March 4, 2022

ASSIA is pleased to submit our comment in response to FCC*'s* Request for Comments on *Empowering Broadband Consumers Through Transparency* - CG Docket No. 22-2 - *FCC 22-7*.

ASSIA looks forward to engaging with FCC in a further exploration of the issues we have raised in this comment through an ex-parte presentation, or other appropriate public process, during the FCC's rule making with respect to mandates under Section 60504 of the Infrastructure Act.

Best regards,

Dr. John Cioffi,
CEO and Chairman,
Adaptive Spectrum and Signal Alignment, Incorporated (ASSIA)

203 Redwood Shores Parkway, Ste. 100, Redwood City, CA 94065 USA main +1 650 654 3400 fax +1 650 654 3404 www.assia-inc.com

FCC*'s* Request for Comments on *Empowering Broadband Consumers Through Transparency* – CG Docket No. 22-2 – *FCC 22*-7: Comment from Adaptive Spectrum and Signal Alignment, Incorporated (ASSIA®), 203 Redwood Shores Parkway, Suite 100, Redwood City, CA 94065.

Contents

1. Introduction

The broadband information label is referred to in the NPRM and the Infrastructure Act itself as a 'Nutrition Label'[1] indicating that the information is expected to be used by a broadband subscriber analogously to how a consumer utilizes the nutrition information on a food label when choosing to purchase a product. In order for a food label to be useful, the nutritional categories provided must align with scientific consensus regarding which nutritional categories are of importance and how to measure the nutrient values, align with similar measures of the foodstuff used for other medical purposes, and be independently verifiable. The information for the Broadband Nutrition Label needs to support similar requirements.

[1] Section 2-23 of the NPRM: "We also propose to adopt the format of the 2016 labels, which resemble the nutrition labels the United States Food and Drug Administration (FDA) has prescribed for food products".

- The data model and definitions for parameters required to be listed in the Broadband Nutrition Label should be consistent with the definitions and use of the same parameters as required in other aspects of the Infrastructure Bill, or existing government programs[2], and all these models should align with the technical consensus as to the meaning of the parameters.
- The meaning of the parameters listed in the label must be well defined and provide information that is useful to a consumer who may not have deep technical knowledge. The user is concerned with the quality of their experience when using broadband, rather than the values of particular technical parameters.
- The veracity of statements made in the label should be independently verifiable and not depend solely upon self-reporting by the network operator.
- The values of parameters made in a label should be based on statistically sound measurements.
- The statements made in the label should align with the measurements made for other governmental purposes; such as, broadband mapping, verification of conformance with terms of a grant[3], required reporting by a network operator,[4] or for addressing challenges[5].
- While the label appropriately will provide information solely about the offered broadband access service, the performance of other network segments all affect performance as seen by the broadband customer, e.g., the customer's Wi-Fi at their premises, the internet backbone, and the performance of a content provider's network and servers. The ability to sectionalize network performance thus becomes necessary to ensure the user's perceived overall service quality and to ensure the utility of broadband performance parameters to users, policy makers, and network operators. Different network operators offer different Wi-Fi equipment and Wi-Fi management practices, resulting in different Wi-Fi performances, so Wi-Fi is an important part of a broadband service offering. Poorly performing Wi-Fi can be perceived as a poorly performing broadband service, and it is in the interest of public policy to understand the relationship between Wi-Fi performance, broadband access, and overall user-perceived quality of service. Improved Wi-Fi performance should be encouraged.

To support these requirements the values reported in the Broadband Nutrition Label should be based upon the same data models, data gathering tools and procedures, and analysis methods that support the other mandates with respect to Broadband performance data that are specified in the Infrastructure Act. All the measurements should provide meaningful,

---

[2] This is mandated as a Sense of Congress in Sec. 50102 (m) of the Infrastructure Act: "It is the sense of Congress that Federal agencies responsible for supporting broadband deployment, including the Commission, the Department of Commerce, and the Department of Agriculture, to the extent possible, should align the goals, application and reporting processes, and project requirements with respect to broadband deployment supported by those agencies."

