Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Federal Communications Commission Invites Comment on LightSquared Request to Modify its ATC Authorization	)	IB Docket No. 12-340
	)	
International Bureau Invites Comment on NTIA Letter Regarding LightSquared Conditional Waiver	)	IB Docket No. 11-109
	)	
LightSquared Subsidiary LLC Request for Modification of its Ancillary Terrestrial Component Authority	)	File No. SAT-MOD-20120928-00160 File No. SAT-MOD-20120928-00161 File No. SAT-MOD-20101118-00239 File No. SES-MOD-20121001-00872
LightSquared Subsidiary LLC Petition for Rulemaking to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use	)	RM-11681
	)	
Comments Sought on LightSquared Subsidiary LLC *Ex Parte* Filing	)	WT Docket No. 12-327

COMMENTS OF THE GPS INNOVATION ALLIANCE

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TABLE OF CONTENTS

SUMMARY

The GPS Innovation Alliance ("GPSIA") herein strongly urges the Commission to refrain from ruling on LightSquared's various proposed modifications on the basis of the incomplete and flawed analyses submitted in LightSquared's July 15 *Ex Parte* filing on the potential interference impact of terrestrial wireless handsets operating in the 1626.5-1660.5 MHz band ("Uplink Bands"). At the outset, it should be clear that the GPSIA shares the desire to promote expanded wireless broadband. However, as the GPSIA has consistently stressed, in the process of evaluating spectrum proposals offered for the purpose of expanded broadband services, the Commission must not inadvertently jeopardize the reliable reception of GPS – a critical component to our nation's economy and infrastructure.

The GPSIA's primary concern with respect to the *Ex Parte* is the potential that LightSquared's proposed terrestrial handsets operating in the Uplink Bands (and other operations proposed by LightSquared) will cause harmful interference to GPS devices in virtually ubiquitous use across many sectors nationwide for critical positioning, navigation, timing, safety-of-life, public safety, industrial, government and consumer applications, which millions of users depend on today. The GPSIA submits that whether and to what extent the Commission should authorize LightSquared's plan to use the Uplink Bands as a part of its proposed terrestrial network should not be resolved on the basis of limited and flawed technical analyses as was submitted in the *Ex Parte*. Indeed, this *ad hoc* approach is precisely what has impeded LightSquared from providing its initially proposed service in the first instance. Instead, these issues should be considered in a broader spectrum planning process in the context of a transparent public notice-and-comment rulemaking proceeding in which established spectrum protection criteria and all relevant public policy issues can be considered to determine the

parameters in which the spectrum can be safely used. This path is entirely consistent with the Commission's recent approach in other Mobile Satellite Service operations at 2 GHz and in the Big LEO spectrum.

Nevertheless, if the Commission considers, out-of-sequence, the narrow issues presented by the *Ex Parte*, it should find it fundamentally flawed because it fails to account for or address previous technical studies and concerns, disregards the aggregate effects of LightSquared's proposed services, and relies on inapplicable metrics and faulty assumptions. Given the deficiencies in LightSquared's methodology and incorrect assumptions throughout its technical analysis, it should be clear that the potential impact of LightSquared's proposed terrestrial operations in any of the bands it proposes to use is better considered in the context of a rulemaking proceeding.

Finally, the Commission should recognize that the *Ex Parte*'s analysis regarding overload and out-of-band emissions specific to the aviation, general navigation and high precision use cases suffers from a number of fundamental technical defects that render the analysis simply inadequate to support a decision on its modification application. Those deficiencies include faulty assumptions about the appropriate parameters in each of the use cases and mistaken technical assessments, as described in further detail in the GPSIA comments.

For these reasons, the GPSIA urges the Commission to address all of the outstanding issues before it with regard to LightSquared's ability to protect GPS operations in any terrestrial system it proposes – including the Uplink Bands issues presented by the *Ex Parte* – through a rulemaking proceeding. In any case, the Commission should find that the analyses presented in the *Ex Parte* are fundamentally flawed and should be rejected.

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COMMENTS OF THE GPS INNOVATION ALLIANCE

The GPS Innovation Alliance ("GPSIA") hereby submits these comments in response to the Public Notice issued on August 7, 2013,[1/] seeking comment on an *ex parte* presentation made by LightSquared Subsidiary LLC ("LightSquared") in the above-referenced proceedings regarding the potential operation of terrestrial wireless handsets in the 1626.5-1660.5 MHz Mobile Satellite Service ("MSS") band.[2/] The *Ex Parte* purports to provide technical analyses of the potential interaction of LightSquared terrestrial wireless devices with Global Positioning System ("GPS") units used for general location/navigation ("GLN"), high precision, and aviation

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1/ *See Comments Sought on LightSquared Subsidiary LLC Ex Parte Filing*, Public Notice, DA 13-1717 (rel. Aug. 7, 2013) ("*Public Notice*").

2/ *See* "LightSquared Assessment of Uplinks in the 1626.5-1660.5 MHz Band," *attached to* Letter from John P. Janka, Latham & Watkins LLP, Counsel to LightSquared, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 11-109, *et al.* (filed July 15, 2013) ("*Ex Parte*").

services. As demonstrated below, LightSquared's technical analyses are flawed in a variety of ways and are insufficient to demonstrate that its proposed operations, even as modified in the above-referenced application, will not interfere with the operation of GPS receivers, as the Commission required in granting LightSquared a conditional waiver of its MSS service integration rules in January 2011.[3/] In light of this, the Commission cannot, on the present record, grant the application. Rather, given the serious concerns raised by government and private parties throughout the LightSquared proceedings, it is clear that the policy issues raised by ubiquitous terrestrial use of any of the L-Band spectrum covered by LightSquared's evolving requests are best considered in the context of a rulemaking proceeding.

I. INTRODUCTION AND BACKGROUND

The GPSIA was formed in February 2013 to protect, promote, and enhance the use of GPS and Global Navigation Satellite System technologies. Members and affiliates of the GPSIA

[3/] The *Ex Parte* only relates to the use of the 1626.5-1660.5 MHz band for handset operations. However, LightSquared's proposed operations involve more than that. LightSquared's ability to provide ubiquitous, non-integrated terrestrial service using the MSS L-Band remains prohibited by the January 2011 decision of the International Bureau. *See International Bureau Invites Comment on NTIA Letter Regarding LightSquared Conditional Waiver*, Public Notice, 27 FCC Rcd 1596 (2012) ("*Conditional Waiver Order*"). In that order, the Commission found that LightSquared's proposed business model, as set forth in its November, 2010 "update" filing, would violate the Commission's "integration" requirements for services using the MSS L-Bands. The *Conditional Waiver Order* waived these rules, conditioned on LightSquared's demonstration of non-interference to GPS. To date, LightSquared has failed to satisfy this condition for its earlier proposals, nor has LightSquared proposed to modify its operations to obviate the need for the waiver and the need to satisfy the non-interference condition. S*ee* Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Dep't of Commerce, to the Honorable Julius Genachowski, Chairman, FCC (Feb. 14, 2012) ("NTIA Letter"), *available at* http://www.ntia.doc.gov/files/ntia/publications/lightsquared_letter_to_chairman_genachowski_-_feb_14_2012.pdf; *International Bureau Invites Comment on NTIA Letter Regarding LightSquared Conditional Waiver*, Public Notice, 27 FCC Rcd 1596 (2012); Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, NTIA, U.S. Dep't of Commerce, to Julius Genachowski, Chairman, FCC, IBFS File No. SAT-MOD-20101118-00239, at 1 (filed Jan. 12, 2011) (explaining that "[s]everal Federal agencies with vital concerns about this spectrum band, including the Departments of Defense, Transportation and Homeland Security, have informed NTIA that they believe the FCC should defer action on the LightSquared waiver until these interference concerns are satisfactorily addressed"). The non-interference condition remains in effect for purposes of consideration of this application.

are drawn from a wide variety of fields and businesses reliant on GPS, including manufacturing, aviation, agriculture, construction, 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 use of automobiles, smart phones, and tablets.[4/] GPS is a highly innovative, successful, and increasingly ubiquitous technology that is critical to the smart infrastructure, services, and applications of today, tomorrow, and decades to come.

