National Hispanic Media Coalition

Regarding
Improving the Quality and Accuracy of Broadband Availability Data
[Docket No. 180427421–8421–01]
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Towards a Consumer Centric Perspective on Availability of Access to the Open Internet

Comments of the
National Hispanic Media Coalition (NHMC)

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I. Introduction

1. **Objective:** The National Hispanic Media Coalition (NHMC) respectfully submits these comments in response to the Request for Comments (RFC) seeking public input to improve the quality and accuracy of broadband availability data. NHMC is the media watchdog for the Latino community, ensuring that Latinos are fairly and consistently represented in news and entertainment and that their voices are heard over the airwaves and on the Internet. Universal and affordable access to an open Internet represents a key barrier to social, economic, and political participation of Latinos and other marginalized communities, and is therefore an advocacy priority for NHMC.

2. **Opportunity:** Collection and dissemination of indicators that offer a realistic picture of the "availability" of access to high speed connectivity represents a critical input into research and development of effective public policies and private sector strategies required to counteract growing inequalities in the quality of broadband infrastructure in both rural and urban communities. While broadband quality and affordability problems are more pronounced in rural America, they are also a pervasive problem in many urban communities and small towns. Unfortunately, the traditional manner in which federal agencies have been measuring "availability" both underestimates the magnitude of broadband capacity gaps in rural communities and totally obfuscates them in urban and suburban ones. Moreover, FCC Form 477 data that goes into the existing broadband map capture only maximum speeds sellers advertise, which is not a good proxy for effective service quality levels they deliver/buyers receive in return for their subscription fees. Calling data that comes out of FCC Form 477 "availability" rather than advertised speeds therefore represents a one-sided view of the market that takes into account claims from the side of the sellers and therefore leads to misleading overestimates of the quality of high-speed connectivity that is available to Americans. It is high time to correct this error. This represents an opportunity for NTIA to modernize how federal agencies monitor the evolution of basic and essential telecommunications infrastructure of our country. Our comments here aim to assist the NTIA improve the nation's ability to analyze broadband "availability" by building a more balanced evidentiary basis for conceptualizing and mapping broadband infrastructure quality. Furthermore, the "big data" analytic approach that we outline below aims to account for the growing service quality differentiation in the delivery of Internet access services. The rise of a "two-tiered" Internet consisting of a basic service access path to the open Internet and premium prioritized/sponsored traffic has implications for conceptualizing and measuring the quality of access that is effectively "available" to consumers. Internet measurements that capture the quality of service users experience from different vantage should be prioritized in augmenting existing Form 477 data in modernizing the national broadband map to reflect the evolving nature of Internet connectivity.

3. **Context:** NHMC is pleased that Congress has recognized the well-known problem of overestimating service "availability" associated with FCC Form 477 data. These indicators essentially capture maximum "best effort" (up to xMbps) theoretical speeds providers advertise in a particular area and report to FCC via Form 477, not the effective bandwidth/quality of service these operators actually provision for their customers in that community.[1] Actual service quality levels sellers deliver/users experience tends to vary from "best effort" advertised rates specified in retail contracts with users, often substantially.[2] This is particularly the case with providers that rely on legacy/slower technologies and in rural communities where a relative lack of competition limits incumbent providers' incentives to improve effective capacity in response to demand growth.[3] Poor Internet service quality also represents a problem in some urban and suburban areas where private sector incentives to provision sufficient access network capacity does not keep up with growing demand by user for network intensive applications and over-the-top (OTT) media services (e.g. lower income, older neighbourhoods). In addition to underestimating the magnitude of gaps in rural area as the Congress has recognized, since Form 477 based mapping only captures maximum advertised speeds those selling the service claim are theoretically available in a particular area, the existing mapping framework wholly obfuscates connectivity problems associated with capacity under-provisioning in underserved urban areas, suburbs, and smaller towns.

4. **Economics:** "Availability" of shared network capacity is the outcome of dynamic interaction between supply and demand in local and regional markets. A community that might be considered "served" today may become "underserved" tomorrow if growth in user demand for network resources is higher than the rate by which the infrastructure provider is willing to provision additional capacity overtime. The existing approach to measuring availability with maximum advertised "best effort" rates is not capable of accounting for economic dynamics that shape broadband "availability" users experience in mature markets such as the U.S. where access to some form of "high-speed" connectivity is near ubiquitous. As network coverage issues have been increasingly solved through public subsides and private investments over the past two decades, quality and affordability of services have evolved as key factors that determine the "availability" of consumers' access to content and applications that meet their heterogeneous needs. Developing a more economic approach to conceptualizing "availability" and collecting data that is more reflective of the user experience can significantly enhance the value of the national broadband map as a tool for infrastructure capacity gap identification and investment prioritization for all levels of governments, as well as potential private investors/service providers willing to invest in advanced broadband technologies (e.g. fiber-to-the-premises

