BEFORE THE

Federal Communications Commission

WASHINGTON, DC 20554

In the Matter of	)	
LightSquared Subsidiary LLC	)	IB Docket No. 11-109
Technical Working Group Report	)	
In re the Application of	)	
LightSquared Subsidiary LLC	)	File No. SAT-MOD-20101118-00239
Request for Modification of its Authority for an Ancillary Terrestrial Component	)	

To: The Commission

COMMENTS OF THE U.S. GPS INDUSTRY COUNCIL

THE U.S. GPS INDUSTRY COUNCIL

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TABLE OF CONTENTS

SUMMARY iv

I. Introduction and Summary. 2

II. The TWG Final Report Confirms Unequivocally That the Interference and Compatibility Problem the USGIC Identified Prior to the January 2011 *LightSquared* Order Exists. 7

III. The TWG Final Report Confirms That There Are No "Appropriate and Feasible" Mitigation Techniques That Will Enable LightSquared To Operate Its Proposed 4G LTE Terrestrial Broadband Service as Planned in the 1525-1559 MHz Band. 11

A. The TWG Final Report Confirms That Increasing Filtering on Future GPS Receivers and Devices Is at Best a Theoretical Option; No Suitable Filters Exist Today or Were Available for Testing by the TWG. 13

1. The Fact That Filters Capable of Rejecting an Adjacent-Band 4G LTE Signal Have Not Been Developed Is a Fatal Flaw in LightSquared's Approach. 13

2. The TWG Final Report Clearly Reflects the Expectation That Increases in Filtering Would Negatively Impact GPS Receiver Performance, and Would Degrade the Accuracy of GPS Receivers. 15

3. GPS Innovation in Positioning, Navigation, and Timing is Proceeding in the Direction of Wideband GPS Signals and Wider Band Use of the GPS Allocation. 16

4. The TWG Final Report Confirms That Filtering Does Nothing To Protect the Hundreds of Millions of Direct GPS Users in the Installed Base, and the Many More Who Benefit Indirectly from GPS. 18

B. The TWG Final Report Confirms That LightSquared 4G LTE Terrestrial Broadband Operations Using Only the Lower 10 MHz Channel at 1526-1536 MHz Would Cause Harmful Interference to GPS Receivers and GPS-Dependent Applications. 19

1. No TWG Sub-Team Concluded That LightSquared 4G LTE Operation on Only the Lower 10 MHz Channel Would Be a Viable Mitigation Technique. 19

2. The Commission Must Reject LightSquared's Attempt To Reduce the Number of Affected GPS Receivers and GPS-Dependent Applications by Introducing New, Unsupported Harmful Interference Criteria. 22

C. Based on the TWG Final Report, It Is Evident That the Harmful Interference Concerns Raised with Respect to LightSquared's Proposed 4G LTE Terrestrial Broadband Operations in the 1525-1559 MHz Band Have Not Been Resolved. 26

IV. The TWG Final Report Results, Endorsed By All Parties Other Than LightSquared, Are Consistent with Findings Made in Other Contemporaneous Studies of Potential LightSquared Harmful Interference to GPS Receivers and GPS-Dependent Applications. 26

V. The LightSquared Response Is Out of Step with the TWG Final Report. 29

A. LightSquared's Attempts to Distance Itself from the TWG Final Report's Conclusions by Accusing GPS Manufacturers of Producing Deficient Products Are Fallacious. 29

B. LightSquared's Assertion That GPS Manufacturers Should Have Anticipated "Adjacent Band Terrestrial Transmissions" Is Wrong. 34

C. LightSquared's Response Mischaracterizes the TWG Final Report in a Wholly Unsuccessful Attempt To Buttress the Prospects for its Last-Minute "Split the Baby" Proposal. 39

D. The Commission Should Reject Outright the Extraneous and Incorrect Non-Technical Factors LightSquared Includes in its Response. 46

1. LightSquared Expenditures Are Irrelevant. 46

2. LightSquared's Proposed Terrestrial Services Mean Nothing for Unserved and Underserved Rural and Tribal Areas. 48

3. LightSquared's Claim that GPS Manufacturers Have Been Subsidized by the Federal Government Is Incorrect. 49

4. Contrary to LightSquared's Claim, GPS Receivers Are Extremely Efficient Users of the Spectrum Resource. 51

5. LightSquared Wrongly Tries to Portray the Interference Issue as a Battle Between GPS and Terrestrial Broadband Services. 52