Nor is the use of GPS spectrum merely a matter of private interests or the interests of the "GPS industry." From its inception in the late 1970s, the GPS satellite constellation has been operated using spectrum expressly allocated domestically and internationally for the Radio Navigation Satellite Service ("RNSS"). Public investment in the constellation of GPS satellites created and maintained by the Department of Defense has totaled over $35 billion. The GPS constellation was originally intended primarily for military use, but was subsequently opened to full commercial use.

The critical nature of GPS has been recognized in no fewer than three presidential directives, adopted in both Republican and Democratic administrations.[5/] As such, federal government users are and have been the primary party-in-interest in preserving and enhancing the use of GPS. A remarkable variety of federal government departments and agencies use GPS to manage a wide array of critical government functions, from aviation safety and training our

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4/ A full list of members and affiliates can be found on the GPSIA's website at http://www.gpsalliance.org/about-us.aspx (last visited Sept. 5, 2013).

5/ *See* White House, National Security Decision Directive Number 102, U.S. Response to Soviet Destruction of KAL Airliner (Sep. 5, 1983), *available at* http://www.fas.org/irp/offdocs/nsdd/nsdd-102.htm; White House, National Security Decision Directive Number 6, U.S. Global Positioning System Policy (March 28, 1996), *available at* http://www.fas.org/spp/military/docops/national/gps.htm; White House, Presidential Policy Directive Number 4, National Space Policy of the United States of America (June 28, 2010), *available at* http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.

nation's troops, to tracking government assets purchased with taxpayer dollars, to climate analysis and early warning of storms and other natural disasters, to name just a few. Consideration of any proposal for the use of the MSS L-Band to support ubiquitous terrestrial broadband service, whether by base stations or handsets, requires thorough consideration of critical governmental interests, as highlighted by interference concerns affecting aviation which are set forth below.

The *Ex Parte* is a follow-up submission to several LightSquared filings over the last year, describing, in piece-parts, how LightSquared plans to proceed with a modified deployment of its terrestrial network. Prior to the *Ex Parte*, LightSquared had submitted an application for modification in which it proposed to permanently relinquish its authority to conduct terrestrial operations in the upper 10 megahertz of the L-Band at 1545-1555 MHz ("Upper L-Band"), unilaterally defer any terrestrial deployment on the lower 10 megahertz of the L-Band at 1526-1536 MHz ("Lower L-Band"), and relocate terrestrial downlink operations to the 1670-1680 MHz band,[6/] the reallocation of which is the subject of a separate LightSquared request.[7/] LightSquared would use the 1670-1680 MHz band with the 1627.5-1637 MHz and 1646.7-1656.7 MHz bands ("Uplink Bands"), for which it is currently authorized to provide terrestrial services, while the FCC considers the use of the Lower L-Band.[8/] The *Ex Parte* attempts to

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6/ *See* Modification Application of LightSquared Subsidiary LLC, IBFS File Nos. SAT-MOD-20120928-00160, SAT-MOD-20120928-00161, SES-MOD-20121001-00872, at Response to Question 43 at 2-3 (filed Sept. 28, 2012 and Oct. 1, 2012) ("Modification Application").

7/ LightSquared already has authority to use the 1670-1675 MHz band and has submitted a separate Petition for Rulemaking requesting that the Commission amend the U.S. Table of Allocations to add a primary allocation permitting non-Federal terrestrial mobile use of the 1675-1680 MHz band (and presumably license it to LightSquared). *See* Petition for Rulemaking of LightSquared Subsidiary LLC, RM-11681, at 1 (filed Nov. 2, 2012); *Consumer & Governmental Affairs Bureau Reference Information Center Petition for Rulemaking Filed*, Public Notice, Report No. 2967 (rel. Nov. 9, 2012).

8/ *See* Modification Application at Response to Question 43 at 4.

validate the application for modification by demonstrating that the Uplink Bands may be used by terrestrial wireless handsets without causing harmful interference to GPS devices.[9/]

The GPSIA recognizes that spectrum is a scarce resource[10/] and has no desire to unnecessarily impede the further deployment of spectrum for wireless broadband. However, as the GPSIA as well as government users have also stressed, in making more spectrum available for mobile broadband services, the Commission must not inadvertently jeopardize the reliable reception of GPS – a critical component to our nation's economy and infrastructure – and must ensure that any unresolved concerns regarding interference to GPS are fully resolved before there are any changes to the permitted use of that spectrum.[11/] This should be done in the context of a broader, long-term spectrum planning process to the greatest extent possible.[12/]

Accordingly, the Commission must not consider the *Ex Parte* in a vacuum. If it concludes that it is time to re-evaluate the purposes for which spectrum was initially licensed, it should do so in a rulemaking proceeding, as it has done with 2 GHz MSS spectrum (2000-2020 MHz and 2180-2200 MHz), now known as AWS-4 spectrum, and as it has been asked to do with

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9/ *See Public Notice* at 1.

10/ *See* Comments of the GPS Innovation Alliance, ET Docket No. 13-101, at 2 (filed July 22, 2013).

11/ *See, e.g.*, *id.*; Comments of the Coalition to Save Our GPS, IB Docket No. 12-340, *et al.*, at 3-4 (filed Dec. 17, 2012) ("Coalition Modification Comments"); Reply Comments of the Coalition to Save Our GPS, IB Docket No. 11-109, IBFS File No. SAT-MOD-20101118-00239, ET Docket No. 10-142, at 46-49, 65 (filed Mar. 30, 2012); Reply Comments of the Coalition to Save Our GPS, WT Docket No. 11-186, at 11 (filed Dec. 20, 2011)p; Comments of the Coalition to Save Our GPS, IB Docket No. 11-109, IBFS File No. SAT-MOD-20101118-00239, at 3-7 (filed Aug. 1, 2011) ("Coalition TWG Comments").

12/ *See, e.g.*, Coalition Modification Comments at 5 ("The Coalition does not object to the FCC initiating a proceeding to more fully examine whether it is feasible to use the Lower L-Band and the Uplink Bands for wireless terrestrial services; indeed, a rulemaking proceeding is required to authorize a fundamentally different use of the bands than currently permitted."); Comments of the Coalition to Save Our GPS, IB Docket No. 11-109, *et al.*, at iii (filed March 16, 2012) ("The FCC must act to prevent any potential interference with [critical government GPS-based] systems, and to carefully plan to address any such interference proactively in connection with the consideration of future changes to the use of the L-Band.").