[1] Null, E. (2018). Why Can't the U.S. Government Make a Decent Broadband Map? Slate. https://slate.com/technology/2018/03/why-cant-the-u-s-government-make-a-decent-map-of-broadband-access.html

[2] Rajabiun, R. & Middleton, C. (2015). Lemons on the Edge of the Internet: The Importance of Transparency for Broadband Network Quality. *Communications & Strategies*, *1*(98), 119-136. https://ideas.repec.org/a/idt/journl/cs9805.html

[3] Riddlesden, D., & Singleton, A. D. (2014). Broadband speed equity: A new digital divide?. Applied Geography, 52, 25-33. https://www.sciencedirect.com/science/article/pii/S0143622814000782

(FTTP), high throughput 4G+ wireless) in underserved communities. Construction of more realistic "availability" metrics by federal agencies can provide significant leverage to state and municipal governments trying to convince private sector providers to invest in broadband networks in their communities. This is particularly important at a time when large telecommunications providers appear more interested in investing in media assets than broadband network improvements (e.g. recent AT&T and Comcast merger announcements).

5. **Cognitive dissonance:** Based on FCC Form 477 data and 25/3 Mbps universal service targets, this RFC states that "approximately 8 percent of Americans lived in places where fixed terrestrial broadband service was unavailable by the end of 2016." This characterization of the data may be technically valid given the construction of Form 477 data from maximum connection speeds suppliers advertise in particular areas of the country and then report to the FCC. However, it is critical to recognize that data underlying this claim have little to do with the effective service quality levels most Americans experience under normal use conditions, such as when everybody in the neighbourhood is also trying to access content and application services they need or when the user is trying to access non-prioritized/cached data from the open Internet (i.e. the "slow lane"). To help contextualize the dissonance between official FCC Form 477 data's relatively optimistic picture of "availability" and effective bandwidth American consumers experience, Figure 1 below documents the distribution measured download speeds for a sample of 99,999 unique IP addresses conducted by users on the M-Lab Network Diagnostic Tool (NDT) performance measurement platform between 2015 and 2016. According to these measurements, only around 40% connections at the time had sufficient effective capacity available that allowed users to exceed FCC's 25 Mbps download speed target. This stands in sharp contrast to the manner in which NTIA characterizes the problem. Effective bandwidth available to the majority of users (approximately 60%) fell short of FCC's 25 Mbps aspirational universal service target (vs. 8% according to NTIA/FCC's interpretation of Form 477 data). The cognitive dissonance between the official agency view of broadband "availability" and effective network capacity both explains and validates Congressional concerns about overestimation of "availability" under the current approach and justified appropriations for NTIA to develop a more realistic picture of capacity gaps communities across the country experience. Nobody should be surprised that claims by vendors about the quality/capacity of their products/services would systematically overstate their capabilities.