VI. LightSquared's "Proposed Solution" Is No Solution at All. 53

A. LightSquared Is Not Proposing a Power Level Lower Than That Considered in the TWG. 53

B. LightSquared's Proposal for a Standstill Period Incorrectly Presumes That GPS Receiver Mitigation Is Forthcoming. 54

1. LightSquared's Proposal for a Standstill Period Would Improperly Shift the Burden of Mitigation from LightSquared to GPS Users. 55

2. GPS Receivers Are State-of-the Art Machines That Include All "Appropriate Filtering." 56

C. There Is Nothing in the Record or the TWG Final Report To Support the Idea That 4G LTE Terrestrial Broadband Service Can Ever Be Provided Anywhere in the 1525-1559 MHz Band Without Causing Harmful Interference to GPS. 57

VII. The Only Conclusion To Draw from the TWG Final Report and the LightSquared Response Is That LightSquared's 4G LTE Terrestrial Broadband Service Needs To Be Provided in a Different Frequency Band. 61

VIII. Conclusion. 61

SUMMARY

In these Comments, the U.S. Global Positioning System Industry Council (the "USGIC") strongly supports the unequivocal conclusions reflected in the June 30, 2011 Final Report of Technical Working Group established by the International Bureau in *LightSquared Subsidiary LLC* ("*LightSquared*") ("TWG Final Report"). The TWG Final Report addresses issues associated with the interference threat to Global Positioning System ("GPS") receivers and GPS-dependent applications in the radionavigation-satellite service ("RNSS") band at 1559-1610 MHz that is presented by LightSquared's November 2010 proposal to deploy a high-power terrestrial broadband system in the 1525-1559 MHz and 1626.5-1660.5 MHz bands for mobile-satellite service ("MSS") and ancillary terrestrial component ("ATC") use.

In the TWG Final Report, the overwhelming majority of participants – *i.e.*, all participants representing technical expertise from across the mobile broadband, GPS manufacturing, and GPS user communities *other than* LightSquared's representatives – present the comprehensive and objective results of detailed technical studies and analysis that took place over the four month period from February 25, 2011 to June 30, 2011. The key conclusions the FCC must accept from the TWG Final Report are:

1. That LightSquared's proposal to deploy 4G LTE terrestrial mobile broadband services in the 1545.2-1555.2 MHz "upper" and 1526-1536 MHz "lower" channels will result in harmful interference to GPS receivers and GPS-dependent applications in all deployment scenarios;

2. That there are no appropriate and feasible techniques available today that would mitigate this harmful interference – and this conclusion includes the clear assessment that limiting LightSquared 4G LTE terrestrial mobile broadband operation to the "lower" 10 MHz channel would not mitigate the harmful interference to either the more than 500 million GPS receivers already in use or future GPS receivers and GPS-dependent applications; and

3. That because the conditions established in the *LightSquared* order for allowing commencement of commercial operation from LightSquared have not been met, the Commission must now rescind the International Bureau's waiver of the Commission's rules requiring integrated MSS and ATC components.

It is important to note that tests and analyses performed by independent groups outside of the TWG process, but provided for consideration to the U.S. Government and the Commission, demonstrated similar results of harmful interference across all ranges of GPS devices and applications, and came to similar conclusions about the unavailability of mitigation techniques.

The USGIC also responds to the June 30, 2011 Recommendation of LightSquared Subsidiary LLC in IB Docket No. 11-109 ("LightSquared Response"), which contains LightSquared's views on the GPS interference situation and LightSquared's proposed solution, including LightSquared's proposal to operate initially only in the lower 10 MHz, to the harmful interference determinations that are reported in the TWG Final Report. In its Response, LightSquared tries to rewrite the procedural history of the ATC rulemaking and licensing proceedings, and levels false accusations about the technical integrity of all manufacturers of GPS receivers and associated equipment. LightSquared's attempts to distract attention from the undeniable reality of the harmful interference effects its proposed new high-power terrestrial mobile operations would have by blaming the victim service, and its repeated tactic of hiding behind a cloak of national broadband policy, offer very little in the way of constructive substance. The essential conclusion is that LightSquared's three-pronged "solution" does not solve the harmful interference problem.

