



January 31, 2022

ASSIA is pleased to submit our comment in response to *NTIA's Request for Comments on the Broadband Programs in the Bipartisan Infrastructure Law [Docket No. 220105-0002]*.

ASSIA looks forward to engaging with NTIA in a further exploration of the issues we have raised in this comment through an Ex-parte presentation, or other appropriate public process, during NTIA's rule making with respect to its mandates under Division F of the BIL.

Regards,

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

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1. Introduction

The NTIA in its request for comments [Docket No. 220105–0002] raises a number of critical questions with respect to successful implementation of the Bipartisan Infrastructure Law (BIL)¹. NTIA’s first question, ‘what are the most important steps NTIA can take to ensure that the Bipartisan Infrastructure Law’s broadband programs meet their goals with respect to access, adoption, affordability, digital equity, and digital inclusion?’ is open ended, however the text of the Infrastructure Investment and Jobs Act: Division F – Broadband mandates quality of service (QoS), reliability and resilience with respect to the broadband services supported by the law as a critical requirement, one that will underlie success of the projects funded by the BIL.

In order to ensure compliance with these mandates, NTIA will specify how these service quality requirements are measured and reported. These measures must provide meaningful, consistent, and accurate measurements, 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 both on a regional and national basis. This comment explores the nature of such requirements, and processes to support them which can be met by tools commercially

¹ *The Infrastructure Investment and Jobs Act: Division F – Broadband*
203 Redwood Shores Pkwy. Ste 100 Redwood City, CA 94065 USA main +1 650 654 3400 www.assia-inc.com

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.

2. Mandates in the BIL with respect to Broadband Measurements and Reporting

Division F Title I² of the BIL specifies NTIA’s mission with respect to administering broadband grants under this Act and contains a number of specific requirements with respect to QoS and measurement of the performance of services funded under this section of the act [Emphasis in the quoted text is added]:

1. The definitions at SEC. 60102 (a)(1),(I) defines a Priority Broadband Project as:
The term *priority broadband project* means a project designed to—
 - (i) provide broadband service that *meets speed, latency, reliability, consistency in quality of service, and related criteria as the Assistant Secretary shall determine*; and
 - (ii) *ensure that the network built by the project can easily scale speeds over time to—*
 - (I) *meet the evolving connectivity needs of households and businesses*; and
 - (II) *support the deployment of 5G, successor wireless technologies, and other advanced services.*
2. SEC. 60102 (g)(1)(C) requires of subgrantees:
A subgrantee, in carrying out activities using amounts received from an eligible entity under this section—
 - (A) *shall adhere to quality-of-service standards, as established by the Assistant Secretary*;
 - (B) ...;
 - (C) *shall incorporate best practices, as defined by the Assistant Secretary, for ensuring reliability and resilience of broadband infrastructure*; and
 - (D) ...;
3. SEC. 60102 (h)(2)(A) requires eligible entities to support an evidence based challenge process:

“...ensure a *transparent, evidence-based, and expeditious challenge process* under which a unit of local government, nonprofit organization, or other broadband service provider can challenge a determination made by the eligible entity in the initial proposal as to whether a particular location or community anchor institution within the jurisdiction of the eligible entity is eligible for the grant funds, including whether a particular location is unserved or underserved.”
4. Section 60102(j)(2)(B) requires reports from grantees:
Each report submitted under subparagraph (A) shall—
 - (i) describe each type of project carried out using the subgrant and the duration of the subgrant;
 - (ii) in the case of a broadband infrastructure project—
 - (I) include a list of addresses or locations that constitute the service locations that will be served by the broadband infrastructure to be constructed;
 - (II) identify whether each address or location described in subclause (I) is residential, commercial, or a community anchor institution;
 - (III) describe the types of facilities that have been constructed and installed;
 - (IV) *describe the peak and off-peak actual speeds of the broadband service being offered*;
 - (V) *describe the maximum advertised speed of the broadband service being offered*;
 - (VI) describe the non-promotional prices, including any associated fees, charged for different tiers of broadband service being offered;
 - (VII) *include any other data that would be required to comply with the data and mapping collection standards of the Commission under section 1.7004 of title 47, Code of Federal Regulations, or any successor regulation, for broadband infrastructure projects*; and
 - (VIII) *comply with any other reasonable reporting requirements determined by the eligible entity or the Assistant Secretary*; and
 - (iii) *certify that the information in the report is accurate.*