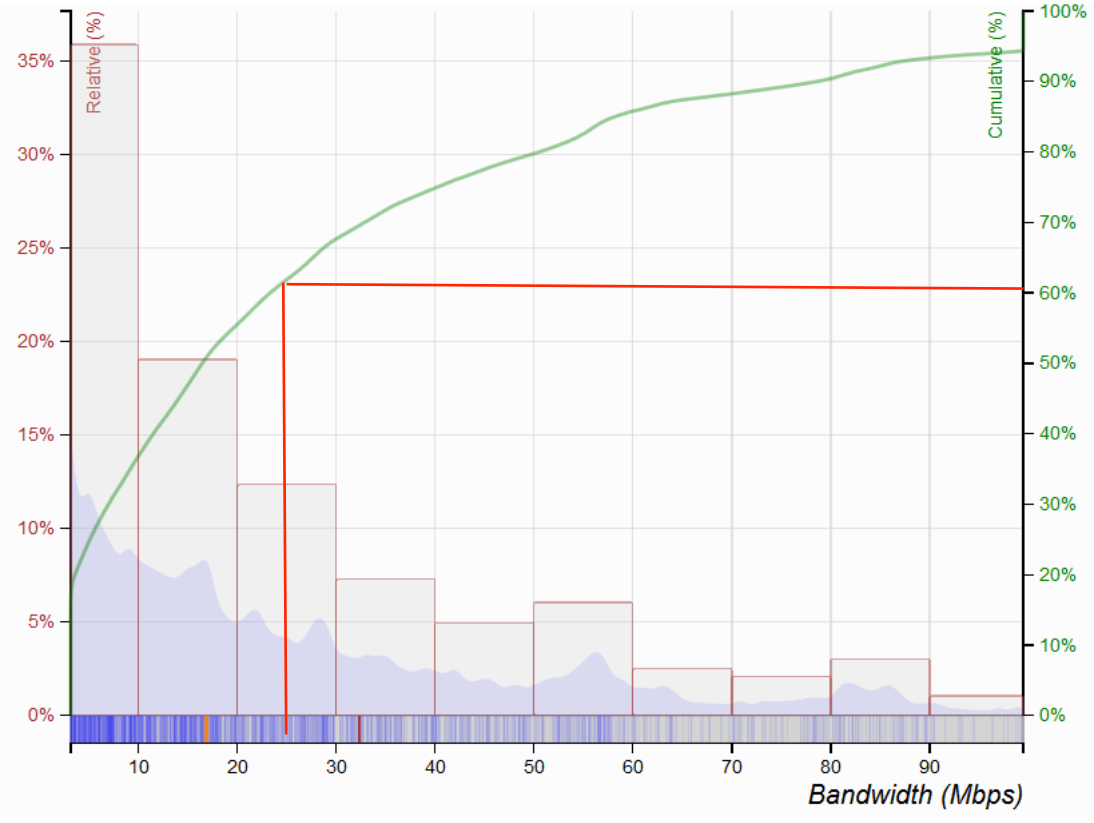

Figure 1. Distribution of Connection Speeds in the U.S. (2015-2016)
Source: M-Lab NDT/RIPE NCC, n=99,999

6. **Data accuracy and diversity:** As part of their network monitoring and provisioning systems, Internet Service Providers (ISPs) collect detailed internal data on effective bandwidth and service quality levels they deliver to their customers. In terms of NTIA's objective to improve the accuracy of the national broadband availability mapping capabilities, internal ISP data (e.g. on average, median effective bandwidth, latency, other quality of service metrics, available technologies, oversubscription ratios, etc.) is likely to be superior to Internet measurement by third party entities. However, service providers consider this type of data to be proprietary and generally unwilling to share it with public policymakers or independent researchers, even under strict confidentiality conditions. Thankfully, due to demand by users and businesses that depend on high-speed and reliable connectivity, a diverse range of Internet measurement methodologies and platforms have evolved over the past decade that purport to measure connection quality users experience. We do not want to elaborate on specifics of these tests here as we suspect many vendors of speed testing and network performance monitoring datasets will be submitting their own comments and offer NTIA information about their capabilities. Nevertheless, we think it is important to recognize that third party data tend to utilize distinct methodologies, vantage points, aggregation procedures, etc. (e.g. M-Lab, Akamai, Ookla/Speedtest, SamKnows, Speedchecker,

etc).[4] Consequently, they tend to measure different aspects of network performance and can generate results that may appear inconsistent. For example, it is well known that average connection performance metrics generated from the Ookla/Speedtest and Samknows methods tend to produce effective bandwidth numbers that are substantially larger than those generated by M-Lab NDT and Akamai (2 to 3 times). Figure 2 documents the range of three commonly used speed measurement indicators across advanced economies. In general, speed tests can be configured and their results aggregated such that they produce outcomes within a desired target range of results.