At a minimum, and bolstered by the clear findings in the TWG Final Report, the Commission must reject the notion promoted by LightSquared that a decision to protect GPS is somehow a decision against mobile broadband in general and against LightSquared in particular. Instead, the only path open to the Commission after the comprehensive and compelling conclusions from the TWG Final Report is to rule that the conditions established in the *LightSquared* order for allowing LightSquared to provide terrestrial mobile broadband services in the 1525-1559 MHz and 1626.5-1660.5 MHz MSS/ATC bands have not been met, and to

immediately and permanently rescind the International Bureau's waiver of the Commission's rules requiring integrated MSS and ATC components.

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COMMENTS OF THE U.S. GPS INDUSTRY COUNCIL

The U.S. Global Positioning System Industry Council (the "USGIC"), by its attorneys and pursuant to the Commission's June 30, 2011 Public Notice in IB Docket No. 11-109,[1] hereby comments upon (i) the June 30 Final Report of the Technical Working Group ("TWG") established and co-facilitated by LightSquared Subsidiary LLC ("LightSquared") and the Council in response to a condition the International Bureau placed upon LightSquared in a

[1] Public Notice, *Comment Deadlines Established Regarding the LightSquared Technical Working Group Report*, IB Docket No. 11-109, DA 11-1133 (released June 30, 2011) ("June 30 Notice"). The USGIC understands that the Commission directed submissions on the TWG Report and LightSquared filing be filed to IB Docket No. 11-109 as a matter of public convenience, and that all submissions into IB Docket No. 11-109 will in fact also be considered to be submissions into the record of the underlying LightSquared modification application proceeding in File No. SAT-MOD-20101118-00239, and that all submissions into File No. SAT-MOD-20101118-00239 (both before and after the June 30, 2011 creation of IB Docket No. 11-109) will be considered as submissions in the docket should IB Docket No. 11-109 prove to be the vehicle of further Commission action on the LightSquared application and the issues of harmful interference treated by the TWG.. If this is not the Commission's intent, USGIC hereby requests that the Commission explicitly include or deem included in File No. SAT-MOD-20101118-00239 all materials filed in IB Docket No. 11-109 pursuant to the June 30 Notice.

January 2011 Order and Authorization;[2] and (ii) LightSquared's June 30 response and recommendations relating to the TWG Final Report.[3] The TWG Final Report addresses issues associated with the interference threat to Global Positioning System ("GPS") receivers and GPS-dependent applications in the radionavigation-satellite service ("RNSS") band at 1559-1610 MHz that is presented by LightSquared's November 2010 proposal to deploy a high-power terrestrial broadband system in the 1525-1559 MHz and 1626.5-1660.5 MHz bands for mobile-satellite service ("MSS") and ancillary terrestrial component ("ATC") use and that were at issue in the Bureau's January 2011 decision in *LightSquared*. The LightSquared Response contains LightSquared's views on the interference situation and LightSquared's proposed solution to the serious interference determinations that are reported in the TWG Final Report.

The USGIC demonstrates below that the concerns over the potential for harmful interference from LightSquared's proposed terrestrial mobile broadband service in the MSS/ATC bands that were raised in *LightSquared* and studied in the TWG have not been resolved. LightSquared has thus not satisfied the prerequisite established for its commencement of operation under the waiver of the Commission's ATC rules. The Commission must therefore rescind the waiver that was issued in *LightSquared*, and determine that terrestrial mobile broadband services cannot be provided in the MSS frequencies licensed to LightSquared.

I. <u>Introduction and Summary.</u>

Established in 1991, the USGIC is the leading organization worldwide representing the interests of the satellite navigation industry manufacturers and users. The USGIC serves as an

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[2] *See LightSquared Subsidiary LLC*, 26 FCC Rcd 566, 586 (Int'l. Bur. 2011) ("*LightSquared*"), *review pending*. The June 30, 2011 Final Report of the Working Group that was formed to study the GPS overload/desensitization issue is referred to herein as the "TWG Final Report."

[3] Recommendation of LightSquared Subsidiary LLC, IB Docket No. 11-109 (filed June 30, 2011) ("LightSquared Response").

information resource on GPS technology and applications to the United States and international governments on national and international policies, regulation, and practices affecting market-driven innovation in satellite navigation-based technologies and applications.

