



November 10, 2021

Mr. Jon Eisenberg
Director, Computer Science and Telecommunications Board
National Academy of Sciences,
Engineering, and Medicine
500 Fifth St., N.W.
Washington, D.C. 20001

Dear Mr. Eisenberg:

Section 1663 of the FY2021 National Defense Authorization Act (“NDAA”)^{1/} directs the National Academies of Sciences, Engineering, and Medicine (“National Academies”) to carry out an independent technical review of the Order adopted by the Federal Communications Commission (“FCC”) permitting Ligado Networks LLC (“Ligado”) to operate a terrestrial wireless network.^{2/} The GPS Innovation Alliance (“GPSIA”)^{3/} welcomes this independent assessment to evaluate the potential degradation of service to Global Positioning System (“GPS”) devices that may be caused by Ligado’s proposed operations.^{4/} GPS is a critical national asset that is used for countless applications in a wide variety of sectors, and the *Ligado Order* threatens to cause harmful interference to the hundreds of millions of GPS devices relied upon by U.S. consumers, businesses, and the government, while doing nothing to support the deployment of Fifth Generation (“5G”) wireless technologies.

^{1/} See National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283, Sec. 1663 (2021).

^{2/} See *LightSquared Technical Working Group Report, et al.*, Order and Authorization, 35 FCC Rcd 3772 (2020) (“*Ligado Order*”).

^{3/} The GPSIA was formed in February 2013 to protect, promote, and enhance use of GPS and Global Navigation Satellite Systems (“GNSS”) technologies. Members and affiliates of the GPSIA are drawn from a wide variety of fields and businesses reliant on GPS, including manufacturing, aviation, agriculture, construction, defense, transportation, first responders, surveying, and mapping. The GPSIA also includes organizations representing consumers who depend on GPS for boating and other outdoor activities, and in their automobiles, smart phones, and tablets. The GPSIA recognizes the ever-increasing importance of GPS and other GNSS technologies to the global economy and infrastructure and is firmly committed to furthering GPS innovation, creativity, and entrepreneurship.

^{4/} Consistent with the terms of their litigation settlements with Ligado, GPSIA members Deere & Company (“Deere”) and Garmin International, Inc. (“Garmin”) do not affirmatively endorse or oppose the deployment of Ligado’s proposed communications network. Deere supports the discussion with respect to the appropriateness of using the 1 dB standard to assess potential interference to GNSS receivers. As Garmin has reiterated on a number of occasions, under the settlement, it retains the right to express concerns about the detrimental effect Ligado’s operations may have on its certified aviation devices and maintains its ability to advocate for use of the 1 dB standard.

Consistent with the National Academies’ plan to conduct “[t]he bulk of the technical analysis . . . based on public reports and open science and engineering literature and practice,” GPSIA urges it to consider the extensive technical studies and analyses on the potential impact of Ligado’s proposed operations to GPS devices that have already been submitted to the FCC. A list of, and links to, those filings are included in an Attachment to this letter. Among other things, the filings explain the technical differences between communications devices and navigation devices like GPS and how those devices experience harmful interference. They also demonstrate why the widely accepted 1 dB C/N₀ degradation criterion should be used as a measure of when harmful interference would likely occur to GPS devices and why implementation of Ligado’s proposals will likely interfere with the operation of certified aviation devices essential for aviation safety. Finally, the filings include analyses of the technical studies conducted by the federal agencies with expertise on GPS, including the GPS Adjacent Band Compatibility Assessment Final Report (“DOT ABC Report”) submitted by the Department of Transportation and the Technical Memorandum submitted by the National Telecommunications and Information Administration (“NTIA”).^{5/}

The materials in the Attachment provide important technical information and conclusions about the impact that Ligado’s operations will have on the day-to-day operation of GPS devices in the U.S. GPSIA encourages the National Academies to carefully evaluate the information, which should play a central role in the National Academies’ review.

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Should you or other members of the National Academies have any questions regarding the foregoing or attached, please do not hesitate to contact me.

Sincerely,

/s/ J. David Grossman

J. David Grossman
Executive Director
GPS Innovation Alliance

Attachment

^{5/} See U.S. Department of Transportation, “Global Positioning System (GPS) Adjacent Band Compatibility Assessment,” Final Report (Apr. 2018), <https://www.transportation.gov/sites/dot.gov/files/docs/subdoc/186/dot-gps-adjacent-band-final-reportapril2018.pdf>; *Assessment of Compatibility Between Global Positioning System Receivers and Adjacent Band Base Station and User Equipment Transmitters*, Technical Memorandum, NTIA TM-20-536 (Dec. 2020) (“Technical Memorandum”), attached to, Letter from Kathy Smith, Chief Counsel, NTIA, to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 12-340, *et al.* (filed Dec. 4, 2020).