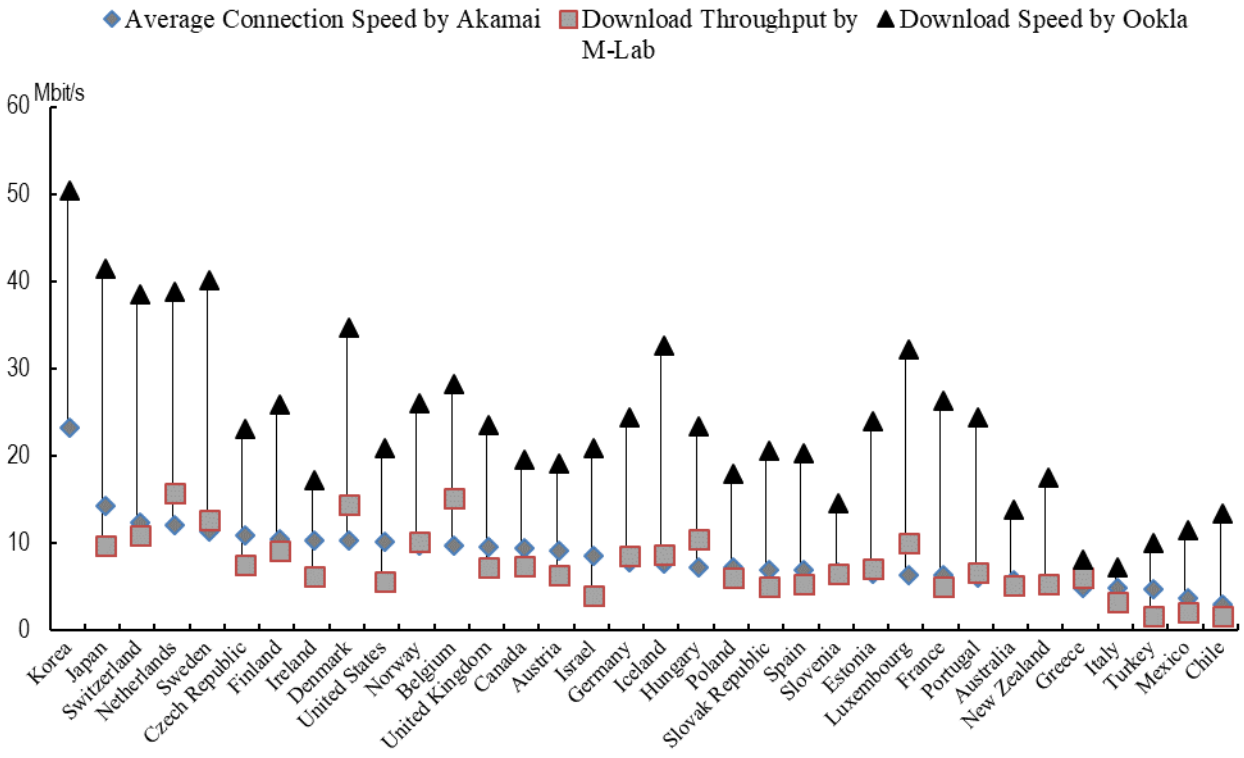

Figure 2. Distribution of Connection Speeds Advanced Economies
(OECD Broadband Portal, Table 5.5., 2014)

[4] For considered discussion of different approaches and technical challenges in measuring network performance see Bauer, S., Clark, D., & Lehr, W. (2010). Understanding broadband speed measurements. Boston: Massachusetts Institute of Technology. http://mitas.csail.mit.edu/papers/Bauer_Clark_Lehr_Broadband_Speed_Measurements.pdf Lehr, William, Steve Bauer, and David Clark. 2013. "Measuring Internet Performance When Broadband Is the New PSTN." Journal of Information Policy 3. http://jip.vmhost.psu.edu/ojs/index.php/jip/article/viewArticle/94 Bajpai, V., & Schönwälder, J. (2015). A survey on internet performance measurement platforms and related standardization efforts. IEEE Communications Surveys & Tutorials, 17(3), 1313-1341. https://www.researchgate.net/profile/Vaibhav_Bajpai3/publication/274569573_A_Survey_on_Internet_Performance_Measurement_Platforms_and_Related_Standardization_Efforts/links/5559e55308ae6fd2d8281417/A-Survey-on-Internet-Performance-Measurement-Platforms-and-Related-Standardization-Efforts.pdf

7. **Towards a "big data" strategy**: Because of their diversity and configurability, attempting to figure out which third party data sources provide a more, or less, "accurate" picture of the differentiated and evolving world of Internet connectivity is not likely to be a fruitful exercise.[5] Inconsistencies between competing tests can lead to confusion for both consumers and policymakers, particularly if they are viewed as competing perspective on a singular reality. From an analytical perspective, incorporating information from distinct methodologies is likely to provide a richer picture of reality than any single one, or those that capture essentially the same thing.[6] By combining perspectives from tests that offer distinct vantage points into a complex, increasingly differentiated, and fast evolving work of Internet connectivity, it would be feasible to "triangulate" relevant signals from them and develop a more sophisticated view of broadband availability than any single third party indicator. At a rudimentary level that is relevant in the context of questions raised in the RFC, it would be desirable and readily feasible to compile relevant data and analyze "availability" in terms of the range of speeds generated by third party datasets NTIA manages to procure to augment Form 477 advertised rates (within particular census blocks or lower level/standardized geographical units that help address problems NTIA recognizes exist with large rural census blocks). Ookla/Speedtest for example tend to place its test servers within the networks of service providers (i.e. "on-net"). Consequently, much like the FCC Form 477 advertised rates, Speedtes/Ookla's estimates of speeds and latency might be relevant for capturing effective service quality levels/speeds users experience when accessing prioritized/sponsored Internet content and application services or those cached on the networks of the service providers (i.e. upper bound of the range of effective "availability"). At the other extreme (i.e. lower bound), Akamai measures performance while trying to optimize delivery of content and applications for its corporate clients to users from its distributed Content Delivery Network (CDN). Somewhere in the middle between the two boundaries of the range are the results generated by the M-Lab NDT testing platform, which makes its raw data available for free and is widely used by public sector organizations in the U.S. and around the world to benchmark and map broadband infrastructure quality at the local level. While Akamai and M-Lab use very distinct measurement methodologies and offer different vantage points, they both test connection quality from the user device to an "off-net" server outside of the network of Internet service provider (usually in a nearby city). Consequently, their estimates of average/median speeds are likely to more closely reflect what users experience when trying to access content and application services from the open Internet (i.e. the lower bound) than Form 477, Speedtest/Ookla, or SamKnows measurements (i.e. the upper bound).

8. **Bad data:** Data collection via Form 477 can be maintained to enable the analysis of gaps between service provider claimed/advertised maximum "best effort" speeds and the range of third party indicators of effective service quality levels American experience NTIA chooses.