The USGIC is a party to the ongoing proceeding, now before the Commission on multiple applications for review of the *LightSquared* order, that addresses LightSquared's proposal to offer non-integrated, non-ancillary 4G LTE terrestrial mobile broadband services in the 1525-1559 MHz and 1626.5-1660.5 MHz bands that are authorized to LightSquared for MSS and MSS/ATC operations. Prior to the Commission's *LightSquared* order, the USGIC submitted extensive engineering data and analysis demonstrating the devastating harmful interference effects that LightSquared's stand-alone high-power terrestrial transmissions in the 1525-1559 MHz band in particular would have on GPS operations across the adjacent 1559-1610 MHz band.[4] While the International Bureau chose not to address the interference concerns raised by USGIC and others on the merits, it did condition LightSquared's ability to provide commercial terrestrial broadband service in the MSS bands on the completion of a technical assessment of the interference issue by a working group of experts and a Commission determination, after consultation with the National Telecommunications and Information Administration ("NTIA"), that "concludes that the harmful interference concerns <u>have been resolved</u> . . . ."[5]

After the *LightSquared* order was released, the USGIC and its members were instrumental in developing and executing the work plan established by the GPS Interference

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[4] *See, e.g.*, Comments of the U.S. GPS Industry Council, File No. SAT-MOD-20101118-00239 (filed Dec. 2, 2010); Letter dated January 7, 2011, with Attachment, reporting on a January 6, 2011 meeting of USGIC representatives with Commission staff persons from the Office of Engineering and Technology, International Bureau, Public Safety and Homeland Security Bureau, Wireless Telecommunications Bureau, Enforcement Bureau, and Media Bureau; and Letter dated January 25, 2011, from F. Michael Swiek, Executive Director, U.S. GPS Industry Council, to Julius Genachowski, Chairman, FCC, *et al*., at 1-2 (filed January 25, 2011) ("USGIC January 25 *Ex Parte* Letter").

[5] *LightSquared*, 26 FCC Rcd at 587 (¶ 43) (emphasis added). NTIA also expressed concerns about interference to GPS prior to the *LightSquared* order.

Working Group and its Technical Working Group. Fulfilling the International Bureau's expectation that LightSquared and the GPS community would work together to address the interference issues expeditiously,[6] USGIC and LightSquared representatives served as co-chairs of the Working Group, and as co-facilitators of the organization and execution of the technical studies undertaken by the TWG. The TWG Final Report reflects this cooperation in the organization and functioning of the Working Group and TWG.[7]

Less than four months after the inaugural TWG meeting – and following the completion of intensive studies of the LightSquared interference issue that involved multiple independent testing facilities, more than one hundred GPS receivers and devices supplied to seven sub-teams representing the principal GPS receiver categories and GPS operational use scenarios identified by the TWG, thousands of hours by dozens of engineers and technical experts from across the mobile broadband, GPS manufacturing, and GPS user communities, and two weeks of "live sky" field testing in Las Vegas – the TWG Final Report was completed and submitted to the Commission. The TWG Final Report contains the reports prepared by the TWG sub-teams. The sub-team reports include detailed discussions of the manner in which each sub-team addressed the Working Group work plan elements, along with detailed results of the testing as applied to the operational use scenarios each sub-team determined to test and analyze. The studies were a massive undertaking for all participants, and demonstrate the seriousness with which everyone involved treated the interference concerns and the quest for understanding and resolution.

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[6] *Id*. at ¶ 42.

[7] TWG Final Report at 7-9, Sections 2.1 and 2.2.

The full TWG Final Report and its annexes fill nearly 1,000 pages and contain volumes of detailed technical results and analysis. At its essence, the TWG Final Report confirms two things with absolute certainty:

1. That LightSquared's proposed deployment plan will result in harmful interference to GPS receivers and GPS-dependent applications in all deployment scenarios; and

2. That there are no appropriate and feasible techniques available today that would enable either the more than 500 million GPS receivers already in use or future receivers to mitigate the harmful interference.

Importantly, the second finding includes the fact that there is no conclusion in the TWG Final Report, from any of the seven sub-teams, that suggests in any way that a LightSquared decision to limit 4G LTE terrestrial broadband operation to the "lower 10 MHz" at 1526-1536 MHz would mitigate the harmful interference to GPS receivers and GPS-dependent applications that would result from LightSquared's two-channel deployment plan.[8]

Under these circumstances, it is clear that the conditions the International Bureau established in its January 2011 *LightSquared* order for allowing commencement of commercial operation from LightSquared have not been met. The International Bureau's waiver of the Commission's rules requiring integrated MSS and ATC components must thus be rescinded.