[3] E.g., Infrastructure Act Sec. 60102 (g)(1)(C)

[4] E.g., Infrastructure Act Sec. 60102((j)(2)(B)

[5] E.g., Infrastructure Act Sec. 60102 (h)(2)(A)

consistent, and accurate data, be cost-effective to perform, and preserve the privacy and data security of users' information, while simultaneously providing a broad and accurate overview of broadband performance on a per service offered level, as required for the Broadband Nutrition Label, on both a regional and national basis. This comment explores how these requirements for consistency and convergence can be met by tools commercially available today. An organized framework for broadband data is presented which defines the phases of data collection from device extraction to cloud analyses, and which also defines levels of collected data from basic to detailed. Support for such a framework across all the mandated performance measure will help ensure that the information in Broadband Nutrition Labels will be of maximum value to consumers, as well as to other stakeholders, such as the FCC, NTIA, the Department of Agriculture, the states, and any other interested parties.

2. Suggested Improvements to the Broadband Nutrition Label

There are a number of improvements related to the performance parameters[6] as proposed in APPENDIX B of the NPRM that should be made for the Broadband Nutrition Label to be meaningful to a consumer and to enable verification and repeatability of the statements made by a broadband network operator.

- While the tag line of the heading 'Individual performance may vary' is correct as performance as seen by the customer cannot be constant under real-world network conditions, unless there are criteria with respect to how the carrier determines the values of the stated performance parameters in the label that relate these values to varying performance under actual field conditions, the performance figures in the label would significantly lose meaning. This is one of the reasons for the need for the performance values to be based on statistically sound measurements and analysis. The term used in this section of the label for individual parameters is meant to be 'Typical', as in 'Typical speed upstream', but it should be unambiguously defined. This is necessary to present data that is directly comparable. The specific criteria need to be carefully defined, and for example we could include wording such as 'typical is defined as being achieved in 90% or more of all cases during the busiest hour of a day.' It may also be useful to present both median (50%) and worst-case (95%) performances.
- Overall service availability and reliability are important measures of service performance as seen by a user. A reliability parameter such as average time between failures (e.g., retrains), and/or an availability metric such as average uptime, would be very useful to users.
- The concept of packet loss and latency, though important technical measures of performance, are not necessarily meaningful to a technically naive consumer. Instead, it is suggested to present "benchmarks" for these, analogous to the "% Daily Value" seen on an FDA nutrition label. Example broadband latency benchmarks are 20 milliseconds for median latency and 100 milliseconds for 95% worst-case latency. Example packet loss benchmarks are 10^{-4} for median packet loss and 10^{-3} for 95% worst-case packet loss. An

[6] Listed as 'Performance – individual experience may very' in example label in Appendix B of the NPRM.

indication of meeting benchmarks would also be useful, such as color coding the presented "typical" performance measures as red, yellow, or green.

- Ping tests to content servers that support services typically seen as essential to subscribers[7] would also provide critical information about how the ISPs peer/throttle specific content services. This could aid in identifying whether ISP-cloud provider peering affect the overall quality of connections, eliminating a possible false perception of the source of service quality degradation.
- It is essential to provide an easily available test node software library that standardizes data measurements both in terms of how they are performed and in terms of the data collected and presented for analysis. Such a library will enable hardware/software vendors, ISPs, content services, and other stakeholders open access to the data collected. Such software libraries will therefore enable full transparency of both collection and analysis.

Addressing these specific recommendations should be related to the resolution of the general issues raised in the Introduction (Section 1) of ASSIA's comment.

3. Some Interpretation of these Issues

Addressing the issues we have raised in Sections 1 and 2 can be best addressed by viewing the necessary regulations, processes, and tools in terms of a number of underlying requirements. Broadband performance is now typically expressed only in terms of downstream and upstream speeds. This simple characterization does not account for many aspects that directly contribute to service quality; such as, latency and availability. Furthermore, there are many aspects of broadband relevant to particular parts of the network, particular services, and particular aspects of service delivery. For example, while Wi-Fi isn't strictly part of a broadband access line, the user often perceives it to be. As a result, saturated Wi-Fi bandwidth usage or other Wi-Fi impediments directly impact perceived broadband service quality in many serving areas. An ability to sectionalize the cause of problems becomes necessary to guide future policy directions, to best focus improvements on the limiting parts of the broadband network.

