July 21, 2020

The Honorable Roger Wicker
Chairman
Senate Committee on Commerce, Science, and Transportation
555 Dirksen Senate Office Building
Washington, DC 20510

The Honorable Maria Cantwell
Ranking Member
Senate Committee on Commerce, Science, and Transportation
511 Hart Senate Office Building
Washington, DC 20510

Dear Chairman Wicker and Ranking Member Cantwell:

The GPS Innovation Alliance ("GPSIA") thanks the U.S. Senate Committee on Commerce, Science, and Transportation ("Committee") for its continued work overseeing the Federal Communications Commission ("FCC" or "Commission"), including at the Committee's June 24, 2020 hearing.[1/] During the hearing, FCC Chairman Pai and the other Commissioners discussed, among other things, the *Ligado Order*, which granted applications submitted by Ligado Networks LLC ("Ligado") to modify its Mobile Satellite Service authorizations to be able to deploy a nationwide terrestrial wireless network in so-called "L-Band" spectrum.[2/] While the GPSIA appreciates the Chairman and Commissioners' comments on efforts to expand the deployment of broadband services, we believe certain statements made in response to questions asked by Committee members require additional clarification. The GPSIA therefore submits this letter to correct the record.

The 1 dB Standard is the Appropriate Metric to Guard Against Harmful Interference to GPS Navigation and Timing Services

Chairman Pai testified that the FCC has "never embraced" the 1 dB standard and that the National Telecommunications and Information Administration ("NTIA") itself has rejected that standard.[3/] Chairman Pai further stated that utilizing the 1 dB standard would "wipe out wireless communications as we know it." Both statements are inaccurate, and they highlight the

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1/ *See Oversight of the Federal Communications Commission Before the Senate Comm. on Commerce, Science, and Transp.*, 106th Cong. (2020) ("FCC Oversight Hearing").

2/ *See LightSquared Technical Working Group Report, et al.*, Order and Authorization, 35 FCC Rcd 3772 (2020) ("*Ligado Order*"). The L-band frequency bands covered by the *Ligado Order* are 1526-1536 MHz, 1627.5-1637.5 MHz, and 1646.5-1656.5 MHz.

3/ FCC Oversight Hearing (statement of Chairman Pai); *see also* Letter from the Honorable Ajit Pai, Chairman, FCC, to the Honorable Chris Coons, Mike Lee, Edward J. Markey, Ron Johnson, Brian Schatz, John Thune, and Mark Warner at 4 (dated June 12, 2020). The 1 dB standard measures whether a

fundamental flaws in the *Ligado Order* – the Commission's failure to adequately consider the unique characteristics of Global Positioning System ("GPS") devices, *timing and navigation* devices that are fundamentally different from *communications* devices, and to adopt an interference standard that is appropriate for GPS. Since GPS is different, adopting an appropriate interference standard for GPS does not mean the FCC would be required to extend that same standard to *communications* systems. The FCC can, and should, adopt interference standards that are appropriate for each individual service and has done so in the past. Its failure to do so here threatens the 900 million GPS receivers in use in the United States[4/] and the critical activities and systems that depend on them.

First, the FCC has, in fact, utilized the 1 dB standard, including in cases involving GPS.[5/] We note that just two months prior to the adoption of the Ligado decision, the Commission applied the 1 dB standard in order to protect C-band earth stations from terrestrial broadband operations in the adjacent band.[6/]

Second, the FCC has previously distinguished, as it did not do here, between different types of services, adopting an interference standard that is appropriate based on the circumstances. For example, in repurposing "H Block" spectrum for mobile communications services, the Commission adopted a less restrictive 3 dB standard to protect mobile communications systems. But in doing so, the Commission acknowledged that the "1 dB desensitization is most commonly used as an interference protection criterion for noise-limited

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new service causes a 1 dB degradation in a receiver's Carrier-to-Noise Power Density Ratio ("C/N_0") or a 25 percent increase in the noise floor. *See, e.g.*, Letter from J. David Grossman, Executive Director, GPS Innovation Alliance, to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109 and 12-340, at 2 (filed Dec. 20, 2019) ("GPSIA Dec. 2019 *Ex Parte* Letter").

4/ *See* National Space-Based Positioning, Navigation, and Timing Advisory Board, *Twenty-Fourth Meeting*, at 14 (Nov. 2019), https://www.gps.gov/governance/advisory/meetings/2019-11/minutes.pdf.