Big LEO MSS spectrum (2483.5-2500 MHz and 1610-1618.725 MHz).[13/] Nevertheless, if the Commission considers, out-of-sequence, the narrow issues presented by the *Ex Parte*, it should find it flawed because it fails to account for or address previous technical studies and concerns, disregards the aggregate effects of LightSquared's proposed services, and improperly relies on inapplicable metrics and faulty assumptions. Finally, the Commission should recognize that the *Ex Parte*'s specific aviation, GLN, and high precision use cases suffer from a number of technical defects and as a result, significantly understate the potential for interference. The GPSIA looks forward to continuing to work with all relevant stakeholders on these important matters.

II. THE APPLICATION FOR MODIFICATION IS NOT THE APPROPRIATE VEHICLE TO ADDRESS WHETHER THE UPLINK BANDS CAN BE USED FOR HANDSET OPERATIONS

Whether the Uplink Bands can be used for handsets in a ubiquitous terrestrial network cannot be resolved in the context of LightSquared's application for modification based on the limited and flawed technical analysis presented in the *Ex Parte*. Indeed, this *ad hoc* approach is precisely what has impeded LightSquared from providing its proposed service in the first instance. As the Commission is well aware, it was LightSquared's 2010 "update" to its business plan that the International Bureau found required a waiver of its rules conditioned on LightSquared demonstrating that it would not interfere with GPS, and which ultimately led the International Bureau to tentatively conclude that LightSquared could not provide its

[13/] *See Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands, et al.*, Report and Order and Order of Proposed Modification, 27 FCC Rcd 16102 (2012) ("*AWS-4 Order*"); *Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands, et al.*, Notice of Proposed Rulemaking and Notice of Inquiry, 27 FCC Rcd 2561 (2012) ("*AWS-4 NPRM*"); Petition for Rulemaking of Globalstar, Inc., RM-11685 (filed Nov. 13, 2012) ("Globalstar Petition"); *Consumer & Governmental Affairs Bureau Reference Information Center Petition for Rulemaking Filed*, Public Notice, Report No. 2971 (rel. Nov. 30, 2012) ("*Public Notice on Globalstar Petition*").

contemplated service because it could not make the required demonstration. That initial proposal and LightSquared's subsequent various and changing proposals have failed to provide a comprehensive approach to alternative use of MSS L-Band spectrum which avoids potential interference to GPS, and its most recent Uplink Bands proposal is no different.

Instead, if the Commission wishes to evaluate the use of any of the spectrum identified by LightSquared's various proposals for ubiquitous terrestrial operations, it should do so in a rulemaking proceeding, which will allow it, using established RNSS spectrum protection criteria, to consider all relevant public policy issues and establish the parameters under which the spectrum can be safely used.[14/] A rulemaking proceeding would create an inclusive and transparent public forum, allowing interested parties to determine the fundamental question of whether use of the affected spectrum is technically feasible as well as the appropriate parameters necessary for protecting GPS devices. It would also produce a better developed record than one based on any particular entity's preferred approach. Use of spectrum based on a particular entity's proposal may unnecessarily hamstring future licensees of that spectrum; a rulemaking proceeding, in contrast, would ensure that the rules apply generally to the spectrum, not the licensee. It is important that the Commission's rules create certainty for LightSquared, any future licensees of the spectrum, and the GPS community.

A rulemaking proceeding is also consistent with the Commission's recent approach to re-evaluating the use of MSS bands. For instance, the Commission utilized a rulemaking proceeding to repurpose the former 2 GHz MSS spectrum for terrestrial services. In that

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[14/] The Commission recently affirmed the essential nature of notice-and-comment rulemaking when considering proposals that involve significant changes in spectrum use through the waiver process. *See Waiver Requests by Clarity Media Systems, LLC, to Operate CARS Stations at Flying J Travel Plazas*, Order, DA 07-1946, FCC 13-90, ¶ 14 (rel. July 2, 2013). The Commission emphasized, "[t]his sort of fundamental change is the province of rulemaking." *Id.* These same principles apply here.

proceeding, the Commission noted that it is important "[t]o create a solid and lasting foundation for the provision of terrestrial services in this spectrum"[15/] and "to provide a stable regulatory environment in which broadband deployment could develop."[16/] The Commission appears to be taking the same path with respect to the Big LEO band in which Globalstar, Inc., one of the MSS licensees for the spectrum, proposes that the FCC initiate a rulemaking proceeding that would allow it to use the upper portion of the band (along with unlicensed spectrum at 2473-2483.5 MHz) to provide a terrestrial low power service ("TLPS"), while the FCC investigates the technical issues involved in using the lower Big LEO band for TLPS.[17/]

The Commission must recognize that it is not writing on a blank slate; it must also take into consideration 20 years of international consensus on these matters, which LightSquared's modification application fails to address. For example, contrary to LightSquared's approach, the International Telecommunications Union has not used probabilistic methods – as LightSquared does – for interference analyses, but rather "RNSS protection criteria" that consider "worst case" scenarios.[18/] As noted above, the International Bureau tentatively concluded that LightSquared may not provide its proposed service because of the expected interference to GPS. This analysis, which requires the use of known, internationally established, RNSS protection criteria, should be the continued yardstick for repurposing spectrum adjacent to the GPS service. If the FCC were to assess the *Ex Parte* and modification application as LightSquared suggests and adopt the proposed approach to interference analysis, the agency would set a dangerous precedent for

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15/ *AWS-4 Order* ¶ 2.

16/ *AWS-4 NPRM* ¶ 1.

17/ *See generally* Globalstar Petition; *Public Notice on Globalstar Petition.*

18/ *See* International Telecommunication Union, *Recommendation ITU-R M.1903: Characteristics and Protection Criteria for Receiving Earth Stations in the RNSS (Space-to-Earth) and Receivers in the ARNS Operating in the Band 1559-1610 MHz* (Jan. 2012), *available at* http://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1903-0-201201-I!!PDF-E.pdf.

others who would propose their own favored approach in lieu of established international and domestic standards. The Commission must reject such an outcome.

III. LIGHTSQUARED'S OVERALL ANALYSIS IS FLAWED

Regardless of whether it considers the issues in the *Ex Parte* on a standalone basis as LightSquared requests or, as the GPSIA recommends, as part of a comprehensive approach to alternative use of the MSS L-Band, the Commission must take cognizance of the limitations and flaws of the *Ex Parte*'s analyses, and conclude that it lacks a sufficient basis to allow LightSquared to proceed based on the information provided to date.

