threshold and 94% do for the 100/20 Mbps threshold. These are large errors in identification, so speed-test data appear useless for subsidy allocation.

Table 3 summarizes the average, minimum, and maximum Ookla download speeds by a few maximum-advertised speeds groupings. For expositional purposes, I have grouped the maximum-advertised speeds and restricted the sample to tiles with a single maximum-available download speeds. Note that nearly all locations (98.4%) have a maximum-available download speed of at least 1 Gbps. Gigabit cable and fiber are available nearly everywhere.

Table 3. Statistics by Maximum Advertised Speed
(Single Maximum-Available Download Speed in Tile)

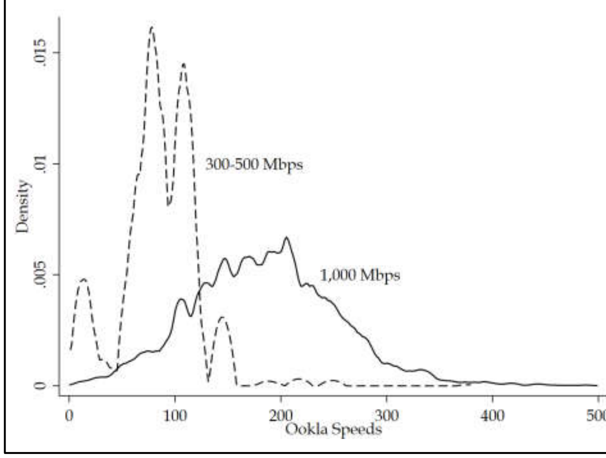
Max Speed Group	Mean	Min	Max	*Obs.*
150-200 Mbps	56.1	2.2	191.2	886
200-300 Mbps	63.6	1.7	260.1	1,375
300-500 Mbps	84.3	1.1	515.0	1,737
1000 Mbps ‡	179.9	0.2	841.1	946,151
1000-10000 Mbps	192.5	1.5	942.9	21,638

† Device Weighted Mean
‡ There are no locations between 500 and 1000 Mbps.

Table 3 shows that mean and maximum download speeds are correlated with maximum-available speeds (ρ = 0.99 for maximum-speed groups at or below 1 Gbps), but for each group the speed-test data includes results well below maximum-available speeds. An interesting result is the average speed-test results for areas the Iowa map identifies as having 1 Gbps or better service. The average speed is just under 200 Mbps, though results for some tiles in these maximum speed groups are as low as 0.2 Mbps. Also, for this group, the maximum reported speed-test results are well below 1 Gbps; the means of speed-test results shade the maximum-available speed. That said, the maximum measured speeds are more comparable to the maximum-available speeds for the groups below 1 Gbps.

Figure 1 illustrates the kernel distributions of speed-test results for the 300-500 Mbps and 1 Gbps maximum-speed groups. (The largest value on the horizontal axis is restricted to 500 Mbps for expositional purposes.) For the 1 Gbps group, the bulk the distribution is between 50-300 Mbps, where the bulk of the distribution for the 300-500 Mbps group falls between about 50-150 Mbps.

Figure 1. Distribution of Test Results



Consumers do not appear to be buying 1 Gbps service even where it is available. Further, other factors can reduce the tested speeds such as older devices or in-home interference with Wi-Fi. In all, Table 3 suggests a murky relationship between what speeds are available and speed-test results, though average speeds are higher when maximum speeds are higher. This relationship may reflect differences in the lowest-speed offerings of ISPs in areas where gigabit services are available (that is, a relatively high-speed service is the lowest-priced service offered).

[S]peed-test results are not a suitable substitute for rigorous and careful mapping efforts, such as those the FCC is currently undertaking.

Caveats

A few caveats are worth mentioning, and I suspect there are others unmentioned. First, the analysis is limited to data from Iowa; whether these findings are generalizable to other states is unknown. Second, I have assumed, implicitly at least, that the Iowa data is correct. It may not be. I find, for instance, some high speed-test results in areas where the Iowa data suggests only low speeds are available—a finding that suggests a potential use for speed-test results in broadband mapping. Errors in the map may be indicated by speed-test results entirely inconsistent with the broadband map. Ookla has more detailed data than it makes available in its open data and mapping authorities may want to obtain such data as an accuracy check.

If public officials use bad information to target broadband funds, then the resources will be used in areas where they are not needed and will miss areas where they could be useful.

Conclusion

New, and hopefully more accurate, broadband maps are forthcoming. Until then, substituting speed-test data for a broadband map to allocate subsidies is strongly discouraged. Speed-tests are an unreliable indicator of what broadband speeds are available. If public officials use bad information to target broadband funds, then the resources will be used in areas where they are not needed and will miss areas where they could be useful. The same caution applies to any use, such as academic research, that relies on speed-test data as an indicator of availability. That said, speed-test data may point to problems with mapping data. Additional research on this topic is certainly encouraged.

NOTES:

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1 *See, e.g.,* G.S. Ford, *A Quality Check on Form 477 Data: Errors, Subsidies, and Econometrics*, PHOENIX CENTER POLICY PERSPECTIVE NO. 21-05 (October 27, 2021) (available at: https://www.phoenix-center.org/perspectives/Perspective21-05Final.pdf); G.S. Ford, *Quantifying the Overstatement in Broadband Availability from the Form 477 Data: An Econometric Approach,* PHOENIX CENTER POLICY PERSPECTIVE NO. 19-03 (July 11, 2019) (available at: https://www.phoenix-center.org/perspectives/Perspective19-03Final.pdf).

2 J. Rosenworcel, *Another Step Toward Better Broadband Maps*, Federal Communications Commission (September 2, 2022) (available at: https://www.fcc.gov/news-events/notes/2022/09/02/another-step-toward-better-broadband-maps).

3 *C.f.,* G.S. Ford, *Challenges in Using the National Broadband Map's Data,* PHOENIX CENTER POLICY BULLETIN NO. 27 (March 2011) (available at: https://www.phoenix-center.org/PolicyBulletin/PCPB27Final.pdf).

4 D. Goovaerts, *NTIA Won't Have the Broadband Map It Needs for BEAD Until 2023*, FIERCETELECOM (September 6, 2022) (available at: https://www.fiercetelecom.com/telecom/ntia-wont-have-broadband-map-it-needs-until-2023).

5 *See, e.g.,* R. Schulman, G. Bullen and N. Thieme, *The United States of Broadband Map: Mapping the Gulf Between the Broadband Speeds That ISPs Report and Those Measured by Consumers,* Open Technology Institute (July 17th, 2019) (available at: https://www.newamerica.org/oti/reports/united-states-broadband-map); D. Goovaerts, *NTIA's New Broadband Map Ruffles Feathers At NCTA,* FIERCETELECOM (June 18, 2021) (available at: https://www.fiercetelecom.com/telecom/fresh-ntia-map-throws-broadband-gap-into-sharp-relief).

6 Using Wi-Fi connections will, if anything, bias the measured speed of fixed connection downward.

7 It might be argued that an increase in the number of providers will lower price, but those lower prices come at a high cost. It is implausible that the net benefits from subsidized competition are positive, since the subsidies incorporate competitive effects. Subsidized competition is a notoriously bad idea, especially given the very-high costs of building a broadband network. *C.f.,* T.R. Beard, G.S. Ford, L.J. Spiwak, and M. Stern, *The Law and Economics of Municipal Broadband,* 73 FEDERAL COMMUNICATIONS LAW JOURNAL 1 (2020) (available at: http://www.fclj.org/wp-content/uploads/2020/09/MunicipalBroadbandArticleFINAL.9.2.20.pdf).