5/ *See, e.g.*, *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, Memorandum Opinion and Order, 18 FCC Rcd 3857, ¶¶ 12, 14 (2003) (utilizing the 1 dB standard when the FCC established emission levels for ultra-wideband transmission systems); *Amendment of Parts 73 and 74 of the Commission's Rules to Establish Rules for Digital Low Power Television, Television Translator, and Television Booster Stations and to Amend Rules for Digital Class A Television Stations*, Report and Order, 19 FCC Rcd 19331, ¶ 230 (2004) (using the 1 dB standard to establish rules to limit the emissions of low-power television stations into the spectrum band used by GPS); *Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, Memorandum Opinion and Order, 20 FCC Rcd 4889, ¶ 23 (2005) (modifying the interference protection criteria for existing digital and analog facilities by adopting a 1 dB standard).

6/ *See Expanding Flexible Use in the 3.7-4.2 GHz Band*, Report and Order, Order Proposing Modification, 35 FCC Rcd 2343, ¶¶ 366-89 (2020) ("*C-Band Order*"); *id.* ¶ 382 ("We find that a protection criteria of I/N = -6 dB is appropriate for TT&C links, as we did for the FSS earth stations described above. The 3.7 GHz Service licensee must ensure that the aggregated power from its operations will meet an I/N of -6 dB as received by the TT&C earth station."); *id.* ¶ 388 ("To protect TT&C earth stations from adjacent channel interference due to out-of-band emissions, we set the same interference protection criteria of -6 dB I/N ratio."). An interference-to-noise ("I/N") ratio of -6 dB is equivalent to a 1 dB rise in the noise floor.

receiver systems."[7/]

GPS receivers are precisely the type of "noise-limited receiver systems" that the Commission recognized that the 1 dB standard should be used to protect. As the FCC has explained, "noise limited" systems and services include receivers that are expected to continue to operate even when they receive very weak signals and are limited by the presence of radiofrequency noise that is expected to be present at the same level as the desired signal.[8/] A 1 dB adverse change, which represents a 25 percent increase in noise, is a sizable impact on such systems. Unlike typical wireless communications systems, which operate at high power relative to satellite signals and operate *above* the noise floor, wide bandwidth, spread spectrum GPS signals are *below* the thermal noise floor when they are received.[9/] Indeed, GPS satellites transmit with no more power than a 50-watt light bulb, and signals arrive on earth with a power of less than a millionth of a billionth of a watt.[10/] Therefore, GPS receivers are inherently vulnerable to high-powered transmissions in closely adjacent spectrum.

That is why, while GPS receivers are designed to withstand adjacent-band transmissions that are substantially stronger than GPS signals, they can be "overloaded" by high-powered mobile broadband transmissions in adjacent frequencies.[11/] Even lower power mobile telephone networks operating in adjacent spectrum will be a billion times stronger than a GPS signal when

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[7/] *Service Rules for Advanced Wireless Services H Block—Implementing Section 6401 of the Middle Class Tax Relief and Job Creation Act of 2012 Related to the 1915-1920 MHz and 1995-2000 MHz Bands*, Report and Order, 28 FCC Rcd 9483, ¶ 144 (2013). In that same decision, the FCC also referenced an Interference Protection Criteria Technical Report released by NTIA on the 1 dB standard, demonstrating that both the FCC and NTIA *have* relied on or utilized the 1 dB standard. *See id.* ¶ 144, n.440.

[8/] *See Technical Standards for Determining Eligibility for Satellite-Delivered Network Signals Pursuant to the Satellite Home Viewer Extension and Reauthorization Act*, Notice of Inquiry, 20 FCC Rcd 9349, ¶ 6 n.19 (2005); FCC White Paper, *The Public Safety Nationwide Interoperable Broadband Network: A New Model for Capacity, Performance and Cost*, at 15 & n.23 (June 2010), https://transition.fcc.gov/pshs/docs/releases/DOC-298799A1.pdf (noting that cellular networks are generally "interference limited rather than noise limited" and that noise-limited networks are "inherently more vulnerable to interference, including adjacent-channel interference, than commercial networks").

[9/] *See* GPSIA Dec. 2019 *Ex Parte* Letter at 2; Phillip W. Ward, John W. Betz, and Christopher J. Hegarty, UNDERSTANDING GPS PRINCIPLES AND PRACTICE 247 (Elliot D. Kaplan and Christopher J. Hegarty eds. Artech House, 2d ed. 2006).