First, the *Ex Parte* fails to account for concerns presented by federal agencies in previous studies related to different types of GPS equipment. Both the National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum ("NPEF") and the National Telecommunications and Information Administration ("NTIA") have raised serious questions about the effects of LightSquared's proposed use of the Uplink Bands. As NPEF has reported, "[t]est data show some GPS receivers were susceptible to receiving interference from LightSquared handset transmissions in the 1627.5-1656.7 MHz band."[19/] NTIA has likewise noted that "some personal/general navigation receivers were susceptible to LightSquared handset signals in the 1627.5-1656.7 MHz band" and suggested that "additional analysis is necessary to assess the impact of handsets on personal/general navigation receivers."[20/] With respect to GPS used in aviation, while the *Ex Parte* attempts to address the impact of handset emissions on some

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19/ National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum, *Follow-on Assessment of LightSquared Ancillary Terrestrial Component Effects on GPS Receivers*, at iv (Jan. 6, 2012) ("NPEF Report"), *available at* http://www.ntia.doc.gov/files/ntia/publications/npef_lsq_follow-on_test_report_final_public_release.pdf.

20/ NTIA Letter at 5 n.26.

low-altitude aviation operations,[21/] it does nothing to allay the breadth of these and other concerns.

Second, the *Ex Parte* fails to consider the aggregate effects of LightSquared's operations – whether base station or handsets – on GPS operations. For instance, as the Federal Aviation Administration ("FAA") noted in a January 2012 report, an interference analysis of the impact on aviation devices from LightSquared's proposed network must consider the aggregate effects of both overload and out-of-band emissions ("OOBE") from all of LightSquared's planned operations in the uplink and downlink bands.[22/] Although LightSquared relies on independent Minimum Operational Performance Standard limits for OOBE and overload to aviation devices, it never considers the aggregate effects across all of its operations.[23/] For GLN devices, LightSquared similarly analyzes overload and OOBE independently for a single handset band;[24/] if it had combined them, its analysis would have shown harmful interference.[25/] Further, for high precision devices, LightSquared analyzes OOBE and overload independently, but never considers the aggregate case.[26/]

Third, the *Ex Parte* selectively uses parts of the interference analysis employed by the Commerce Spectrum Management Advisory Committee ("CSMAC") working group, while

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21/ *See Ex Parte* at 13-16.

22/ *See* U.S. Dep't of Transportation, FAA, *Status Report: Assessment of Compatibility of Planned LightSquared Ancillary Terrestrial Component Transmissions in the 1526-1536 MHz Band with Certified Aviation GPS Receivers*, at 71(Jan. 25, 2012), *available at* http://www.ntia.doc.gov/files/ntia/publications/faa_report_public_release_25_jan_2012_final.pdf (noting that among the issues that are unresolved are the "impacts of LightSquared handset use on the aggregate interference environment").

23/ *See infra.* GPSIA has also attached as Appendices A and B summaries of the flaws of LightSquared's analyses of the aviation and general navigation use cases.

24/ *See Ex Parte* at 2-11.

25/ *See infra.*

26/ *See Ex Parte* at 11-13.

ignoring critical elements and the overall import of the report. The CSMAC working group was tasked with developing recommendations for use of the 1695-1710 MHz band for commercial services while protecting federal meteorological earth stations from harmful interference.[27/] The CSMAC report provides initial recommendations for protecting sensitive satellite-to-earth receivers from in-band terrestrial transmissions. CSMAC's analysis used an interference-to-noise ratio of -10 dB, corresponding to a 0.4 dB increase in the receiver noise floor, to establish the interference protection criteria for the meteorological-satellite receivers.[28/] While LightSquared purports to rely on the CSMAC approach, it selectively continues to challenge the validity of a 1 dB harmful interference threshold, and ignores the 0.4 dB threshold which CSMAC used in its protection analysis.[29/]

Putting aside LightSquared's failure to use the CSMAC interference-to-noise ratio, the methodology used in the CSMAC report is not applicable here. As an initial matter, the CSMAC analysis is concerned with a small number of fixed, ground-based receivers.[30/] Different assumptions are required for analyzing ubiquitous GPS receivers,[31/] particularly aviation receivers, which are moving and constantly changing in their geometry with respect to LTE

27/ *See* Commerce Spectrum Management Advisory Committee, *Final Report, Working Group 1 – 1695-1710 MHz Meteorological-Satellite* (Jan. 22, 2013) ("CSMAC Report"), *available at* http://www.ntia.doc.gov/files/ntia/publications/wg-1_report_v2.pdf.

28/ *See id.* at Appendix 7-9.

29/ *See, e.g., Ex Parte* at 7.

30/ The CSMAC report was initially focused on 18 sites, but CSMAC later identified additional sites requiring protection, bringing the total to 27 sites. *See* CSMAC Report at 4, n.4; Commerce Spectrum Management Advisory Committee, *CSMAC Working Group 1 (WG-1) Report*, at 3 (June 18, 2013), *available at* http://www.ntia.doc.gov/files/ntia/publications/csmac_wg-1_report_for-june_18_2013_final.pdf.

31/ Over 500 million GPS receivers are in use in the United States alone. *See* Coalition TWG Comments at 12, 42; *see also* Ludovic Privat, *10 Million GPS Cameras Sold Next Year*, GPS BUSINESS NEWS (Nov. 19, 2012), *available at* http://www.gpsbusinessnews.com/10-Million-GPS-Cameras-Sold-Next-Year_a3952.html (reporting that "there will be 10 Million digital cameras sold next year that embed a GPS chipset"); *Dramatic Increase in GPS Tracker Sales*, ROCKY MOUNTAIN TRACKING (Jan. 27, 2012), *available at* http://www.rmtracking.com/blog/2012/01/27/dramatic-increase-in-gps-tracker-sales/.

transmitters. In addition, CSMAC's methodology sought to define protection zones around the ground stations it was trying to protect.[32/] Large numbers of GPS devices cannot realistically be safeguarded using a protection zone methodology, and frequency coordination would be impractical.[33/]

Further, the CSMAC report uses a Monte Carlo analysis with random seeding of interfering handsets in relation to the victim receiver.[34/] Using this method of analysis, CSMAC developed a cumulative distribution function ("CDF") showing the percentage of locations where interference *will statistically occur* whenever an LTE transmitter is active.[35/] By working from the 90th percentile point of the CSMAC CDF curve in its analysis, LightSquared effectively invites interference with GPS receivers in 10 percent of all locations. GPS devices cannot cede 10 percent of areas (suburban and rural based on the particular LightSquared GLN analysis) where interference will occur. GPS users expect their devices to function all the time and in all locations. Indeed, as noted below, for many safety and health applications, like those used in the aviation setting, it is critical that GPS devices operate all the time.[36/] Finally, CSMAC acknowledges that its analysis is untested and will require validation through field-

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32/ CSMAC sought to define protection zones around the ground stations where LTE operation was not allowed and to permit limited operation within protection zones predicated on an effective frequency coordination process. *See* CSMAC Report at 2 ("The framework is conditioned on Protection Zones that will be based on the NTIA interference analysis and protection criteria . . . .").

33/ The CSMAC sharing recommendations are predicated on real-time spectrum monitoring within and near protection zones to ensure that interference limits are not exceeded, but such real-time monitoring is not practical for GPS receivers.

34/ *See* CSMAC Report at 4.

35/ *See id.*

36/ *See infra* Section IV.

testing prior to any FCC rulemaking proceeding,[37/] further confirming that it is inappropriate to apply CSMAC's methodology to LightSquared's network.