² “Titled: Broadband grants for States, District of Columbia, Puerto Rico, and territories”

5. Section 60102 (h) (3), requires standardized methodology:
 - (3) Standardization and coordination
 The *Assistant Secretary and the Commission* shall collaborate to—
 - (A) standardize and coordinate reporting of locations at which broadband service was provided using grant funds received under this section in accordance with title VIII of the Communications Act of 1934 (47 U.S.C. 641 et seq.); and
 - (B) *provide a standardized methodology to recipients of grants and subgrantees under this section for reporting the information described in subparagraph (A).*

6. Section 60102 (m) requires coordination between the Department of Commerce, the Department of Agriculture, and the FCC with respect to reporting and measurements:
 - (m) Sense of Congress regarding federal agency coordination
 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. Some interpretation of these mandates

The requirements listed above cover four significant types of performance measurement mandates specified in section 60102 of the BIL:

1. Performance requirements for the funded services must be defined that allow determination that the service *'meets speed, latency, reliability, consistency in quality of service, and related criteria as the Assistant Secretary shall determine'*
2. Measurement and reporting methods must be specified.
3. These measurement methods must be used to support reports, and for 'challenge processes' where the quality of the service provided is questioned by an interested party.
4. The requirements, metrics, and processes shall be standardized across the government entities (the Department of Commerce, the FCC, and the Department of Agriculture) responsible for overseeing broadband deployment.

Addressing these mandates throughout the Division F of the BIL can be best addressed by viewing the necessary regulations, processes, and tools in terms of a number of underlying requirements. The required measurements must enable the verification of QoS, and the reliability and constancy of the services offered and funded under the BIL programs.

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. Further, 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 perceives it to be. So, saturated Wi-Fi bandwidth usage or other Wi-Fi impediments directly impact perceived broadband service quality in many serving areas. The mandates of the BIL imply that 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. 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 network rather than a small sample of volunteers who agree to provide information.

Further, the broadband performance mandates in the BIL address various regulatory issues that include: evaluating and mapping the overall quality and availability of broadband services nationwide, by state, and by geographic location with the state; determining whether a deployment-support grantee for funds 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 underlies the analysis required to address these various mandates must ultimately have the same source and should be based on the same requirements with respect to the parameters gathered, their accuracy, 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.

The data and analysis to address the various Broadband performance mandates will be varied depending on the purpose. For example, the two purposes of Broadband Mapping and evaluating a challenge to a particular grantee's broadband-deployment quality can each require its own dedicated analysis tools and procedures.

4. Broadband Data collection framework

A broadband data collection framework is now presented. This framework defines the phases of data collection and stratifies broadband parameters into levels.

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. Here, an 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: Determine statistical performance across the population. Histograms, max, min, average and other statistics are effective outputs of Phase 2.

Phase 3: Evaluation is performed where 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.