[10/] *See* Comments of GPS Innovation Alliance, Docket No. 181130999-8999-01, at 4 (filed Jan. 22, 2019) ("GPSIA NTIA Spectrum Management Plan Comments"); *see also, e.g.*, Tim Bartlett, *Threats to GPS from Land-Based Signal Boosters*, POWER AND MOTORYACHT (Sept. 19, 2017), https://www.powerandmotoryacht.com/electronics/understanding-impact-threats-gps-land-based-signal-boosters ("GPS signals come from solar-powered 50-Watt transmitters 12,000 miles out in space."); Sebastian Anthony, *Think GPS is Cool? IPS Will Blow Your Mind*, EXTREMETECH (Apr. 24, 2012, 12:52 PM), http://www.extremetech.com/extreme/126843-think-gps-is-cool-ips-willblow-your-mind ("Detecting a GPS signal on Earth is comparable to detecting the light from a 25-watt bulb from 10,000 miles.").

[11/] *See* Letter from Russell H. Fox, Counsel for Trimble Navigation Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109 and 12-340, Attachment at 3 (filed June 19, 2015).

a GPS receiver is in close proximity (*e.g.*, 100 meters). Given the ubiquity of GPS devices in the United States, high-powered operations in adjacent spectrum are likely to seriously degrade and/or disrupt the operation of GPS devices on an ongoing basis. For these reasons, continued adherence to the 1 dB standard is critical.

The consequences of disruption to GPS receivers and the devices and systems in which they are embedded are also fundamentally different from the consequences of interference to communications devices. Mobile phone users can observe the results of interference in dropped calls or poor call quality. In contrast, the disruption or degradation to the accuracy and integrity of a GPS receiver is not readily detectable by the end user, producing an inaccurate readout of position or time, which can have untold consequences. The device or system will continue to operate with a degraded position or timing output, but will perform worse as a result.[12/] In extreme cases of interference, when a GPS receiver "loses lock" on available GPS satellites altogether, the user is left with no means of determining location until the interference is abated – another potentially catastrophic outcome when GPS is relied upon for critical life-saving services.

Wireless operators have technology and expertise to monitor operations and design their networks to minimize interference to wireless operators in adjacent spectrum. Wireless systems can also take advantage of adaptive power control, forward error correction, retry capability, and other systems that allow mobile devices and the network to dynamically adjust to reduce the impact of interference. It is therefore appropriate to adopt more permissive standards of what constitutes harmful interference protection for communications systems, as the FCC did when it adopted a 3 dB standard for the H Block.

Because interference to positioning, navigation, and timing ("PNT") services, as opposed to communication services, creates different kinds of risks, the Commission's rules, like those of the International Telecommunications Union, defines interference to each differently. In particular, the Commission's rules define harmful interference as that "***which endangers the functioning of a radionavigation service or of other safety services*** *or* [which] seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations."[13/] The *Ligado Order* mistakenly applies the Commission's own "seriously degrades, obstructs, or repeatedly interrupts" standard for *radiocommunications* to GPS – a radionavigation service. A 1 dB standard serves as the appropriate level to protect GPS receivers against severe impact to performance and guard against harmful interference. The international standard metric for protecting the functioning of a radionavigation service and

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12/ *See* GPSIA NTIA Spectrum Management Plan Comments at 7-8; Letter from M. Anne Swanson, Counsel to Garmin, to Ms. Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109 and 12-340, at Attachment 2 at 4-5 (filed Oct. 27, 2015).

13/ *See* 47 C.F.R. § 2.1(c); *see also* ITU Radio Regulations § 1.169; Reply to Opposition to Petition for Reconsideration of Trimble, IB Docket Nos. 11-109 and 12-340, at 5 (filed June 8, 2020) (explaining that the definition of harmful interference is also different for communications and navigation systems).

guarding against it from being endangered is the 1 dB standard,[14/] and it should have been employed in the *Ligado Order*.

The difference in standards is critical. The Commission's rules and ITU Radio Regulations are specifically written to ensure that a pilot, farmer, boat owner, or first responder is not required to demonstrate after the fact, once the harm has already occurred, that the operation of his or her GPS-dependent device has been "seriously degraded" or "repeatedly interrupted." The FCC should have determined whether Ligado's operations "endanger[] the functioning" of GPS devices, and the Commission's failure to do this was a fundamental error that requires correction.

Ligado's Spectrum Does Nothing to Advance U.S. Leadership in the Race to 5G

When asked if Ligado's spectrum is necessary to win the race to 5G, Chairman Pai responded by listing other bands to which the FCC faced resistance in the process of converting them to full mobile wireless use.[15/] He claimed that if the Commission had listened to all those objections, there would be no 5G spectrum. Chairman Pai seems to be suggesting that all objections to converting spectrum to 5G are equally invalid. His statements do not account for different spectrum band characteristics and, because of how they are used, their vulnerabilities to interference. The distinction between communications and navigation systems discussed above should have required a different evaluative approach alongside the laudable goal of pursuing 5G deployment.