[5] For an example of one such attempt, see: Bennett, Richard. 2016. "How Not to Measure Internet Speed." High Tech Forum (blog). June 28, 2016. http://hightechforum.org/getting-up-to-speed-doesnt/

[6] Rajabiun, R., & McKelvey, F. (2018). Complementary Realities: Public Domain Internet Measurements in the Development of Canada's Universal Access Policies. Forthcoming. *Information Society*.

However, it is relevant to note that widespread public dissemination of Form 477 advertised rates as "availability" indicators also makes the public sector complicit in marketing claims of Internet service providers and can mislead consumers in thinking that the Form 477 advertised rates mean that services at those speeds are actually available in particular communities and can be purchased for a price.[7] While a business center or a few buildings may be connected to technologies that can offer these maximum rates in particular communities, Form 477 based indicators have little to do with what type of services are available to the majority or average households/users in that area under normal use conditions. Policymakers and other stakeholders committed to the development of high quality Internet access infrastructure should be careful not to overinterpret what Form 477 data implies as it sends erroneous and counterproductive signals about "availability" in local and regional broadband markets.

9. **Relevance:** From an economic perspective, information asymmetries between buyers and sellers have both allocative/static and productive/dynamic efficiency implications by (a) enabling sellers of low quality product to extract prices that are too high from vulnerable consumers, and (b) making it difficult for providers of higher quality services to signal the superiority of their services to potential consumers ex post, which reduces their ex ante incentives to invest in the higher quality services and new technologies in the first place (i.e. the Lemons Problem).[8] Reliance on reported maximum advertised "best effort" speeds as a proxy for broadband availability may have been justified in the early stages of the development the Internet in the 1990s and 2000. "Best effort" broadband is still good enough for basic Internet applications such as email and web browsing. Over time however, a wide variety of advanced Internet applications have emerged that require reliable high-speed connectivity (i.e. minimum effective bandwidth/speed, symmetry, Quality of Service (QoS) guarantees). The supply and use of broadband has therefore evolved significantly, but the methodology by which FCC/NTIA construct the broadband availability map and evaluate which areas are "served", and which ones are not, remains as a relic of a bygone era. Funding from Congress that motivates this RFC offers a unique opportunity to catch up with the times and construct a modern "big data" analytics approach to monitoring the evolution of connectivity across both rural and urban areas, identifying existing and predicting emerging capacity gaps, and adopting effective reactionary and proactive strategies to address them.

10. **Consumer impacts:** Appreciating the relevance of the task before the NTIA to American consumers and the need to conceptualize availability in terms of the user experience requires recognizing the extent to which slower than expected broadband speeds/service quality levels restrict consumers' ability to access information and applications that meet their heterogeneous needs. To better understand barriers facing American consumers trying to access the open

[7] See for example front end presentation of FCC Form 477 on https://broadbandnow.com/
[8] Rajabiun, R. & Middleton, C. (2015). Lemons on the Edge of the Internet: The Importance of Transparency for Broadband Network Quality. Communications & Strategies, 1(98), 119-136. https://ideas.repec.org/a/idt/journl/cs9805.html

Internet and support evidence-based decision making at the FCC, through a series of requests under the Freedom of Information Act (FOIA), NHMC has managed to obtain the text of more than 50,000 complaints by consumers, FCC ombudsperson communications with service providers, and responses by carriers to their customers' complaints.[9] We have further analyzed the FCC informal complaint documents using quantitative content analysis/Natural Language Processing (NLP) techniques that allow us to map what these parties tried to convey to each other along the complaint process. [10] The analysis clearly documents that the key concern driving consumer complaints is less than expected speeds their service providers deliver to them. In response to these complaints, service providers tend to initially blame bottlenecks in equipment in customers' premises, but ultimately justify their failure to deliver on what their customer was expecting per the "best effort" advertised rate in the retail contract by arguing that broadband speeds tend to "vary" and that unsatisfied customers are getting what they paid for. This "imperfect contracting" problem means that carriers can allocate the risk of capacity under-provisioning to consumers, which is economically inefficient as it is the supplier that makes the provisioning decisions not the paying customers who are getting less than what they paid for. If NTIA has any doubts about why it is important for American consumers to move from advertised "best effort" to effective measured speeds/QoS indicators in conceptualizing and measuring "availability", our analysis of consumer complaints and carrier responses to the FCC may be informative.[11] For a high level overview of barriers facing consumers, Figure 2 provides a visual depiction of the content of a sample of approximately 20,000 of the complaints NHMC has obtained from the FCC through our FOIA requests. Consumers' concerns are clearly driven by "slow" actual vs. "advertised" "download" "speeds" (top cluster) for the "Internet" "services" they "pay" for (middle cluster). In addition limited "bandwidth"/service "quality" during "hours" when most people want to use the Internet "limit" their ability to "use" (right hand side cluster) application and services "people" "need".