The LightSquared Response ignores the TWG Final Report in many key respects, and distorts or overstates the report's findings in others. For example, LightSquared erroneously claims that the TWG concluded that both the Cellular sub-team and the General Location/Navigation sub-team found that operation of LightSquared 4G LTE transmissions on only a lower 10 MHz segment of the 1525-1559 MHz band would be compatible with all tested

[8] As reported in the TWG Final Report, "[a]ll teams tested the three phases of LightSquared's planned spectrum deployment – one involving LightSquared's operation of a 5 MHz LTE channel centered on 1552.5 MHz (Phase 0); one involving LightSquared's operation of two 5 MHz LTE channels centered on 1552.7 MHz and 1528.8 MHz (Phase 1), and one involving LightSquared's operation of two 10 MHz LTE channels centered on 1550.2 MHz and 1531 MHz (Phase 2)." TWG Final Report at 13, Section 2.5. *See also id*. at Appendix O.1, p. 2.

devices.[9] In fact, the Cellular sub-team report shows that more than 15% of the devices tested by the Cellular sub-team would experience harmful interference from a 10 MHz LightSquared 4G LTE operation that is limited to the 1526-1536 MHz band.[10] The conclusion of the vast majority of the members of the General Location and Navigation sub-team (specifically, all members other than LightSquared) was that 20 of 29 tested devices (nearly 70%) would experience harmful interference from a LightSquared 4G LTE operation that is limited to the 1526-1536 MHz band.[11]

In addition to citing LightSquared minority views as TWG conclusions and glossing over the views expressed by the substantial majority of the TWG, LightSquared tries to rewrite the procedural history of the ATC rulemaking and licensing proceedings, and levels false accusations about the technical integrity of all manufacturers of GPS receivers and associated equipment.[12] LightSquared thus attempts to distract attention from the undeniable reality of the harmful interference effects its proposed new high-power terrestrial mobile operations would have by blaming the victim service. These attempts, and its repeated tactic of hiding behind a cloak of national broadband policy, offer very little in the way of constructive substance. Regrettably, the three-pronged "solution" LightSquared proffers does not solve the harmful interference problem.

At their core, the solid scientific methodology, analysis, and results presented in the TWG Final Report speak volumes – and clearly state that 4G LTE terrestrial broadband service

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[9] LightSquared Response at 10.

[10] TWG Final Report at 77. *See infra*, at Section III.B.1.

[11] TWG Final Report at 19.

[12] *See* LightSquared Response at 1-2 (asserting that GPS receivers have been deliberately designed to ignore regulations and in disregard of Commission policies), and 27 (asserting that GPS device manufacturers fail to include "appropriate filtering" and need to improve their equipment).

in the 1525-1559 MHz band cannot coexist with GPS receivers and GPS-dependent applications that operate in the upper adjacent 1559-1610 MHz band. This incompatibility is a confirmed fact of physics; it has nothing to do with alleged GPS receiver design deficiencies or ostensibly missed regulatory cues or the Commission's national broadband policy objectives.

As the steward of the public interest and the agency with responsibility over spectrum management principles, and armed with the TWG Final Report, the Commission must acknowledge that the technical flaws alone in LightSquared's attempt to convert its MSS frequency assignments into lucrative terrestrial broadband assignments are fatal. LightSquared has attempted to rezone the 1525-1559 MHz and 1626.5-1660.5 MHz bands by seeking to build high-power terrestrial broadband skyscrapers in what has heretofore been a low-power satellite residential neighborhood. The two uses simply do not mix.

At a minimum, the Commission must reject the notion promoted by LightSquared that a decision to protect GPS is somehow a decision against mobile broadband in general and against LightSquared in particular. The public and the markets are wise enough to recognize that a decision to embrace sound principles of spectrum management in a particular instance based on specific and comprehensive tests is not a decision hostile to mobile broadband. The only solution here is for LightSquared to find a different frequency band where terrestrial broadband service can be compatibly provided.

II. The TWG Final Report Confirms Unequivocally That the Interference and Compatibility Problem the USGIC Identified Prior to the January 2011 *LightSquared* Order Exists.