Enforcement efforts and government oversight should focus on the mandated requirements, and thereby enable government and industry to cooperate to deliver acceptable broadband services to all Americans. Therefore, a wide range of performance parameters and relations between parameters should be evaluated and tracked over time to assess the entire network status comprehensively, and these measurements should be the basis for the values listed in a Broadband Nutrition Label. Currently, available technologies enable pervasive data collection regarding overall end-to-end and sectionalized performance of the broadband network. Such pervasive collection can be secure, preserve anonymity, be non-interfering, and be statistically valid, as it is based on performance information available from the majority of users of the

[7] Examples of such essential content servers might be addressed by pings to the servers of major cloud service providers, e.g., AWS, Azure, Oracle, Microsoft, or Google, or to servers supporting example applications of importance such as search engines (e.g., Google), streaming video sources (e.g., Netflix), or on-line gaming sites.

network rather than a small sample of volunteers who agree to provide information, and the information collected can provide support for accurate and useful Broadband Nutrition Labels.

The Broadband Nutrition Label is one aspect of the broadband performance mandates in the Infrastructure Act and should be coordinated with other measures. These mandates address various regulatory issues that include evaluating and mapping the overall quality and availability of broadband services nationwide, by state, and by geographic location within the state, determining whether a deployment-support guarantee has complied with their grant's terms, enabling challenges regarding the promised services' quality, and supporting the future evolution of broadband services and policy. The data that underlie the analysis required to address these various mandates, including clear definition and verification of the values listed in a Broadband Nutrition Label, should ultimately have the same source, and they should be based on the same requirements for the parameters gathered, accuracy of collection, and frequency of collection. Such data collection, based on common requirements and processes, can thus become a common resource that can be utilized by government, industry, and others for understanding America's broadband infrastructure performance and for guiding its future evolution.

4. Broadband Data Collection Framework

A number of variables should be specified in order to have the parameters in the Broadband Nutrition Labels be consistent and directly comparable across network operators and regions. Data collection and distillation and broadband parameter definitions are inherently variable and should be well-specified.

A broadband data collection framework is now presented that can support the requirements for an accurate Broadband Nutrition Label and other mandates of the Infrastructure Act. This framework defines the phases of data collection, stratifies broadband parameters into levels, and defines parameters in detail.

4.1. Data Collection Phases

The need to enable the use of commonly collected and comparable data to support disparate analysis invites the following division into process 'phases' for gathering and analyzing broadband performance data:

Phase 0: Raw data and measurements are collected from network and user devices. Installing a software agent on the devices is an effective way to run tests and gather measurements.

Phase 1: Devices send data reports to a remote server or cloud database. For this phase, a software agent is very useful for aggregating raw data, such as averaging many 5 second measurements and then reporting every 15 minutes to limit telemetry traffic. A standardized protocol such as Broadband Forum TR-69 or TR-369 is recommended for sending the data.

Phase 2: Determination of statistical performance across the population is conducted. Histograms, max, min, average, and other statistics are effective outputs of Phase 2.

Phase 3: Evaluation is performed where derived metrics and figures of merit are produced and presentations generated (e.g., plots, trends, and overall scores such as the Quality of Experience Delivered (QED) metric as defined in Broadband Forum BBF MR 452.2).

Figure 1 illustrates the data collection and analysis phases.