[9] http://www.nhmc.org/foia-release/

[10] Rajabiun, R. (2017). Consumer Barriers to Accessing the Open Internet: A Preliminary Analysis of Informal Consumer Complaints to the Federal Communications Commission (FCC) and Related Documents. In the matter of Restoring Internet Freedom, WC Docket No. 17-108. NHMC Expert Report. https://www.fcc.gov/ecfs/filing/1121274019518

[11] Ibid.

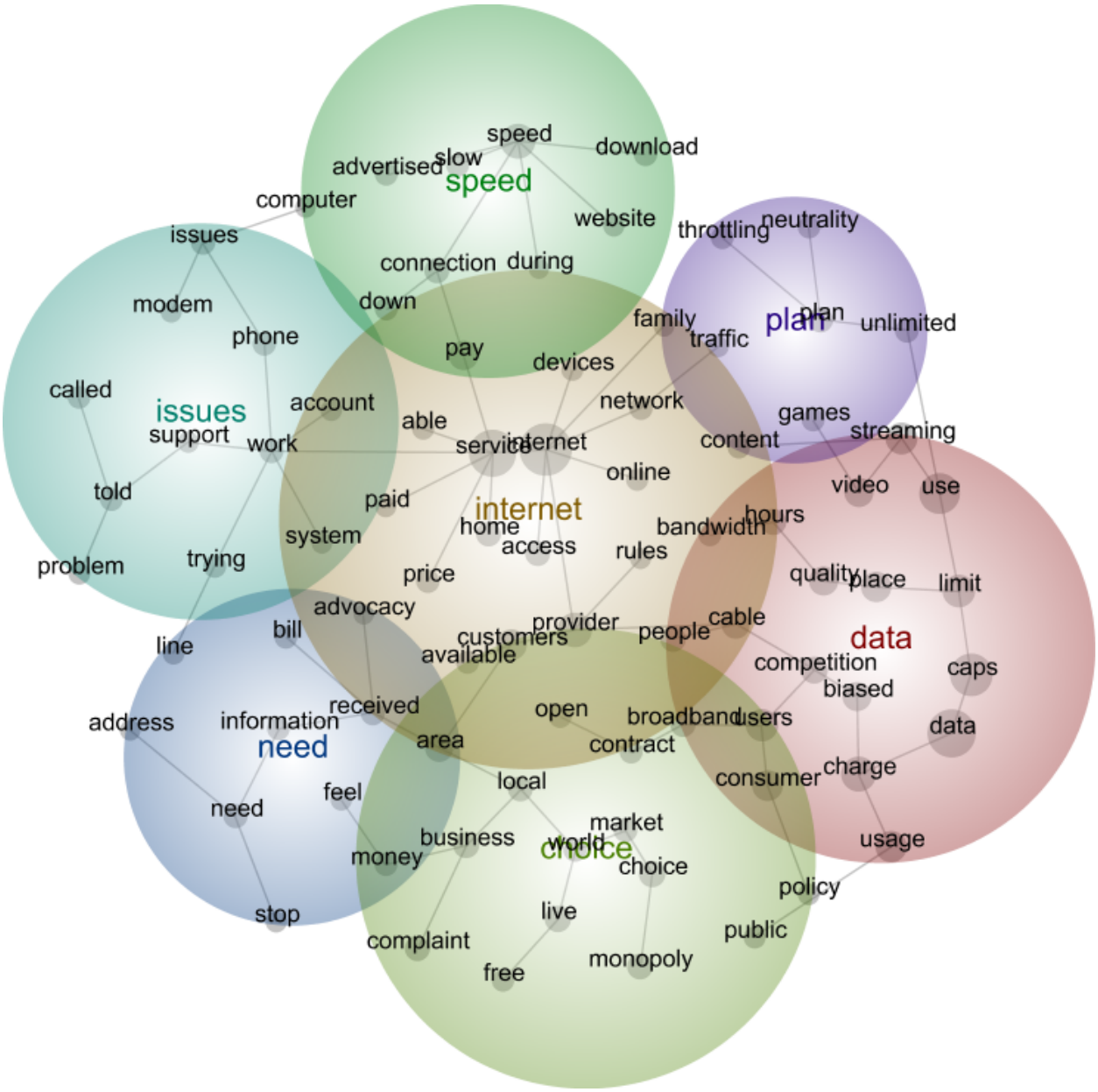

Figure 3. Content Map of Consumer Complaints about Internet Access to the FCC (2015-2017); n~20,000