The conclusions of the experts that are presented in the TWG Final Report are a confirmation of the existence of a serious interference issue that was raised prior to the January 2011 Order and Authorization in *LightSquared*. The USGIC, in particular, demonstrated before the International Bureau's decision that "the record of this proceeding is replete with references

to the real and unavoidable interference impact the LightSquared proposal for independent, non-integrated, high-power mobile broadband transmitters in the 1525-1559 MHz band will have on the entire base of hundreds of millions of installed users of the GPS system."[13]

The TWG Final Report proves beyond any shadow of a doubt that the USGIC and its members were right. Each of the TWG sub-team reports unanimously concluded that the three-phase LightSquared deployment plan would result in harmful interference to GPS receivers and GPS-dependent applications.

The Aviation sub-team reported that LightSquared's proposed deployment of a 4G LTE terrestrial mobile broadband system into the mobile-satellite service band at 1525-1559 MHz would cause the "complete loss of GPS operations" for airborne receivers.[14] The Cellular sub-team reported that LightSquared's system would result in "GPS failure" for a significant number of tested cellular devices.[15] The General Location/Navigation sub-team, which included assessments of public safety and maritime receivers, stated that LightSquared's deployment plan would lead to "widespread harmful interference to GPS signals and service" for devices used in general location and navigation applications.[16] In their joint report, the High-Precision, Timing, and Network sub-teams stated that LightSquared's terrestrial broadband system would "harmfully interfere with High-Precision, Timing, and Network GPS receivers over long

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[13] USGIC January 25 *Ex Parte* Letter, at 1-2.

[14] TWG Final Report at 15.

[15] *Id*. at 17.

[16] *Id*. at 18. Although the stated quoted is from the GPS Industry Perspective section of the sub-team's report, there is no counterstatement from LightSquared on the applicability of this conclusion to the LightSquared deployment plan tested in the TWG.

ranges."[17] Finally, the Space-based sub-team concluded that LightSquared would cause interference to space-based GPS receivers that "would be severely disruptive to NASA's science missions …."[18]

To the extent that there are any non-consensus views in the TWG Final Report, the disagreement focuses primarily on the subject of what techniques, if any, are available to resolve the harmful interference that LightSquared's 4G LTE mobile broadband transmissions would cause if deployed under LightSquared's current plans.[19] In other words, the views reported above on the harmful effects of LightSquared's proposed terrestrial operations are true consensus views. It is important to note, moreover, that where non-consensus views are expressed in the TWG Final Report, it is universally the case that one view is representative of all of the very diverse participating entities *other than* LightSquared and its affiliates/partners (*i.e.*, the substantial majority view), and the alternative view is a minority view from LightSquared and its affiliates/partners alone.

The USGIC emphasizes that the conclusions in the TWG Final Report about the potential for harmful interference to GPS receivers and GPS-dependent applications are not limited to potential LightSquared 4G LTE operations on the upper 5 MHz channel or on both the upper and lower 5 and 10 MHz channels as outlined in Section 2.5 of the TWG Final Report.[20] For each and every sub-team, the TWG Final Report demonstrates that with respect to the potential

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[17] *Id*. at 21. As with the General Location/Navigation sub-team, the statement quoted is from the GPS Community Positions section of the sub-teams' report, and is not challenged in the LightSquared position with respect to the planned deployment phases tested.

[18] *Id*. at 25.

[19] The only other area of the report that generated such a stark lack of consensus is the discussion over the harmful interference metric that applies to the 29 devices subjected to testing by the General Location/Navigation sub-team. The discussion of that issue, and its ramifications, is found in Section III.B.2, below.

[20] *See supra* at n. 9.

mitigation technique of limiting LightSquared operations to the lower 10 MHz channel only, harmful interference to GPS receivers and GPS-dependent applications either will occur or requires further testing.