ATTACHMENT

Differences Between Communications Systems and Navigation Systems

- [GPS Innovation Alliance, Ex Parte](#) (January 21, 2021) – Highlights that GPS, as a navigation system, differs from radio communications systems in how it is measured and receives signals (pg. 10)
- [GPS Innovation Alliance, Ex Parte](#) (July 21, 2020) – Explains the distinction between interference to communications and navigation systems (pgs. 4-5)
- [Trimble Inc., Reply to Oppositions to Petitions for Reconsideration](#) (June 8, 2020) – Explains the distinction between what is considered interference for communications and navigation systems and the different tests for each (pgs. 5-7)
- [NTIA Reply to Ligado Opposition to Petition for Reconsideration](#) (June 8, 2020) – Explains that for radionavigation systems, the applicable definition is whether interference “endangers the functioning” of the service, going beyond simple “performance” impacts (pgs. 8-9)
- [GPS Innovation Alliance Response to Energy and Commerce Committee Questions](#) attached to [GPSIA Innovation Alliance, Ex Parte](#) (Sept. 18, 2014) – Clarifies the parameters that should be used to manage potential interference, including the similarity or dissimilarity between uses (*e.g.*, mobile broadband and GPS services) and proximity of uses in space (or geography) and frequency (pgs. 8-11)

1 dB C/N₀ Degradation Metric

- [GPS Innovation Alliance, Ex Parte](#) (January 21, 2021) – Explains that 1 dB is the proper metric for assessing interference and has been recognized internationally and domestically (pg. 11)
- [GPS Innovation Alliance, Ex Parte](#) (July 21, 2020) – Provides a detailed analysis of the appropriateness of the 1 dB standard for evaluating GPS interference, including past applications of the standard and the likelihood of overload or lock loss (pgs. 1-5)
- [NTIA, U.S. Department of Transportation, Ex Parte Presentation](#) (July 10, 2020) ([accompanying ex parte letter](#), July 10, 2020) – Explains that the rejection of the 1 dB metric is inconsistent with Administration standards, and that the intent of this metric is to preserve the accuracy and integrity of timing, ranging, and position information (pg. 11)
- [Trimble Inc., Reply to Oppositions to Petitions for Reconsideration](#) (June 8, 2020) – Explains why the 1 dB standard is the more appropriate metric, including because it is designed to ensure that harmful interference is prevented *before* it occurs (pgs. 5-6)
- [Deere and Company, Comments](#) (June 1, 2020) – Demonstrates why the Commission erred in not applying the 1 dB metric and notes the importance of retaining the 1 dB standard for protecting GPS in the future as the FCC considers new technologies (pgs. 3-7)
- [Trimble Inc., Petition for Reconsideration](#) (May 22, 2020) – Advocates for use of the 1 dB metric because it correlates with degradation of GPS performance and explains that the Department of Transportation Adjacent Band Compatibility Assessment (“DOT ABC Report”) utilized a 1 dB degradation in C/N₀ metric to assess potential interference (pgs. 18-20)

- [GPS Innovation Alliance, Ex Parte](#) (Feb. 18, 2020) – Provides a detailed analysis of reliability of the 1 dB metric and explains that temporal fluctuations in GPS/GNSS signals are not the same as persistent degradation, that variance in different C/N₀ measurement techniques does not invalidate the utility of the 1 dB standard, and that the record demonstrates that Ligado’s claims that the 1 dB standard lacks adequate precedent with respect to evaluating adjacent band emissions are false (pgs. 1-7)
- [GPS Innovation Alliance, Ex Parte](#) (Dec. 20, 2019) – Provides a detailed analysis of the 1 dB metric and explains that changes in C/N₀ are a direct measure of receiver performance, a 1 dB degradation of C/N₀ is a direct and early indicator of interference, and short-term variations in GPS signals do not impact the use of the 1 dB standard to identify interference. It also argues that Ligado’s claim that use of the 1 dB standard lacks domestic or international precedent is wrong and seems to be based on an incorrect understanding of the relationship between C/N₀ and the GPS noise floor (pgs. 1-10)
- [Garmin International, Inc., Ex Parte](#) (Sept. 10, 2019) – Explains that the 1 dB standard remains the only reliable means for assessing harmful interference to GPS and is more efficient than piecemeal regimes such as key performance indicators (pgs. 2-3). Also discusses how concerns about harmful interference to certified aviation devices, which have been documented extensively in the record, remain unaddressed (pgs. 3-5)
- [Garmin International, Inc., Reply Comments](#) (July 26, 2018) – Supports the 1 dB standard as the universal metric for measuring interference to GNSS devices and notes the importance of planned system margins for variations in real-world environments (pgs. 2-4) and also raises concerns about certified aviation devices (pgs. 4-8)
- [Trimble Inc., Comments](#) (July 9, 2018) – Provides a detailed analysis of why the 1 dB metric is the appropriate standard for GNSS systems to be able to deliver a signal that is accurate, has integrity, and is available and continuous in nature and why other methods are unreliable and administratively impractical (pgs. 4-12)
- [Garmin International, Inc., Comments](#) (July 9, 2018) – Supports use of the 1 dB metric because it aggregates increases in the noise floor from out-of-band emissions alongside degradation from overload interference (pgs. 9-13) and documents concerns about certified aviation devices (pgs. 6-9)
- [Garmin International, Inc., Ex Parte](#) (May 16, 2018) – Supports use of the 1 dB metric and explains that the National-Space Based Positioning, Navigation and Timing Systems Engineering Forum Gap Analysis Final Report is consistent with the position that the 1 dB standard is the proper metric for assessing interference (pgs. 2-6) and notes that the same report raises awareness of critical unaddressed issues regarding certified aviation devices (pgs. 6-7)
- [GPS Innovation Alliance, Ex Parte](#) (July 13, 2017) – Explains that the test results published by the National Advanced Spectrum and Communications Text Network (“NASCTN”) provide both direct and indirect support for the use of the 1 dB metric (pgs. 1-11)