11. **The "two-tiered" Internet:** The emergence of new personal and business application that require better than "best effort" service quality over the past decade has in turn has stimulated the development of a wide range of network management technologies that enable the delivery of quality of service guarantees and fine-grained service quality and price differentiation (e.g. across applications, senders, users). The combination of these factors has led to the development of a multi-tiered Internet in which scarce capacity is bifurcated into a basic "best effort" access path to the open Internet infrastructure as premium prioritized/sponsored services (and/or a number of better than best effort services depending on application requirements). In the

presence of capacity constraints, growth in traffic in the premium tier on the same physical infrastructure poses a negative externality on basic service quality in the "slow lane" that remains "available" to subscribers trying to access everything else from the open Internet. In addition to calls for the adoption and implementation of non-discrimination rules, these negative externalities also create demand for ensuring the availability of some minimum universal service quality standards to mitigate against negative externalities on basic service quality (i.e. in the "slow lane".[12] Due to recent decisions by the FCC and increased vertical integration by dominant network providers who are making large investments in media assets, it would be reasonable to suspect that the proportion of traffic in the premium/prioritized access path is likely to accelerate in the next few years. This increases the risk of negative externalities on the quality of service "available" for basic "best effort" access to the third party resources available from the open Internet. The rise of the two-tired Internet presents another explanation for the growing consensus around the inadequacy of broadband availability indicators based on maximum advertised speeds. The maximum advertised speeds that service providers claim are "available" might be achievable when the user is accessing prioritized/sponsored/cached content and applications, but not in the basic service/"slow lane" that remains available for accessing all other third party resources. Indicators that enable the NCTA to capture actual speeds in the slow lane to the open Internet are therefore increasingly important for evaluating broadband availability in the U.S. as the level of traffic in the premium/prioritized grows. Measurements from Akamai and M-Lab which assess connection quality from end users to an "off-net" server (usually on the "edge of the cloud" in a nearby city) are relevant to consider for capturing "availability" in terms of basic service quality when accessing the open Internet.

12. **Broadband divergence:** Research on the evolution of broadband connectivity suggests increasing variation in the median effective speeds large network infrastructure providers deliver to their customers trying to access the open Internet.[13] Driven by distinct technological, financial, and organizational choices of network providers that dominate regional markets, divergence of effective bandwidth service quality across service providers may not have a negative impact on "availability" in local/regional markets where infrastructure competition creates relatively strong incentives to improve quality to minimize subscriber churn. This may be the case in some relatively high income urban markets where there is more competition and investment in ultra-high capacity FTTP networks (e.g. in the North East, West Coast), but in lagging urban centers (in the South, Midwest), older and smaller towns, and rural areas relatively limited investment and competition result in subpar speeds. Measuring and monitoring broadband quality infrastructure available for accessing the open Internet is particularly relevant for ensuring

[12] Brennan, T. J. (2011). Net Neutrality or Minimum Quality Standards: Network Effects vs. Market Power Justifications. In Network Neutrality and Open Access (pp. 61-80). Nomos Verlagsgesellschaft mbH & Co. K G. https://papers.ssrn.com/abstract=1622226

[13] Rajabiun, R., & Middleton, C. (2018). Strategic choice and broadband divergence in the transition to next generation networks: Evidence from Canada and the US. *Telecommunications Policy*, 42(1), 37-50. https://www.sciencedirect.com/science/article/pii/S0308596117301143

equality of opportunities available to people and business in communities where effective capacity supply is not keeping up with effective growth in demand. By adopting a "big data" analytic approach that incorporates both maximalist and minimalist perspective on availability of access, NTIA can make a valuable contribution to improving market transparency, assisting state and local governments in validating users' concerns about broadband infrastructure quality problems in underserved communities, and enabling effective targeting of scarce universal service subsidies and private capital expenditures into lagging communities.

II. Responses

13. **RFC Q1:** For reasons noted above, FCC Form 477 data should be viewed as an upper bound for maximum theoretical speeds sellers claim might be available in particular areas (e.g. prioritized/cached traffic, when everybody else in the vicinity is sleeping/at work). In terms of indicators that help capture effective speed/service quality levels that Americans experience when trying to access the open Internet via fixed and mobile networks, there are a large number of commercial vendors; some which are likely to submit comments in response to this RFC. Some of these make high level estimates of speeds/service quality levels public, but there is however a dearth of standardized public domain Internet measurements that enable low level mapping to accuracy levels required by the broadband map. The notable exception to this are the results from the M-Lab NDT testing platform, which offers raw test data on which capacity gaps analysis can be conducted at relatively low levels of disaggregation (subject to some limits on geolocation accuracy due to technical and privacy concerns). The M-Lab platform is integrated into the Google search engine, already widely used by lower levels of government that have already recognized the need to look at broadband access availability in terms of actual speeds, and measures connection quality of users to "off-net" servers in nearby cities around the U.S. It therefore offers a realistic benchmark for measuring availability of effective capacity and connection latency when users are trying to access the open Internet. If NTIA chooses to adopt the "big data" outlined here, FCC Form 477 data can be used as the upper bound and M-Lab's open database of crowdsourced tests as the lower bound of the range of speed/quality of service metrics needed to develop a realistic picture of broadband "availability" across the country. Budgetary implications of starting with this approach to modernizing the broadband map are likely to be limited, particularly compared to purchasing raw data streams for all of the United States from a commercial vendor. Given the importance of broadband to both the U.S. economy as a whole and the technology industry, it may also be worthwhile for NTIA to consider engaging with companies with large Content Delivery Networks (CDNs) across the country such as Akamai, Google, Amazon, Cloudflare, etc. that deliver content and applications to users. Perhaps they may be willing to contribute geolocated performance data streams from the vantage points of their networks to a national project that can help close digital divides Americans experience.

