Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
LightSquared Request To Modify Its ATC Authorization	)	IB Docket No. 12-340
	)	
	)	IBFS File Nos. SAT-MOD-20120928-00160; SAT-MOD-20120928-00161; SAT-MOD-20101118-00239; SES-MOD-20121001-00872; SAT-AMD-20180531-00044; SAT-AMD-20180531-00045
	)	
LightSquared Technical Working Group Report	)	IB Docket No. 11-109
	)	

REPLY COMMENTS OF GARMIN INTERNATIONAL, INC.

Garmin International, Inc. ("Garmin") files these reply comments in response to Ligado Networks LLC's ("Ligado's") amended applications for modification of its Mobile Satellite Service ("MSS") licenses and the comments that Ligado has filed in support of the amended applications.[1] Garmin submits these comments to supplement the record. In processing the Modification Applications and Amendment, it is important that the FCC take these points into account. Garmin does not oppose or affirmatively endorse Ligado's amended application for modification of its MSS licenses.

[1] *See* Applications of LightSquared Subsidiary LLC, Narrative, IBFS File Nos. SAT-MOD-20151231-00090, SAT-MOD-20151231-00091, and SES-MOD-20151231-00981 ("Modification Applications"); Ligado Networks LLC Amendment License Modification Applications, IBFS File Nos. SAT-AMD-20180531-00044 and SAT-AMD-20180531-00045 ("Amendment"). *See also* FCC Public Notice, Report No. SAT-01321, released June 8, 2018; "Reply Comments of Ligado Networks LLC," IB Docket No. 11-109, SAT-AMD-20180531-00044, SAT-AMD-20180531-00045, July 19, 2018 ("Ligado's July 19 Comments"); "Comments of Ligado Networks LLC," IB Docket No. 11-109, SAT-AMD-20180531-00044, SAT-AMD-20180531-00045, July 9, 2018 ("Ligado's July 9 Comments"). (In these comments, Garmin uses the term "Ligado" to refer to Ligado's predecessor as well.)

I. THE 1 dB STANDARD REMAINS THE UNIVERSAL METRIC FOR ASSESSING HARMFUL INTERFERENCE TO GNSS DEVICES

Ligado's Reply comments imply that Garmin's testing of its new GPS receiver designs against the 1 dB Standard, which measures a 1 dB decrease in a GPS device's carrier-to-noise-density ratio ("C/N_0"), can also be stretched to suggest non-interference with the entire universe of GPS devices.[2] Ligado's comments in this regard are difficult to square with its contention that the Commission can ignore the 1 dB standard entirely.[3] Only Ligado can explain on which side it wants to stand. Garmin has difficulty reconciling Ligado's statements.

Ligado's July 9 Comments and Ligado's July 19 Comments once again overlook the critical differences between navigation and communication systems and the underlying engineering concepts that govern their operation. Not all current Garmin consumer devices are compatible with Ligado's possible operations, as Garmin's July 9, 2018 comments make clear when read in their full context. Consistent with its settlement agreement with Ligado, Garmin is working diligently to ensure future devices, those that are not subject to Federal Aviation Administration ("FAA") performance standards for certified aviation devices, meet the 1 dB Standard in the presence of Ligado interference.[4] In the same way, Ligado's statement that the

[2] Ligado's July 19 Comments at 2, 12.

[3] Ligado's July 19 Comments at 3. Contrary to Ligado's claim, Garmin's July 9 comments did not represent the first time that Garmin had told the Commission that it has tested Ligado's proposed operations using the 1 dB Standard. *See* Letter of M. Anne Swanson to Marlene H. Dortch, IB Docket Nos. 11-109, *et al.*, May 16, 2018, at 6 n. 16 ("Garmin's May 16, 2018 Filing").