Fourth, LightSquared inappropriately reduces OOBE power levels throughout its analyses by relying on several faulty assumptions. LightSquared incorrectly assumes that it can probabilistically reduce OOBE proportionally with in-band radiated power.[38/] OOBE generated from a LightSquared handset into the 1559-1610 MHz band, however, may be spurious in nature and, as a result, unrelated and independent from a handset's intentionally radiated emissions. In fact, a device may generate parasitic RF spurs (*i.e.*, power confined to a narrow frequency range that can occur periodically at frequencies greatly removed from the transmit band) with static, consistent EIRP levels, regardless of adjustments to in-band radiated power.[39/] Given that OOBE and in-band radiated power may be independent of each other, any analysis that adjusts OOBE downward in lockstep with reductions to in-band radiated power is inherently flawed, and may grossly underestimate the effect of OOBE in the 1559-1610 MHz band.

In extrapolating its own conclusions from the CSMAC report, LightSquared also incorrectly underestimates OOBE by introducing transmit power coupling loss and transmit antenna impairments caused by nearby obstructions. For example, LightSquared assumes 3 dB of transmit power coupling loss when modeling the interference effect created by a simulated interfering signal on aviation receivers.[40/] However, given that OOBE is a radiated EIRP

[37/] *See* CSMAC Report at 4.

[38/] *See, e.g.*, *Ex Parte* at 17, Table 6 (explaining that LightSquared's calculations with respect to aviation receivers had utilized a "dB-for-dB reduction of OOBE PSD with fundamental Tx power").

[39/] The limits on OOBE which LightSquared reaffirmed for its handsets on August 7 do not in any way correspond or connect with the in-band radiated power levels proposed for LightSquared handsets. *See* Letter from Jeffrey Carlisle, LightSquared Executive Vice President, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 11-109, *et al.* (filed Aug. 7, 2013) ("OOBE *Ex Parte*").

[40/] *See, e.g.*, *Ex Parte* at 15, Table 5.

specification, any internal losses that attenuate the OOBE are already taken into consideration. By introducing an additional 3 dB of transmit power coupling loss into its calculations LightSquared is effectively adding 3 dB of attenuation that does not exist. The introduction of this additional, non-existent attenuation results in a marked underestimation of handset OOBE throughout LightSquared's analysis.

These incorrect assumptions lead to over-optimistic generalizations regarding OOBE interference. In particular, these assumptions minimize the potential for OOBE interference in urban scenarios while neglecting rural cases. In reality, with respect to OOBE, there is no meaningful distinction in urban and rural scenarios.

Given the deficiencies in LightSquared's methodology and incorrect assumptions with respect to OOBE, further analysis using proper methodology and assumptions is required to properly determine the effect OOBE alone or in combination with other signals will have on GPS receivers. The appropriate forum for the Commission and stakeholders to evaluate the impact of OOBE from any of the bands LightSquared proposes to use, including the Uplink Bands and any spectrum designated for base station operations, is a notice-and-comment rulemaking proceeding. Neither the Commission nor the public should be asked to shortcut the rulemaking process with respect to this important matter.

IV. LIGHTSQUARED'S ANALYSIS OF THE AVIATION USE CASE IS FLAWED

In addition to the defects in the *Ex Parte*'s overall analysis, LightSquared's consideration of the impact that its use of the Uplink Bands would have on aviation devices has significant flaws as well. The GPSIA has serious concerns with LightSquared's uplink analysis with respect to both overload and OOBE issues related to aviation devices.

In support of its assertions, LightSquared provides analyses for three particular aviation use cases: (i) passengers using LightSquared handsets on an aircraft; (ii) numerous

LightSquared handsets operating near an aircraft parked at the gate; and (iii) a single user at the top of the stairs used to enter an aircraft from the tarmac.[41/] Unlike an original use case, which was thoroughly studied by RTCA, Inc. ("RTCA"), analyzing the potential impact of LightSquared devices operating at ground level on an aircraft in flight overhead,[42/] these use cases include assumptions that have not been subjected to review and comment by the aviation community, including regulators.

Further, LightSquared incorrectly applies a number of CSMAC assumptions to the various aviation scenarios. For instance, LightSquared's analysis assumes a maximum uplink EIRP of 20 dBm, with a 9.5 dB backoff power reduction due to uplink power control, which is the 95th percentile value of the CSMAC CDF curve for suburban environments.[43/] For aviation applications, however, the FAA typically analyzes failure conditions using a flight-hour measurement, and GPS malfunctions are typically associated with "major" or "hazardous" failure conditions; failure conditions must occur at rates less than 10^{-5}/hour (one failure per one hundred thousand flight hours) for major failures and 10^{-7}/hour (one failure per ten million flight hours) for hazardous failures.[44/] Assumptions based on a 95th percentile level are therefore inconsistent with industry standards and inappropriate under these circumstances. The 95th percentile, which was arbitrarily chosen by LightSquared, is too generous for an aviation safety

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41/ *See id.* at 13-19.

42/ *See* RTCA, Inc., *Assessment of the LightSquared Ancillary Terrestrial Component Radio Frequency Interference Impact on GNSS L Band Airborne Receiver Operations*, IBFS File No. SAT-MOD-20101118-00239 (filed June 7, 2011).

43/ *See Ex Parte* at 16-18.

44/ *See* RTCA, Inc., *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment*, Document No. DO-229D, at 41, 60 (Dec. 13, 2006) (demonstrating GPS failure condition classifications); U.S. Dep't of Transportation, FAA, *Advisory Circular*, AC No. 23-1309E, at 23 (Nov. 17, 2011), *available at* http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/719e41e1d26099108625795d005d5302/$FILE/23.1309-1E.pdf (mapping failure conditions to per flight hour probability).

analysis, particularly given the operational and safety implications of GPS interference for aviation, thus rendering LightSquared's handset analysis ineffectual.

LightSquared's analysis of passengers using handsets is also inappropriate. *First*, LightSquared asserts that, utilizing path loss measurements published by the National Aeronautics and Space Administration ("NASA") and referenced by RTCA, interference from LightSquared handsets operating on board an aircraft, even in extreme use cases, will not exceed the FAA's specified limits.[45/] The NASA study itself, however, recognizes that its interference path loss measurements are limited and that they have not been conducted for a significant number of aircraft types.[46/] Moreover, LightSquared uses a set of measurements made on a Boeing 737-200, which generally has a higher path loss than would be found in smaller aircraft like regional jets, producing misleading results.[47/] Indeed, the NASA study includes measurements from a Canadair regional jet that showed more than 20 dB *less* path loss than measured in the case of a Boeing 737-200, meaning that many more aircraft would experience interference from LightSquared handsets than LightSquared predicts.[48/]

45/ *See Ex Parte* at 14-15, Appendix 3 at 1.