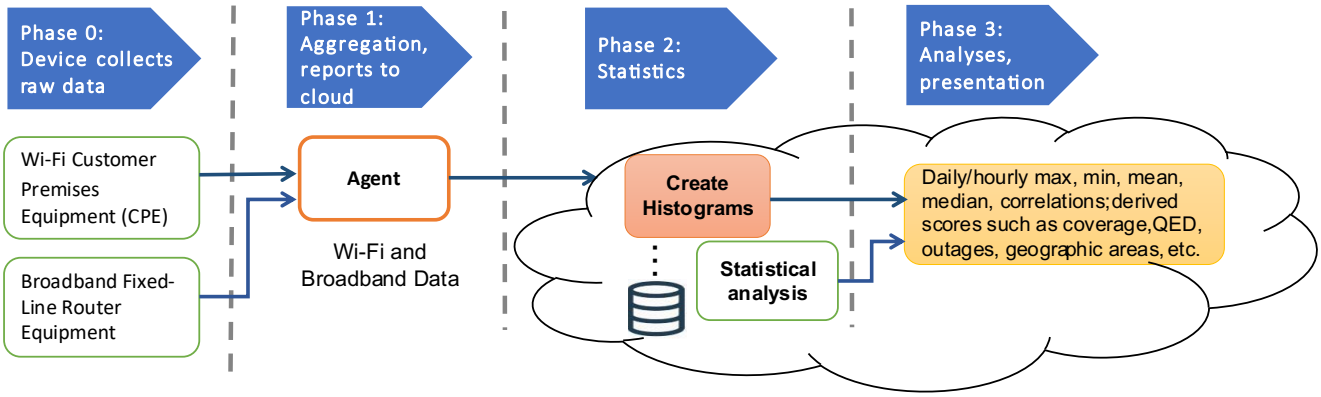

Figure 1 – Overview of the Phases of Analysis of Broadband QoS and Reliability Data

Examining the QoS and reliability requirements of Section 60102 of the Infrastructure Act, the regulations promulgated by the Government, including the FCC with respect to the Broadband Nutrition Label, should specify requirements for Phase 0 and Phase 1 as seen in this model to enable a wide and versatile range of Phase 2 and Phase 3 data aggregation and analyses. The FCC, in coordination with the NTIA and the Department of Agriculture and other interested government bodies, would specify the parameters and their characteristics that need to be collected in Phase 0, then Phase 1 requirements would support uniform collection formats and reporting intervals. The requirements to support Phases 2 and 3 would largely relate to the analysis and presentation of the final data. In the case of the Broadband Nutrition Label, this analysis would be specific to the requirements of the regulations defining the Label.

4.2. Broadband Parameters Levels and Definitions

One can divide the type of information that needs to be collected as supporting a number of 'Levels' for stratifying parameters. A Broadband Nutrition Label should include parameters in levels 0-2 defined here, with Level 0 and Level 1 being the most visible, while Level 2 is also important.

- Level 0: Advertised broadband speeds as stated by service providers or regulation. Level 0 values are not measured per-se but rather are stated and published. The rules being developed should specify the Level 0 parameters that underlie the regulations.
- Level 1: Salient performance measures (e.g., measured speed and latency). Perceptible by consumers, these measures required for evaluating conformance with broadband performance targets.
- Level 2: Further parameters that directly influence service quality (e.g., availability, loss rates) for network operators to determine service issues, perform diagnostics, and determine performance. Moreover, a level of sectionalizing problems is needed for

determining network bottlenecks; for example, between the Broadband access and the customers Wi-Fi. Sectionalization is important firstly because a broadband access guarantee is not necessarily responsible for the performance of a customer's own Wi-Fi and secondly because information about location of problems can be used to guide further regulatory actions, such as, allocation of spectrum to Wi-Fi or the encouragement of industry research or standardization to address these quality issues. Such knowledge could have very significant impact on the use of infrastructure funds. For instance, if expensive fiber deployment is undertaken in an area where the in-home end broadband connectivity is limited, then the fiber investment does not produce immediate benefit. Instead, funds to improve spectrum use and assignment might best first be spent.

- Level 3: Level 3 parameters may not be of explicit concern for these rules. These parameters indirectly influence performance, for deep-dive diagnostics and troubleshooting. Level 3 measurements are used by a network operator to diagnose issues and engineer their networks.

The parameters to be collected to support broadband measurement requirements are listed in Table 1 and defined in the text below.

Table 1. Broadband access parameters and levels

Parameter	Direction	Recording Frequency	Unit	Level
Offered speeds	Downstream and upstream	N/A	Mbps	0
Throughput	Downstream and upstream	Daily (hourly also optional)	Mbps	1
Latency	Roundtrip	Daily (hourly also optional)	Milliseconds	1
Packet loss rate	Downstream and upstream	Daily	Percent	2
Internet Down Count		Daily	Number of occurrences/day	2
Internet Down Duration		Daily	Seconds/day	2

Broadband throughput

Broadband throughput (speed) is measured as the average throughput for upstream and downstream in Megabits per second (Mbps). Speed tests measure the upload/download speeds of the Broadband service. Typically, speed or throughput is measured between the broadband gateway and a test server. Test servers are geographically distributed, and the broadband gateway dynamically selects the closest speed-test server (e.g., through cached latency tests), performs throughput measurements, and reports the results to the remote server. Each speed test result sent by the device contains broadband throughput data.