[4] *See* Settlement Agreement and Releases, by and between Garmin International, Inc. and New LightSquared LLC and LightSquared Subsidiary LLC, at Paragraph 6(a) (dated Dec. 16, 2015) ("Settlement Agreement"), attached to Letter from Gerard J. Waldron to Marlene H. Dortch, IB Docket Nos. 12-340 *et al.* (filed Dec. 17, 2015). Similar to the contentions of Deere & Company (Comments of Deere & Company, IB Docket No. 11-109, July 9, 2018, at 6-8.) Garmin would like to repeat for the record that, as a result of its Settlement Agreement and as has been true in

1 dB Standard has never been used for adjacent band services overlooks the many filings from Garmin and others that offer evidence to the contrary.[5]

Ligado's latest attack on the 1 dB Standard "as neither measured nor reported according to an established standard"[6] ignores that it is a measure of the change in the noise-floor; it is not a measure of interference *per se*, but rather a tool to signal when interference occurs. Ligado's criticism that a GPS receiver's C/N_0 "fluctuates by multiple dBs in a 'natural state' – *i.e.*, even in the absence of *any* wireless signals in the proposed Ligado bands"[7] completely overlooks the necessity of planned system margin for variations in the real-world environment such as atmospheric changes and multipath. Finally, Ligado's latest claims that the 1 dB Standard itself is "inherent[ly] unreliab[le]," "inaccurately and inconsistently measured," "arbitrary," and "represents a flawed proxy for harmful interference because it does not translate to any predictable impact on *actual* device performance"[8] are belied by Ligado's own data from the NASCTN testing, which provide both direct and indirect support for the correlation between a 1 dB drop in C/N_0 and degradation of the key performance indicators that Ligado directed

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its filings throughout this record, Garmin does not speak for all GPS device manufacturers and speaks only for itself.

[5] Most recently, Garmin discussed and documented at length why the 1 dB Standard is the appropriate metric for evaluating harmful interference from adjacent band services, explaining that the metric successfully aggregates increases in the noise floor from out-of-band emissions alongside degradation from overload interference; it does so in a manner even more generous than some existing International Telecommunications Union recommendations cited in a recent analysis by the United States Air Force supporting the 1 dB Standard. Garmin's May 16, 2018 Ex Parte Filing at 3-4, *citing* Air Force, SMC/GP (GPS Directorate), Background Paper on Use of 1-dB decrease in C/N_0 as GPS Interference Protection Criterion, at 2, 6-9 (June 2017), available at http://www.gps.gov/ spectrum/ABC/1dB-background-paper.pdf.

[6] Ligado's July 19 Comments at 17.

[7] Ligado's July 19 Comments at 18.

[8] Ligado's July 19 Comments at 16-17.

NASCTN to measure.[9] All of these deficiencies again point to a lack of understanding of the distinctive engineering considerations that go into the design of navigation systems.

II. LIGADO'S REPLY COMMENTS DO NOT ADDRESS GARMIN'S CERTIFIED AVIATION CONCERNS

Ligado summarily dismisses Garmin's concerns about certified aviation devices with little technical rationale for its statements. In effect, Ligado simply asks the aviation industry, and passengers who expect and rely on safe air transportation, to trust it when it states, for instance, that "any real-world deployment of Ligado's operations would result in more favorable conditions than those assumed by FAA and DOT modeling."[10] If this statement is true, then Ligado should have no objection to specific FAA and DOT assumptions (including important parameters like minimum tower spacing and tower density, antenna height, downtilt, and polarization) being reflected as conditions upon its licenses.

The omission in Ligado's July 9 Comments and Ligado's July 19 Comments of any discussion of tower spacing, a key parameter in the DOT/FAA modeling, is particularly

[9] *See* Garmin's May 16, 2018 Ex Parte Filing at 4-5. Also, it is well understood in the industry that measuring changes in C/N_0 can be done both accurately and repeatedly; the results are consistent across a variety of GPS devices. DOT included C/N_0 linearity testing in its Adjacent Band Compatibility study and also repeated key test events in order to ensure the accuracy and repeatability of C/N_0 measurements against the 1 dB standard. *See* presentation of Hadi Wassaf, *et al.*, "GPS-ABC Radiated Chamber Testing Overview and Results" (GPS-ABC Workshop VI, RTCA Washington, DC: March 30, 2017) at pages 2 and 22. *See also* U.S. Dept't of Transportation, *Global Positioning System (GPS) Adjacent Band Compatibility Assessment*, (Apr. 2018) ("DOT ABC Report") at Sections 3.1.5.1 and 3.1.5.2.