46/ *See* NASA, *Portable Wireless LAN Device and Two-Way Radio Threat Assessment for Aircraft Navigation Radios*, NASA/TP-2003-212438, at xii (2003) ("NASA/TP-2003-212438"), *available at* http://ia700606.us.archive.org/5/items/nasa_techdoc_20030067884/20030067884.pdf (recommending that it "conduct additional [interference path loss] measurements on different types of aircraft where minimal data currently exists"); *see also* T. X. Nguyen, *et al.*, NASA Langley Research Center, *Wireless Phone Threat Assessment and New Wireless Technology Concerns for Aircraft Navigation Radios*, NASA/TP-2003-212446, at vii (July 2003) ("NASA/TP-2003-212446"), *available at* http://ia700604.us.archive.org/26/items/nasa_techdoc_20050204034/20050204034.pdf ("Available aircraft [interference path loss ("IPL")] data are insufficient for estimating the minimum possible IPL in US airline passenger airplane fleets."); NASA, *Portable Wireless LAN Device and Two-Way Radio Threat Assessment for Aircraft VHF Communication Radio Band*, NASA/TM-2004-213010 (March 2004), *available at* http://www.cs.odu.edu/~mln/ltrs-pdfs/NASA-2004-tm213010.pdf.

47/ *See* NASA/TP-2003-212446 at 35 ("Larger aircraft generally have higher [interference path loss]*.*").

48/ *See* NASA/TP-2003-212438 at 102.

Second, LightSquared notes that, in addition to using path loss values from NASA, it utilized "a fixed Tx/Rx antenna coupling loss of 3 dB."[49/] Such an approach, however, improperly minimizes the potential effects of its operations. In effect, LightSquared has "double counted" the antenna effects because it took a 3 dB credit for the coupling loss between the receive and transmit antennas that was already included in the NASA path loss measurements.[50/]

Third, LightSquared presents an alternate scenario that purports to show seven users "randomly" scattered around the cabin.[51/] However, this "random" distribution uses an "average path loss" figure of 74.0 dB.[52/] As LightSquared's own analysis demonstrates, aggregating seven users with this power level results in a lower total interference power than might be expected from a single user operating in a window seat in the first few rows of an aircraft, likely because of the proximity of the first few rows to the aircraft's GPS antenna.[53/] This type of random analysis, which understates the interference potential from handsets actually used near GPS devices, is not appropriate for use cases that raise safety-of-life concerns.

In its analyses of handset users near an aircraft parked at the gate or a single user boarding an aircraft at the top of an aircraft's stairs, LightSquared makes several assumptions about GPS receive antenna loss that do not apply to all or even most aircraft types or airport gate configurations.[54/] For instance, when estimating GPS receive antenna coupling loss between the horizon and 45 degrees of elevation, LightSquared employs antenna pattern measurements from

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49/ *Ex Parte* at 14-15.

50/ *See* NASA/TP-2003-212438 at 77.

51/ *See Ex Parte* at Appendix 3 at 1-2, 3.

52/ *See id.* at Appendix 3 at 3.

53/ *Compare id. with id.* at Appendix 3 at 4-5.

54/ *See id.* at 15-19.

RTCA that were used to validate a model of GPS receiver antenna gain below the horizon.[55/] This estimate is less conservative and more favorable to LightSquared than the model actually employed in the RTCA analyses, which is based on published performance standards for GPS receive antennas.[56/] Additionally, as noted above, LightSquared uses a User Equipment ("UE") transmit power backoff associated with a 95 percent value from the suburban CDF curve, which was explicitly rejected in the RTCA analysis of OOBE interference.[57/] These assumptions have not been endorsed by aviation regulatory authorities and aviation parties with appropriate operational experience. Such deviations must be considered in an appropriate forum and reviewed and approved by industry experts. It is inappropriate for such deviations in assumptions to be unilaterally posited by LightSquared – a party driven first by concerns over its own commercial success, rather than aviation safety.

Notwithstanding these incorrect assumptions, LightSquared claims that GPS devices should be able to tolerate its emissions since they have not experienced problems with "much higher PCS emissions."[58/] This is a flawed comparison. Even though PCS handsets are subject to a less stringent OOBE limit than LightSquared is proposing, their operating frequency is greatly removed from the GPS band. The primary cause of OOBE from PCS handsets occurring in the GPS band is from narrowband spurs, which, as noted earlier, can occur periodically at frequencies greatly removed from the transmit band. Prudent design practice and the distance

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55/ *See id.* at Appendix 5 at 5.

56/ *See* RTCA, Inc., *Assessment of Radio Frequency Interference Relevant to the GNSS L1 Frequency Band*, Document No. DO-235B, at Appendix G at G-12 (March 13, 2008); *id.* at 17-18; RTCA, Inc., *Aeronautical Spectrum Planning for 1997 - 2010*, Document No. DO-237, at 6-7 (Jan. 27, 1997).

57/ *See* RTCA, Inc., *Assessment of the LightSquared Ancillary Terrestrial Component Radio Frequency Interference Impact on GNSS L1 Band Airborne Receiver Operations*, Document No. DO-327, at 14 (June 3, 2011).

58/ *Ex Parte* at 18.

between PCS and GPS operations make the likelihood of OOBE from PCS handsets occurring in the GPS band unlikely (but not impossible). LightSquared's handsets, in contrast, would operate immediately adjacent to the GPS band, and their OOBE (occurring within the GPS band) would present broadband noise above the OOBE limit that cannot be suppressed further by handset transmit filters.

V. LIGHTSQUARED'S ANALYSIS IN THE USE CASE FOR GENERAL NAVIGATION DEVICES IS FLAWED

LightSquared's analysis on the impact of its handset operations on GLN devices also suffers from technical shortcomings. Like the aviation use cases and as noted above, there are both overload and OOBE issues with the LightSquared analysis of GLN devices. One fundamental flaw is that LightSquared bases its entire GLN analysis on the assumption of a suburban use case included in the CSMAC data. It notes that the "CSMAC simulations conclude that UE power will be less than 8 dBm in suburban environments in 90% of cases, which is the value used in the present analysis."[59/] Using this assumption, and adding 3 dB of handset antenna gain, LightSquared notes that "[its] devices were modeled as having a [power amplifier] that could operate at a maximum EIRP of 23 dBm, with a 90th percentile value of 11 dBm in urban and suburban environments and 19.6 dBm in rural environments."[60/] LightSquared proceeds to ignore the rural use case throughout the remainder of its GLN analysis, opting instead to use the more lenient and favorable to LightSquared suburban use case. However, GLN devices do not only operate in suburban environments. To the contrary, vast numbers of GLN devices are used in rural areas for public safety, marine and auto navigation, outdoor activities, and numerous other purposes, and the analysis fails to take any such uses into account.

59/ *Id.* at Appendix 1 at 22.

60/ *Id.* at 3, Appendix 1 at 24.

Even accepting every assumption LightSquared makes in its analysis (which GPS parties do not), ignoring the effects of aggregate interference (which LightSquared does), and taking into consideration only the rural use case, LightSquared has still failed to show non-interference. The *Ex Parte* itself notes that 10 percent of the GLN devices tested by NPEF would be jammed in the suburban use case.[61/] Simply updating the analysis to reflect the rural use case would cause all GLN devices to suffer harmful interference from OOBE and, as demonstrated in the testing conducted by NPEF at the White Sands Missile Range, cause a significant number of the personal/general navigation GPS devices to suffer harmful interference from overload.[62/]

Finally, LightSquared overgeneralizes both the GLN installed user base as well as cellular handsets by basing its analysis on a single type of antenna for each there – a 2006 CDMA handset with an external antenna for cellular and a 25 mm ceramic patch antenna for GLN.[63/] This simplification ignores the diverse array of handsets and GLN devices and the wide variety of antenna types and configurations available in the market. Using this faulty premise, LightSquared applies probabilistic methods to reduce its interference estimate based on the percentage of time it calculates that the handset and GLN antennas would be aligned. LightSquared also uses its oversimplified characterization of GLN antennas to inappropriately normalize all of the NPEF results, further reducing its interference estimate.[64/] Given NPEF's clear statement about the variety of device orientations, this normalization is unsupported.[65/]

61/ *See id.* at 8, Table 1.