Notably, Chairman Pai did not say that L-Band spectrum is necessary to win the race to 5G. Indeed, nothing about L-Band spectrum makes it even relevant – let alone critical – to winning the race to 5G. As Senator Duckworth correctly pointed out, until the *Ligado Order*, the FCC did not consider this spectrum to be 5G-suitable.[16/] And the 5G FAST Plan introduced by Chairman Pai includes no mention of the L-Band as being necessary or relevant to winning the 5G race or maintaining U.S. leadership on 5G.[17/]

That is not surprising. First, Ligado's spectrum is merely a sliver of spectrum. As compared to the large contiguous swaths of spectrum the FCC has made available to support 5G services,[18/] Ligado's network would operate only on spectrum blocks of 10 non-contiguous

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[14/] *See Background Paper on Use of a 1-dB Decrease in C/N_0 as GPS Interference Protection Criterion*, UNITED STATES AIR FORCE, at 2-4 (2017), https://www.gps.gov/spectrum/ABC/1dB-background-paper.pdf.

[15/] FCC Oversight Hearing (statement of Chairman Pai).

[16/] FCC Oversight Hearing (questions of Sen. Tammy Duckworth).

[17/] *See 5G FAST Plan*, FCC, https://www.fcc.gov/5G (aiming to free up another 2.75 gigahertz of spectrum in the 26 GHz and 42 GHz bands and over 800 megahertz of mid-band spectrum for 5G services, but making no mention of L-band spectrum).

[18/] *See, e.g.*, *C-Band Order* ¶¶ 3-4 (making 280 megahertz of spectrum in the 3.7-4.2 GHz band available); *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959, ¶ 1 (2015) (opening 150 megahertz in the 3550-3700 MHz band for commercial use); *Use of*

megahertz – well below what is needed for 5G. Second, Ligado's spectrum is not internationally harmonized. Neither Europe, China, or Japan, nor any other major country has identified the L-Band for 5G. As GSMA has emphasized, international harmonization is important to "make the best possible mobile services available for everyone and everything."[19/] Third, Ligado's proposed network would only be able to offer limited Internet of Things ("IoT") services. Specifically, Ligado proposes to provide an Industrial IoT service, primarily delivered over custom private networks to specific geographic areas for limited vehicular and utility operations. Not only is this *not* a 5G service offering, but similar services are already being provided by wireless service providers on an ancillary basis, often using the guard band of spectrum otherwise used for wireless broadband.[20/] Ligado's service is simply not a 5G service.

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The GPSIA thanks the Committee for its interest in this matter. Should you or other Committee members have any questions regarding the foregoing, please do not hesitate to contact me.

Sincerely,

David Grossman

J. David Grossman
Executive Director
GPS Innovation Alliance

Spectrum Bands Above 24 GHz For Mobile Radio Services, Fifth Report and Order, 34 FCC Rcd 2556, ¶ 1 (2019) (making "available millimeter wave (mmW) spectrum, at or above 24 GHz, for fifth-generation (5G) wireless, Internet of Things, and other advanced spectrum-based services").

19/ Luciana Camargos, *WRC-19 Strikes a Good Balance, Sets Stage for mmWave 5G*, GSMA (Nov. 25, 2019), https://www.gsma.com/spectrum/wrc-19-strikes-good-balance-sets-stage-for-mmwave-5g/#:~:text=Striking%20a%20balance%20between%20enabling,and%2040%20GHz%20for%20IMT.

20/ *See, e.g.*, *The first Nationwide Narrowband Network Designed for IoT Devices*, T-Mobile, https://www.t-mobile.com/business/coverage (last visited July 8, 2020) ("Our NB-IoT network operates on a dedicated guard band of existing networks, so it can efficiently carry data without competing against other network traffic."); Kendra Chamberlain, *Verizon Lights Up Nationwide NB-IoT Network*, FIERCEWIRELESS (May 14, 2019), https://www.fiercewireless.com/iot/verizon-lights-up-nb-iot-network-across-country; Sue Marek, *AT&T Will Launch Nationwide NB-IoT Network in 2019*, SDX CENTRAL (June 20, 2018), https://www.sdxcentral.com/articles/news/att-will-launch-nationwide-nb-iot-network-in-2019/2018/06/.