[10] Ligado's July 19 Comments at 9. This claim by Ligado as well as the contentions in the declaration of James H. Williams, submitted with Ligado's July 9 Comments, cannot be taken at face value unless the key assumptions of the FAA and DOT analysis regarding minimum tower spacing, antenna height, downtilt, and polarization are incorporated in license conditions and adhered to by the deployed system.

egregious. Surely Ligado is aware of the vital importance of tower spacing in any aggregate power analysis – the omission can hardly be interpreted as accidental.[11]

Ligado is also unwavering in its efforts to selectively harvest points from the U.S. Department of Transportation Adjacent Band Capability Assessment and uses them wholly out of context. For example, the fact that Ligado claims that "DOT and FAA signed off on the 250-foot standoff cylinder" indicates that it may be working off of a different version of the report than the one publicly available, which lists numerous caveats and items for further study.[12] Similarly, it is ironic that Ligado reminds the Commission that helicopter pilots are required to plan their routes with 300-feet of vertical clearance – an impossible task without any publicly available database of Ligado antenna and tower information to which Garmin and other aviation parties have repeatedly asked Ligado to commit.[13]

Ligado's latest statement that it "remains willing to put this commercially sensitive information in a database that could be accessed by all stakeholders and to pay for the building

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[11] On the issue of antenna specifications, Ligado now argues that "any application of the FAA/DOT assessment model using the actual tower height and downtilt in a network would result in a *higher* permissible power level for Ligado's operations than is indicated by the models developed by the FAA." (Ligado's July 19 Comments at 10 (underlining supplied).) Garmin is at a loss to evaluate this conclusion without more information – and hopefully a commitment – regarding tower spacing or tower density. The references to "cross-polarization" in Ligado's accompanying Table 1 can only be taken as examples. Garmin cannot confirm Ligado's broad statement about "*higher* permissible power" since the record includes no commitment on antenna polarization, and a license condition should be required on this important parameter, as well as others.

[12] *Contrast* Ligado's July 19 Comments at 7 *with*, *e.g.*, DOT ABC Report, at VI, summarizing a litany of concerns regarding standoff cylinders.

[13] Ligado continues to cite 14 C.F.R § 135.165 and its requirement that pilots of helicopter air ambulance services ensure 300-foot and 500-foot clearances during day and night operations, respectively. (Ligado's July 19 Comments at 7.) That subpart of the FAA rules also requires that such operators be equipped with HTAWS, implying that the preflight route planning rules of 14 C.F.R § 135.615 are insufficient by themselves to ensure safety. *See* 14 C.F.R § 135.605.

and maintenance of this database …" is a positive first step; the database, however, does need to include all information concerning its deployment that is relevant to ensuring aviation safety and needs to do so in a way that all aviation parties, including pilots, UAS operators, certified aviation device manufacturers, and helicopter air ambulance operators, can access the data easily and seamlessly.[14]

With respect to concerns Garmin and others have raised about helicopter safety, and specifically the ability of the Helicopter Terrain Awareness and Warning System ("HTAWS") to function in the presence of Ligado interference, Ligado countered that "HTAWS is not intended to be used as an aid for navigation."[15] Garmin agrees with that flat statement *per se*. HTAWS is intended to save lives by providing terrain and obstacle alerts,[16] and has been doing so ever since it became available.[17] The Commission must recognize that pilots do not rely solely on GPS

[14] *See* Comments of Garmin International, Inc., IB Docket Nos. 11-109, *et al*, July 9, 2018, at 7-8 n. 20. Garmin's concerns are not allayed by Ligado's citations of FCC and FAA rules related to notices concerning towers. (*See* Ligado's July 19 Comments at 11.) These rules in some cases would require aviation parties, post-tower construction, to visit sites and track down antenna structure registration numbers and then look up information for each tower in the FCC's database before aviation concerns could be assessed. In other cases, the rules would only require notice if towers are over 200-feet in height (not complete reassurance) and may not require adequate notice around private (as opposed to public) airports.