62/ *See* NPEF Report at 29-36.

63/ *See Ex Parte* at Appendix 1 at 4.

64/ *See id.* at Appendix 1 at 21.

65/ *See* NPEF Report at 13.

VI. LIGHTSQUARED'S ANALYSIS OF THE HIGH PRECISION USE CASE IS FLAWED

The serious concerns regarding LightSquared's uplink analysis with respect to both overload and OOBE issues also extend to high precision devices. While LightSquared states that it considered the high precision agricultural use case,[66/] its analysis in fact considers only one scenario (a surveyor) for high precision GPS applications,[67/] from among a wide variety of different high precision uses. High precision receivers are extensively used in modern agricultural, construction, mining and other industrial and scientific applications.[68/] The industrial machine operator scenarios – particularly a machine operator in a cab using high precision GPS on an implement or the blade of the machine – often require sub-inch control of the machine and/or an implement in horizontal and vertical directions. LightSquared's analysis for the high precision case assumes that the user and handset will always be located under the antenna,[69/] in a zone where the null of the antenna minimizes signal reception. This assumption does not adequately reflect possible user and handset locations with respect to the GPS survey receiver. It also assumes that no other workers are utilizing handsets in proximity to the surveyor.

LightSquared's flawed methodology leads to erroneous conclusions. In particular, LightSquared has incorporated probabilistic analysis coupled with a CSMAC model for handset transmissions in the vicinity of fixed satellite receive stations – a model which is not appropriate for ubiquitous mobile navigation receivers. Additionally, LightSquared relies on probabilistic

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[66/] *See Ex Parte* at 11.

[67/] *See id.* at Appendix 2 at 9 (discussing the surveyor use case).

[68/] *See, e.g.*, Coalition TWG Comments at 17-18, 23-24, Comments of Trimble Navigation Limited, IB Docket No. 11-109 and IBFS File No. SAT-MOD-20101118-00239, at 27-28 (filed Aug. 1, 2011).

[69/] *See Ex Parte* at Appendix 2 at 9.

computation of antenna orientation and suggests that attenuation from nearby objects be incorporated to reduce the apparent interference level. LightSquared's analysis of the high precision use case underestimates the performance and signal degradation caused by handset emissions into the 1559-1610 MHz band and the resulting harmful impact on high precision GPS equipment. Adjustments to the LightSquared analyses that consider the line-of-sight effects from handset to high precision GPS receivers show that overload and OOBE limits would be exceeded and would affect a majority of receivers tested in the NPEF Report.[70/]

LightSquared's analysis fails to acknowledge that by their nature, navigation devices are expected to work everywhere. High precision receivers require continuous tracking of GPS signals to enable precise measurements based on the signal characteristics. If tracking is lost, even momentarily, the receiver must go through a re-initialization process. Since positioning is unavailable during re-initialization, operations that require continuous positioning such as auto steering for agriculture and blade control for construction must stop. High precision GPS receivers experiencing excessive RF interference (overload or OOBE limits) will not meet user accuracy requirements and may not meet availability standards for professional users. Thus, "worst case" analysis rather than probabilistic methodology must be used to properly compute the effect of interfering signals on the performance of high precision receivers. Revising the LightSquared analysis to correct for even a few of the aforementioned points reveals that LightSquared handsets transmitting in the 1626.5-1660.5 MHz band, while operated in close proximity to surveyor and machine control high precision GPS receivers, will cause both overload and OOBE interference.[71/]

70/ *See* NPEF Report at Table 11.

71/ LightSquared recently reaffirmed its OOBE thresholds. *See generally* OOBE *Ex Parte*.

VII. CONCLUSION

Although the GPSIA appreciates the need to make additional spectrum available to support the growth of mobile broadband, the FCC must continue to ensure that the nation's reliance on GPS devices is not undermined by such efforts. The most appropriate approach for the Commission to address all of the outstanding issues before it with regard to LightSquared's ability to protect GPS operations in any terrestrial system it proposes – including the Uplink Bands issues presented by the *Ex Parte* – is through a rulemaking proceeding. In any case, the Commission should find that the analyses presented in the *Ex Parte* are fundamentally flawed and should be rejected.

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APPENDIX A -- Specific Critique of LightSquared's Aviation Use Cases

I. *Analysis of Users Inside Aircraft*

A. Analysis relies heavily on path loss measurements conducted in a NASA study and referenced in RTCA/DO-235B. One of the self-identified shortcomings of the NASA study is that the path loss measurements have not been performed in a sufficient number of aircraft to adequately characterize worst case scenarios in the fleet.

B. In particular, the LightSquared analysis uses numbers from a Boeing 737-200 aircraft, a large aircraft that would generally have higher path loss than would be found in smaller aircraft such as regional jets. A separate report cited by the NASA study showed average (not minimum) path loss for a Canadair regional jet was 53.5 dB, more than 20 dB less than the average path loss from Boeing 737-200 measurements. Regulators should not expect that this analysis will hold for regional jets, and it is definitely not valid for smaller rotorcraft and general aviation aircraft.

C. LightSquared books a 3 dB coupling loss for handset antennas; however, no adjustments were made to the NASA measurements to account for the transmit and receive antenna gain, so these factors are already accounted for in the path loss measurements. Booking an additional 3 dB is double counting antenna effects.

D. LightSquared provides an alternate scenario that supposedly represents seven users "randomly" scattered around the cabin; however this "random" distribution uses an "average path loss" figure of 74.0 dB. Aggregating seven users with this power level results in lower total interference power than might be expected from a single user operating in a window seat in the first few rows of an aircraft. This type of random analysis is not appropriate for any operation raising safety of life concerns.

II. *Analysis of Aircraft in Flight/Users on Ground*

A. This is essentially a reworking of the RTCA/DO-327 handset analysis, which was inconclusive.

B. LightSquared backs off an additional 10 dB due to UE power reduction. This power reduction was explicitly rejected in RTCA/DO-327 and is not appropriate for an OOBE analysis because OOBE can be caused by unintentional emissions from the equipment that are independent from the fundamental emission. LightSquared claims that measurements made on UE show that there is a dB for dB reduction in OOBE based on UE transmit power and attempts to use this information to rationalize UE power reduction. It provides a plot of what appears to be a measurement of OOBE power at three different transmit powers as evidence. However, no information is provided to identify the particular UE, and it is clear from the data that only one specific handset was measured. This scant evidence should not be considered representative of the broad range of user equipment.

C. It further reduces the power by another 4.6 dB to account for mean transmit power instead of maximum power.

D. It also reduces the number of handsets transmitting to a particular base station, setting the number at 18 rather than 300 (or 1000), and books another 17 dB of reduction.

E. These assumptions have not been accepted by the FAA; rather, the assumptions simply represent LightSquared's optimistic interpretation of the CSMAC report.