Analysis of Interference Test Results (Analysis of Roberson and Associates, LLC (“RAA”), DOT ABC, and NASCTN Reports)

- [GPS Innovation Alliance, Ex Parte](#) (July 30, 2020) – Explains that, pursuant to the 1 dB metric, DOT found that Ligado’s operations would repeatedly interrupt a significant percentage of GPS receivers on an ongoing basis, even at the FCC-authorized

transmission power of 9.8 dBW, because Ligado is permitted to place base stations in a very dense network topography of every 433 meters (pgs. 2-3)

- [NTIA, U.S. Department of Transportation, Ex Parte Presentation](#) (July 10, 2020) ([accompanying ex parte letter](#), July 10, 2020) – Explains the DOT ABC Report and findings of interference, including widespread interference issues under any definition of harmful interference due to loss-of-lock, and that this interference or degradation may include increased GPS and GNSS satellite acquisition times, reduced position accuracy, false position information, or loss of signal lock resulting in no position solution (pgs. 7-9)
- [Trimble Inc., Petition for Reconsideration](#) (May 22, 2020) – Criticizes the approaches of the RAA and NASCTN reports, including the limited number of devices tested, and provides appendices summarizing Trimble’s analysis of the DOT ABC Report and the GPS industry’s analysis of the flawed methodological limitations in the NASCTN tests (pgs. 16-18)
- [Garmin International, Inc., Ex Parte](#) (May 16, 2018) – Explains that the NASCTN tests provide indirect support by highlighting the extreme complexity of that approach and the unreliability of key performance indicators (pgs. 4-5)
- [National-Space Based Positioning, Navigation and Timing Systems Engineering Forum Gap Analysis Final Report](#) (Mar. 5, 2018) ([accompanying ex parte letter](#), Mar. 17, 2018) – Analyzes the results and methodology of the RAA, DOT, and NASCTN Reports to determine where questions were not answered or conditions were not tested, concludes that the RAA and NASCTN tests did not include sufficient scope to inform spectrum policy, and finds each test’s scope and framework to be insufficient when evaluated against the Space-Based PNT Advisory Board’s set of minimum criteria (pgs. 3-4, 8-9, 16)
- [GPS Innovation Alliance, Ex Parte](#) (July 13, 2017) – Highlights the complexity of measuring the effect of interfering signals on the selected key performance indicators of GPS devices and that the NASCTN report tested a limited number of devices and scenarios (pgs. 2-3)

NTIA Technical Report

- [GPS Innovation Alliance, Ex Parte](#) (January 21, 2021) – Highlights findings from the NTIA Technical Memorandum, including that using even less restrictive interference criteria, such as a 3 dB or 5 dB C/N_0 metric, harmful interference would exist (pg. 12)
- [GPS Innovation Alliance, Ex Parte](#) (Dec. 21, 2020) – Supports inclusion of the NTIA Technical Memorandum in the record for this proceeding, summarizing the critical new information provided in the Technical Memorandum including interference findings for high precision receivers. It also explains that the Technical Memorandum finds harmful interference regardless of the noise floor increase (pgs. 3-7)
- [NTIA, Ex Parte Letter](#) and accompanying [NTIA Technical Memorandum](#) (Dec. 4, 2020) – Determines, among other findings, that a wide range of interfering signal power levels can cause degradation in C/N_0 within the high precision and general location/navigation receiver categories (pgs. ii-iii)