[15] Ligado's July 19 Comments at 7.

[16] *See* RTCA, Inc., *Minimum Operational Performance Standards (MOPS) for Helicopter Terrain Awareness and Warning System (HTAWS) Airborne Equipment*, RTCA/DO-309, prepared by SC-212, Mar. 13, 2008, at § 1.4. Ligado's citation of the same document conveniently ignores the obstacle alerting functions when paraphrasing the intended functions of HTAWS.

[17] In adopting the rule requiring helicopter air ambulances to utilize HTAWS, the FAA noted statistics on the lives that use of HTAWS could save. See FAA, "Press Release-FAA Issues Final Rule To Rule to Improve Helicopter Safety," Feb. 20, 2014, available at https://www.faa.gov/ne-ws/press_releases/news_story.cfm?newsId=15795; s*ee also* FAA, Final Rule, "Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Operations," Docket No. FAA-2010-0982, 79 *Fed.Reg.* 9932 (Feb. 21, 2014).

navigation guidance near obstacles, but also rely upon additional technologies, such as HTAWS, which are intended to save the lives of pilots, passengers, and bystanders by providing timely alerts that help prevent controlled flight into terrain and other obstacles, such as communications towers. Certified aviation devices rely on GPS to provide position and velocity information to HTAWS, which in turn provides alerts to help pilots avoid obstacles. Degrading or interrupting GPS signals, even temporarily, can cause false HTAWS alerts or deny HTAWS' ability to provide any alerts.

Moreover, it does not make sense, when discussing whether and when HTAWS will be degraded, to assume that an aircraft is always going to be operated safely. HTAWS provides warnings when an aircraft is at an unsafe distance from terrain or obstacles. Contrary to Ligado's suggestion,[18] GPS also does not need to be "entirely unavailable" to negatively impact HTAWS. The horizontal and vertical position and velocity information obtained from the GPS signals must be sufficiently accurate to allow HTAWS to function. Thus, even temporary or partial degradation of GPS function due to interference from Ligado towers could render HTAWS, and its attendant safety benefits, inoperable.

Contending that interference to GPS "is likely to be temporary as [a] helicopter moves through the cylinder" overlooks the entire purpose of a safety-of-life system and unnecessarily puts lives in danger.[19] This "temporary" interference that is caused by proximity to a Ligado

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Some have advanced the notion that helicopter pilots must rely on visual awareness when navigating near obstacles (See Ligado's July 19 Comments at 6). However, this simplistic outlook fails to heed the painful lessons of aviation history and the FAA's analysis of the lives that could have been saved by the enhanced situational awareness based on the alerting that technologies like HTAWS provide.

[18] Ligado's July 19 Comments at 8.

[19] *Id*.

tower (that is, an obstacle that may endanger safe flight) would be an entirely unacceptable threat to public safety. Ligado's assertions that concerns about degraded HTAWS performance are unfounded because the aircraft would already be operating below the alerting altitude when inside the 250 foot cylinder are moot if the location of the cylinder is not known.[20] Without the inclusion of Ligado towers in a publicly available obstacle database, Garmin has concerns, as it does with certified avionics overall, about the ability of HTAWS to consistently provide alerts that allow pilots to avoid Ligado towers and their associated standoff cylinders in order to maintain GPS performance.

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Garmin respectfully requests that these comments be taken into account as the FCC reviews the Modification Applications and Amendment.

Respectfully submitted,

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[20] Ligado's July 19 Comments at 7.

DECLARATION

In accordance with 47 C.F.R. §§ 1.16 and 25.154, 1 declare under penalty that the facts included in the forgoing "Reply Comments of Garmin International, Inc." are true and correct.

By _____
John M. Foley

July 26, 2018

CERTIFICATE OF SERVICE

I, Alexandra Carr, hereby certify that on this July 26, 2018 a copy of the foregoing Reply Comments of Garmin International, Inc. was served by first-class mail, postage prepaid, upon the following:

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