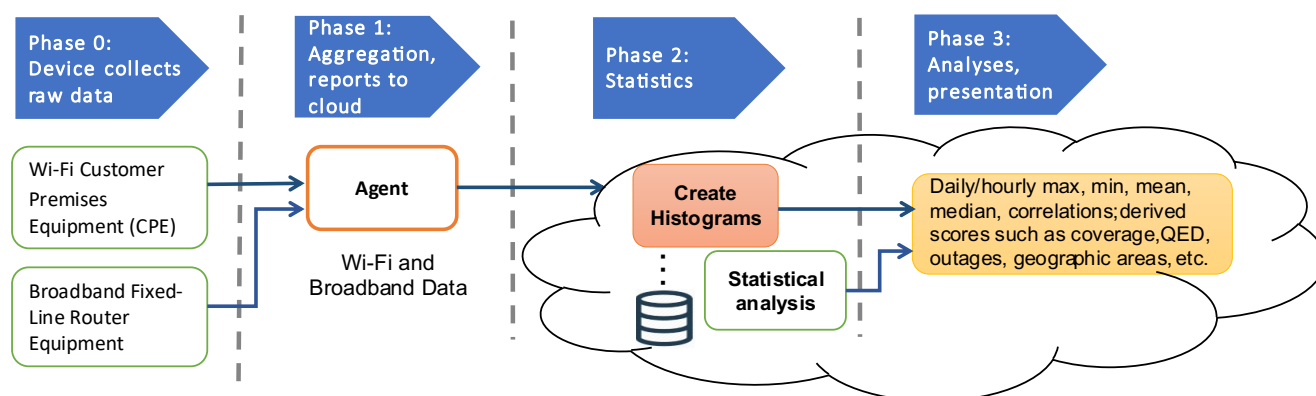


Figure 1 – Overview of the Phases of Analysis of Broadband QoS and Reliability Data

Examining the QoS and reliability requirements of Section 60102 of the BIL, the regulations promulgated by the Department of Commerce 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. NTIA, possibly in coordination with the FCC, the Agriculture Department 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 analyses and presentation of the final data.

The following subsections explore important criteria for defining the Phase 0 and Phase 1 broadband data collection requirements, and to also support versatile Phase 2 and Phase 3 analysis and presentation of the collected data.

4.2. Broadband Parameters and Levels

One can divide the type of information that needs to be collected as supporting a number of 'Levels' of information to validate. The information required to meet the mandates with respect to data collection in the BIL are those related to the parameter levels as described below.

- 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 must specify the Level 0 parameters that underly 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 as mandated by the BIL. Also, 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 grantee is not necessarily responsible for the performance of a customer's 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 the broadband measurement requirements of the BIL 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
Traffic	Downstream and upstream	Daily (hourly also optional)	GBytes/day MBytes/hour	2
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 Broadband service. The speed 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 (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 traffic

Broadband traffic is the total traffic in Gigabytes (GBytes) for upstream and downstream. The traffic is presented as a single total across a time period, daily and hourly. The broadband gateway is to track traffic usage (upstream and downstream) every 5 seconds; and report the summary of the usage (average, min, max, and histogram) to the remote server every 15 minutes.

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 the 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 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 required by the BIL, 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 BSSs density, and received signal strength.

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:

- Broadband type: DSL, cable, fiber, satellite, fixed wireless
- Upstream and downstream
- 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

As stated in the introduction to this section of our comment, the performance and measurement requirements stated in BIL serve a number of purposes which include verification of grantee 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, and to analyze the 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 is collected from most, if not all, customers served by a broadband system.

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 by, 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 which 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 line and the Wi-Fi connections can be accurately measured with an agent. 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 LAN, the broadband access itself, the middle-mile infrastructure, the backend network, and the systems

providing content. Measurement of broadband-access performance requires that the information can support sectionalization. A broadband provider receiving a grant under the BIL 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.

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 which 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. Section 5.3 describes how data collection incorporating a software agent on devices is cost-effective and can run speed and latency tests as desired. Broadband performance parameters, parameter levels, and requirements are also presented here. These comments can assist NTIA in defining requirements for broadband performance data collection and analysis that meet the mandates of Section 60102 of the BIL, while enabling flexible, low cost, secure and anonymous analysis that meets current needs and supports identifying future directions in broadband implementation and policy.

ASSIA looks forward to engaging with NTIA in a detailed exploration of the issue we have raised in this comment through an Ex-parte presentation, or other appropriate public process during NTIA's rule making with respect to its mandates under Division F of the BIL.

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 5G. ASSIA is a strategic partner and trusted solutions vendor to over 35 service providers worldwide with more than 125 million broadband and Wi-Fi lines under contract, in 17 countries, across 5 continents.