The USGIC also emphasizes that the TWG studies were performed using the LightSquared signal characteristics that are stated in Appendix O.1 of the TWG Final Report. The studies were performed using a maximum EIRP of 32 dBW, which is a full 10 dB lower than the maximum EIRP of 42 dBW that was authorized to LightSquared in 2010.[21] The LightSquared signal characteristics also included an antenna electrical downtilt of two degrees.[22] This electrical downtilt figure is substantially lower than the figure of 12 degrees of electrical downtilt that is called for in the 3GPP specifications for urban installations.[23] With higher degrees of electrical downtilt, the power on the ground from a LightSquared transmitter would be substantially higher than the power figures modeled in the TWG sub-teams. Given that LightSquared is attempting to create a new block of 4G LTE spectrum that it can offer on a wholesale basis to mobile service providers, it would undoubtedly use downtilt levels in excess of two degrees in most of its base stations – particularly in the more dense deployments. The upshot here is that while the tests done in the TWG sub-teams that showed harmful interference concerns were valid, they understate – and likely significantly understate – the interference that could be produced from a LightSquared transmitter operating under the current authorizations. Any further studies of a LightSquared terrestrial offering in the 1525-1559 MHz and/or 1626.5-1660.5 MHz bands must involve an assessment of LightSquared transmitters using maximum

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[21] *SkyTerra Subsidiary LLC*, 25 FCC Rcd 3059, 3082 (¶ 46) (Int'l. Bur. 2010).

[22] TWG Final Report, Appendix O.1, at p. 3.

[23] *See 3GPP Self-Evaluation Methodology and Results*, at 12 (reciting that the tilt angle for urban microcell and macrocell antennas is 12 degrees), as prepared for 3GPP LTE Advanced Evaluation Workshop, Dec. 17-18, 2009. 3GPP is the industry standard that is used for 4G LTE.

permissible power levels and maximum electrical downtilt to see if GPS receivers would observe harmful interference.

An additional point that would need to be considered in any further studies is the effect on GPS receivers and GPS-dependent applications of the out-of-band emissions from potentially millions of 4G LTE user transmitters that would operate in the 1626.5-1660.5 MHz band. The initial Working Group Work Plan included the expectation that LightSquared's handsets in the MSS uplink band would be evaluated,[24] but in most of the sub-teams, time pressures and the unavailability of any prototype handsets for testing meant that this necessary assessment did not occur.

III. The TWG Final Report Confirms That There Are No "Appropriate and Feasible" Mitigation Techniques That Will Enable LightSquared To Operate Its Proposed 4G LTE Terrestrial Broadband Service as Planned in the 1525-1559 MHz Band.

The final item in the Working Group Work Plan, and thus in the work plans of each of the TWG sub-teams, is an assessment of whether any mitigation measures are feasible and appropriate.[25] This item of the Work Plan was elevated in significance as a result of the severity of the harmful interference that was observed and reported by the TWG sub-teams during the

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[24] *See* "LightSquared February 25, 2011 Report to the FCC, Prepared Jointly with the USGIC," FCC File No. SAT-MOD-20101118-00239, at 4 (filed February 25, 2011) ("Work Plan Key Milestones for the Overall Analysis"). There, the working parties made plain their intent to consider the impact of both base stations and handsets on the GPS operating environment:

> "Identifying relevant information regarding the broadband terrestrial radiation, including power levels, bandwidth, modulation, antenna pattern, and other technical characteristics that govern the signal(s) to be emitted; average and peak transmit equivalent isotropic radiated power (EIRP) for base stations *and handsets*; modulation, including cycle and multiple access schemes, for both base stations and handsets which are planned to operate in the 1626.5 MHz-1660.5 MHz band; transmit signal envelope data over the range 1525 MHz-1559 MHz, including channelization and allowed operating frequencies; transmit antenna gain contours both azimuth and elevation (-90 degrees to +90 degrees patterns); deployment plans (cities to be covered, transmit sites per city and, if known, site locations in each city covered)"

Id. (emphasis added).

[25] TWG Final Report at 12, Section 2.3, para. 11.

testing of proposed LightSquared deployment phases that include use of the upper 5 and 10 MHz channels – either alone or in conjunction with lower 5 and 10 MHz channels. It is also, as noted above, the area of the TWG Final Report where the greatest level of disagreement between LightSquared and the vast majority of TWG members/advisors was found.