Broadband latency
Broadband latency is measured and recorded as a daily average in milliseconds, using round-trip latency measurements between the broadband gateway and a network-located broadband speed test server. The broadband gateway periodically measures the Round-Trip-Time (RTT) to all the pre-configured speed-test servers and reports the results to the remote server. Broadband latency results are also used for detecting the closest speed-test server and for detecting Internet disconnections.

Broadband packet loss rate
The packet loss rate (PLR) is defined as the loss rate after all error correction is applied. The count of all lost or discarded received packets is divided by the total received packet count to determine the PLR.

Internet down count
Internet down count is a tally of the number of internet disconnections in a day. The device can record an internet down event if it cannot establish a connection to any remote speed-test server. While the internet is down, the broadband gateway or device will not have a connection to remote servers. In such times, the device will record internet connection error. When the internet connection is restored, the device uploads all the results to the server. The internet down count is incremented if the internet connection was down for all the speed tests (to different servers) reporting connection errors.

Internet down duration
Along with the detection of disconnections, the approximate time duration of internet disconnections is provided. Internet down events can be recorded on the device, and these events are uploaded to the remote server once the connection is restored. Internet down count and down duration are raw data that are useful for calculating broadband reliability and availability. Another way of determining availability is to run speed tests by only adding a limited amount of "headroom" test traffic above the current rate of user traffic; such tests can determine if the user perceives broadband to be available for their needs.

4.3. Wi-Fi Parameters

While not directly required for broadband access, determining the performance of the Wi-Fi link of the broadband connection is highly useful for sectionalization and identifying Wi-Fi bottlenecks. Salient Wi-Fi performance parameters are: throughput, latency, traffic, frame loss and retransmission rates, interference, congestion, channel utilization (airtime), Wi-Fi coverage, transmit rate, surrounding BSS's density, and received signal strength. These parameters should be combined into a single score that can be used on a Broadband Nutrition Label to represent a broadband network operator's expected Wi-Fi performance.

4.4. Stratification Dimensions

Each parameter may be further stratified into a list of separate parameters, one for each dimension or for each combination of dimensions. Upstream and downstream can typically be specified for each parameter, except for round-trip measurements such as latency.

Broadband parameters can also be further dimensioned or stratified by:

- Upstream and downstream
- Broadband type: DSL, cable, fiber, satellite, fixed wireless, etc.
- Area: Urban, suburban, and rural areas (can similarly stratify by for income level across a geographic area)
- Per service level or per application type

5. Suggested Requirements

5.1. Uniformity

The performance and measurement requirements serve a number of purposes that include verification of guaranteed compliance with grant terms, addressing challenges from third parties, and gathering data by the government that indicates compliance with overall Congressional mandates and to guide future policy directions. Measurements made by a particular system or for a particular purpose should be comparable to the same or similar measurements made by other systems for other purposes. Systems to collect data, to store data, and to analyze data for the various purposes should have identical data definitions, algorithms, and presentation when the same types of data are collected and analyzed. Standardized, reusable systems and methods should be encouraged to perform Phase 0 and Phase 1 broadband data collection activities, and these systems and methods should be optimized to enable Phase 2 and 3 analysis and presentation.

5.2. Accuracy

Requirements for accuracy of the measurements need to be specified. Tools and systems should enable collecting information that is statistically sound from as large a sample space as possible to provide accurate statistics across the population. Ideally, data are collected from most, if not all, customers served by a broadband network.

5.3. Cost Effective

The requirements must be supportable by systems and processes that are cost effective. These systems should add little to the marginal cost of the broadband deployment, customer equipment, and support systems. Parameters can be sent from the device using standard protocols such as Broadband Forum TR-69 or TR-369. There should also be support for control of the collected data's parameters and frequency of collection.

Another "cost" is adverse impact to the user's service. This can be limited, for example, by injecting only a limited amount of "headroom" test traffic and then summing user traffic plus test traffic to get total traffic.