14. In terms of limitations, one key issue in broadband mapping in underserved communities using crowdsourced Internet measurements is the size of test samples. This can be addressed with community engagement that motivates residents and businesses to test their connections on a particular testing platform to increase sample sized in areas with a low number of users. New measurement techniques and use of GPS capabilities of mobile devices increasingly enable relatively exact geolocation. Exact geolocation to the household level can raise privacy concerns and is also unnecessary for most broadband deployment purposes. The manner in which particular third-party vendors aggregate individual tests across communities is also important to consider in evaluating what they are actually measuring. For reasons documented above, different indicators are primarily limited because they capture a distinct window into a differentiated and evolving world of connectivity, which is why we are recommending moving towards a "big data" analytic framework that incorporates information from multiple sources to gain new insights and limit the impact of their biases in capturing broadband "availability."

15. **RFC Q2:** In addition to strategic choices of large incumbent service providers, that impact their provisioning decisions, technological endowments of incumbent service providers are a key determinant of their ability to scale capacity to growing user demand.[14] From the perspective of users however, the combination of technologies their service provider uses to connect them to the open Internet, is less relevant than the actual speeds/service quality levels they receive in return for what they are paying for. The added informational value of updating how information about availability of technology types is collected may be limited. Furthermore, network infrastructure providers are not always readily willing to share maps of their physical networks with the public sector, making it expensive and challenging to collect accurate technology type information at low levels of aggregation when various indicators of effective speed/service quality levels suppliers deliver are available from multiple open source and commercial vendors. That said, the geographic coverage of old copper/3G+ LTE versus new fiber-to-the-premises (FTTP) fiber/4G+ networks can be very valuable for local and state governments trying to encourage/subsidize improved access to next generation networks.

16. **RFC Q3:** Documenting broadband infrastructure quality in rural areas has traditionally faced two key challenges, which can increasingly be addressed. Due to relatively small number of users, sample sizes in crowdsourced data might be relatively low. An effective approach to addressing this is to engage in community based testing in partnership with state and local communities that encourages residents and business to test their connections (e.g. media outreach, surveys, etc.). Measuring broadband gaps in rural areas is also challenging because of the significant variability in what users can expect due to differences in distance to fiber nodes in the case of fixed access and tower location/environmental factors on the mobile front. Another

[14] Rajabiun, R., & Middleton, C. (2018). Strategic choice and broadband divergence in the transition to next generation networks: Evidence from Canada and the US. Telecommunications Policy, 42(1), 37-50. https://www.sciencedirect.com/science/article/pii/S0308596117301143

problem with measuring availability in rural areas is IP geolocation accuracy of some tests, but this issue has increasingly been resolved with new techniques and use of near exact GPS geolocation capabilities of mobile phones that can be used to measure both fixed home and mobile data network capabilities.

17. **RFC Q4:** As detailed in the first part of these comments, different testing approaches to measuring availability capture distinct windows into a differentiated and evolving world, which makes it hard to take information from any single source for granted. The "big data" strategy outlined here considers availability as a range of indicators with complementary information. Adopting such an approach will not only help improve the quality and accuracy of the resulting map, but will also limit the need for validating particular component indicators. As such, it will be both more accurate and cost effective than previous attempt to capture broadband availability based on advertised rates of local incumbents and then trying to validate claims by sellers.

18. **RFC Q5:** For reasons outlined throughout these comments, NTIA can make an important contribution to enabling effective broadband infrastructure monitoring, capacity gap mapping, and development of public and private initiatives if it recognizes the limited informational value of FCC Form 477 indicators capturing maximum speeds sellers advertise in a particular area. Instead, we suggest leveraging information from multiple sources of third party information to conceptualize and collect broadband availability indicators that offer a realistic picture network quality users experience/service providers provision. The emergence of a two tried Internet and expected growth in the premium/prioritized service tier makes it increasingly important for consumers and policymakers to care about speed/service quality levels that are available for accessing content and applications from the open Internet on the "best effort" "slow lane" versus prioritized/sponsored/cached premium services delivered in the "fast lanes". Our comments in this matter have aimed to help NTIA leverage the limited funds the Congress has appropriated to develop a more balanced broadband mapping framework that incorporates information based on claims by sellers (i.e. FCC Form 477), as well as effective bandwidth/service quality levels that is actually available to users trying to access services they need on capacity constrained network infrastructure.

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