III. *Analysis of Single User on Stairs of Regional Jet*

A. LightSquared banks 9.5 dB for power reduction based on the CSMAC report. This is not appropriate in the general case of multiple users, and it certainly is not appropriate for analyzing a single user.

B. LightSquared is assuming a +20 dBm maximum transmit power rather than +23 dBm. In table 6, it notes that this -3 dB adjustment is made to account for -3 dBi average UE antenna gain. (By contrast, LightSquared addresses this problem in its GLN analysis and adds 3 dB to account for UE antenna gain. This is another example of its selectively applying various corrections to present data in the best possible light.)

C. LightSquared assumes a 10 dB coupling loss for the GPS receive antenna assuming that the user is more than 30 degrees below the receive antenna horizon. It also assumes 3m separation between the handset and GPS receive antenna. These are not reasonable assumptions for all aircraft types. In the photo provided to illustrate the scenario (Appendix 5, figure 1, p 1), multiple aircraft receive antennas are visible on the aircraft fuselage in very close proximity (< 3m) to the passenger door.

IV. *Analysis of Nearby Emitters at Gate*

A. In this analysis, LightSquared takes credit for 9.5 dB of power reduction by using the 95th percentile value from the CSMAC CDF curve for suburban environments. This is inappropriate for an OOBE analysis, and it is larger than the computed 7.3 dB of "margin" for the OOBE analysis.

B. LightSquared is assuming a +20 dBm maximum transmit power rather than +23 dBm. In table 6, it notes that this -3 dB adjustment is made to account for -3 dBi average UE antenna gain. (By contrast, LightSquared addresses this problem in its GLN analysis and adds 3 dB to account for UE antenna gain. This is another example of its selectively applying various corrections to present data in the best possible light.)

C. For the five users on the jetway, LightSquared is booking between 5.5 and 6.2 dB of loss from the GPS receive antenna because the users are at or below 5 degrees from the horizon of the GPS antenna. It provides no basis for this assumption, and it seems contrary to a realistic configuration of aviation facilities at the gate.

D. For the 25 other users in the terminal, LightSquared is booking 3 dB of loss for the GPS receive antenna, claiming that the GPS receive antenna has -3 dBi of gain for signals below 45 degrees elevation relative to the horizon. None of the applicable MOPS for GPS receive antennas (DO-228, DO-301) supports this assumption, and LightSquared applies an invalid model to support its points. LightSquared bases this assumption on antenna gain pattern measurements reported in RTCA/DO-253B (Appendix G, Figure G-13, p. G-12). These antenna measurements are used by RTCA to validate a model of GPS antenna gain for signals below the horizon and are not intended to be representative of maximum antenna gain above the horizon. For maximum GPS receive antenna gain above the horizon, the analyses in both RTCA/DO-235B and RTCA/DO-327 use a model derived from the published performance standards for GPS receive antennas. The model actually used in the RTCA analysis predicts a maximum GPS antenna gain of -0.2 dBi at 45 degrees of elevation rather than the more favorable -3 dBi claimed by LightSquared.

E. A limit of -206.5 dBW/Hz is used for OOBE. This is either based on the initial acquisition interference limit with no accounting for the 6 dB safety margin, or it is based on a GPS tracking limit with 6 dB of safety margin. In the TWG and RTCA work, there was concern for both acquisition performance and the 6 dB safety margin, which would set the limit at -212.5 dBW/Hz. LightSquared objected strongly to this limit, and it was not explicitly stated in the TWG report.

APPENDIX B -- Specific Critique of LightSquared's General Navigation Analysis

I. *LightSquared's "worst-case" overload analysis is insufficiently narrow.*

A. LightSquared assesses interference based on the 90th percentile point of a CDF for a suburban use case provided in a CSMAC handset analysis.

1. LightSquared's inappropriate application of CSMAC assumptions to this analysis notwithstanding, a worst-case analysis must consider rural use cases as well.

2. The CSMAC data is based on spatial sampling of handset power in a given geographic region. Consequently, for suburban use cases, by using the 90^{th} percentile point of the CDF, LightSquared invites interference in 10% of locations. This is not a worst case analysis.

B. LightSquared uses probabilistic methods to predict an antenna coupling factor between a single antiquated handset and a particular 25mm L-band patch antenna.

1. Such analysis ignores the wide variety of GPS receivers, handsets, and their various antenna types.

2. Such probabilistic methods mask the worst-case interference that can occur when there is bore-sight orientation between receive and transmit antennas—a plausible scenario for GLN devices and LightSquared handsets.

3. In its computation of the CDF for antenna coupling between the antiquated handset and 25mm GPS patch antenna, LightSquared fails to account for the fact that Right-Hand Circularly Polarized ("RHCP") L-band antenna gain cannot be compared directly to the linear handset antenna gain. Further, a fixed polarization loss offset cannot adequately represent the linear gain of the L-band antenna in all orientations.

4. LightSquared bases its analysis on a CDMA handset from 2006 that still uses an external antenna.

C. In its analysis, LightSquared inappropriately normalizes the antenna gain of the GPS devices tested at WSMR.

1. LightSquared used the gain pattern of a single 25mm patch antenna to normalize the gains of a variety of GPS devices tested at WSMR, many of which do not even use patch antennas.

2. The point of the WSMR testing was to test complete devices, including the antenna, to remove the uncertainty associated with predicting the performance of various antenna types, orientations, etc.

3. A worst-case analysis should utilize the maximum gains of both antennas under consideration, unless it can be conclusively demonstrated that the antennas cannot be oriented in such a way so as to produce maximum coupling.

II. *LightSquared inadequately addresses OOBE problem with General Navigation receivers.*

A. LightSquared's brief statement (pg. 7) notes that "none of the GPS devices would have experienced interference due to OOBE at these power levels." This statement is not borne out by the analysis in its appendix. That analysis shows only 0.5 dB of margin for OOBE with a suburban use case. Simply updating the analysis to reflect the rural use case would cause widespread failure due to OOBE.

III. *LightSquared optimistically presents the results of its analysis.*

A. Despite LightSquared's overly broad assumptions about a suburban use case, improper normalization of antenna gain, and probabilistic assumptions about antenna orientation, its analysis still concludes that 10% of the devices tested at WSMR would fail due to overload alone.

B. A 10% failure rate is inacceptable in navigation services, particularly when safety of life is at issue.

C. LightSquared does not consider the aggregate case of OOBE + Overload in a single band. Instead, it presents its results in piecemeal fashion, ignoring the reality of the interference its network would cause.

D. LightSquared does not consider the aggregate case of OOBE + Overload in the multiple uplink and downlink bands it plans to utilize in its deployment, further understating the system's interference potential.

IV. *A true worst-case analysis reveals much greater concerns for GPS receivers in proximity to LightSquared handsets.*

A. Simply correcting LightSquared's analysis for worst-case power in a rural case and removing its incorrect normalization of GPS antenna gain reveals that many of the devices tested at WSMR would suffer harmful interference from overload caused by a single LightSquared handset band.

B. Correcting LightSquared's analysis for the shortcomings described above with respect to the OOBE problem reveals that all devices within a few meters of a LightSquared handset would suffer harmful interference due to an increase in the noise floor.