Software-based data collection and analysis is generally more cost-effective than deploying a dedicated hardware box at the user's premise. A most cost-effective solution is to deploy a software agent on home gateway devices that collects data and sends it up to the cloud. Running tests to measure speed and latency generally require such an agent. Speed and latency of both the broadband connection and the Wi-Fi links can be accurately measured with an agent residing, for example, within the Wi-Fi enabled broadband gateway at the customer's premises. The agent can

also assist in reading and averaging or otherwise combining a great many performance parameters.

5.4. Support Problem Sectionalization

A broadband system comprises a number of architectural components: the customer's (wired and/or wireless) LAN, the broadband access itself, the middle-mile infrastructure, the backend network, and the systems providing content. Measurements of broadband access performance requires that the information can support sectionalization. A broadband network operator may have a system that meets the requirements set by regulation, yet the customers' received QoS may be subpar due to problems in other components of the network, e.g., the customers' Wi-Fi networks, the internet, or the content provider's systems. Being able to separate these performance components is not only necessary to ensure that performance issues are addressed in systems that are supported by the grants, but also provides information that may identify global performance issues, where government and industry cooperation may be appropriate to ensure the goals of a nationwide broadband infrastructure. In particular, operator-provided Wi-Fi gateways have variable performance that users should be aware of.

Clear data labeling is critical for understanding where a bottleneck occurs within the end-to-end connectivity that supports broadband applications and identifying which service, content, or hardware provider in this end-to-end chain complies with the advertised performance parameters.

A suggested sectioning of the end-to-end connectivity measurements is the following:

1. Total Connectivity (end to end measurements)
2. Access Network Connectivity (fixed or mobile network section measurements of the broadband access itself)
3. Middle-Mile Connectivity (measurements of performance of the 'middle-mile', where broadband accesses are aggregated by the ISP or carrier from multiple fixed access nodes or the back-haul from mobile access points, e.g., cell towers)
4. Local Area Network Connectivity (fixed or Wi-Fi LAN section measurements at the customer premises)
5. Content Server Performance (Measurements 1,2, 3, or 4 made when communicating to a particular content site)

At a minimum, throughput, latency, stability measurements, and qualitative sub-scores should be gathered.

5.5. Stakeholder Independence

Measurements and analysis of the measurements could be made by a number of sources, each a stakeholder with different and possibly conflicting interests. These include the grantee, challengers, users, and government agencies at the local, state, and national level. The measurement and reporting systems and definitions should enable such multi-sourced measurements and ensure that the measurements are comparable regardless of source. The

architectural separation of the problem of broadband data collection into the phases described in this comment will enable this independence.

5.6. Privacy

The systems, requirements, and methods must ensure anonymity of the data, and protection of the user's personally identifiable information as an inherent quality of the requirements and design of the system. Data collection must be supported by secure systems and processes that enable anonymous, non-interfering and non-invasive collection of performance information.

6. Conclusions

The 'phased approach' to broadband data collection separates data collection from analysis as described in Section 4 of this comment. Broadband performance parameters, parameter levels, and requirements are also presented here. These comments can assist FCC in defining requirements for broadband performance data collection and analysis that help ensure the information in a Broadband Nutrition Label is of maximum value to the consumer, as well as being accurate and thus protects the interests of the broadband network operator, government entities, and other interested parties.

ASSIA looks forward to engaging with the FCC in a detailed exploration of the issues we have raised in this comment through an ex-parte presentation, or other appropriate public process during rule making.

7. About Adaptive Spectrum and Signal Alignment, Inc. (ASSIA)

Adaptive Spectrum and Signal Alignment, Incorporated (ASSIA®) develops innovative technologies for service providers that improve internet connectivity worldwide. ASSIA's market-leading AI-driven solutions make internet connections run faster and more reliably by optimizing the performance of whatever infrastructure is in place, be it copper wires, fiber, various generations of Wi-Fi including Wi-Fi 6, or cellular 5G. ASSIA is a strategic partner and trusted solutions vendor to over 35 service providers worldwide with more that 125 million broadband and Wi-Fi lines under contract, in 17 countries, across 5 continents.