There were two potential mitigation measures in particular that generated the most debate – the use by GPS receivers of additional filtering that would increase rejection of the high-power terrestrial transmissions coming from the MSS band at 1525-1559 MHz, and a potential revision of the LightSquared deployment plans that would limit 4G LTE broadband transmissions to the lower 10 MHz channel at 1526-1536 MHz. As the USGIC discusses below in connection with the LightSquared Response, LightSquared would couple these two mitigation techniques together with a view to allowing 4G LTE operation to commence immediately on the lower 10 MHz channel. And, once the GPS manufacturers incorporate additional filtering into their future devices during a "standstill" period, LightSquared would presumably be able to start using the upper 10 MHz channel at 1545.2-1555.2 MHz.[26]

The reality is that neither of the mitigation techniques championed by LightSquared – either individually and certainly not together – is supported in any objective manner in the TWG Final Report. There were no potential filters available for testing by any of the TWG sub-teams, and indeed none of the theoretical filters relied upon so heavily in the LightSquared Response exist even as prototypes today.[27] Lost in the fog produced by LightSquared on this point is the

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[26] LightSquared Response at 24-27. The channelization plans for LightSquared's deployment proposal are contained in Appendix O.1 of the TWG Final Report.

[27] For example, the "GPS Community" position (*i.e.*, the position of TWG participations other than LightSquared) in the High-Precision, Timing, and Networks Sub-Team report was that "[w]e know of no currently available receiver, filter, antenna or other mitigation technology that would enable the construction of future wideband High Precision, Timing, or Network GPS receivers and augmentation systems that are compatible with the Phase 0, 1, or 2 LightSquared rollout plans." TWG Final Report at 22. LightSquared's position on the same subject is that "potential receiver-side mitigation options … appear to be viable …." *Id*. at 24.

fact that GPS receivers and chipsets already reflect state-of-the-art technology, design, and manufacturing techniques – including multistage filtering that is designed to preserve the GPS signal and reject all other expected inputs.[28]

With respect to alternative deployment strategies, LightSquared did not introduce the idea of testing on the lower 10 MHz channel alone until the last few weeks of the TWG's existence. Several of the sub-teams were able to make late adjustments to their test plans and test methodologies to accommodate the new element, but not all sub-teams were able to do so.[29]

The TWG's consideration of increased filtering and lower 10 MHz-only operation, as reflected in the TWG Final Report, is discussed immediately below. The USGIC emphasizes that the only conclusion that can be drawn from the TWG's studies and deliberations is that no appropriate and feasible technique has been found that will mitigate – much less resolve –the devastating harmful interference that would be caused to GPS by LightSquared's planned 4G LTE transmissions in the MSS bands that bracket the 1559-1610 MHz GPS band.

A. The TWG Final Report Confirms That Increasing Filtering on Future GPS Receivers and Devices Is at Best a Theoretical Option; No Suitable Filters Exist Today or Were Available for Testing by the TWG.

1. The Fact That Filters Capable of Rejecting an Adjacent-Band 4G LTE Signal Have Not Been Developed Is a Fatal Flaw in LightSquared's Approach.

Almost from the beginning of the TWG's tenure, and long before any study results and analyses showing that LightSquared's proposed 4G LTE terrestrial mobile broadband operations would cause harmful interference to nearly all GPS receivers and GPS-dependent applications were even compiled, LightSquared was interested in pursuing the topic of receiver-based

[28] The most sensitive GPS receivers in the precision category typically have five or more stages of state-of-art filtering in an effort to preserve the GPS signal and reject all other inputs.

[29] The Space-based sub-team was able to generate only preliminary results from limited testing of the lower 10 MHz option before the end of the TWG. *See* TWG Final Report at 315.

mitigation within the TWG. It arranged for a presentation by a filter manufacturer to be made to two sub-teams.[30] The closest any of the sub-teams ever came to a meaningful consideration of additional filtering was a pair of Power Point presentations outlining theoretical capabilities of filters that have not even left the drawing board.[31] There were no prototypes available for testing by the TWG sub-teams and no ability for any manufacturer to assess either the feasibility or the appropriateness of increasing filtering for future generation devices.[32] The non-LightSquared participants on the TWG sub-teams were thus uniformly correct in determining that filtering was not shown to be a technique that is available today or even available during any currently-projectable timeframe to mitigate the harmful interference that LightSquared's proposed 4G LTE operations would cause to GPS.[33] In promoting "filtering" for GPS receivers as a mitigation technique, LightSquared is putting the cart well before the horse. It offers only a theoretical and untested solution to the very real and immediate interference problem confirmed by the TWG.

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[30] *See* Third GPS Working Group Progress Report, at 4 (May 16, 2011).

[31] *See* TWG Final Report at Appendixes G4 and G5 (copies of PowerPoint presentations prepared by Taiyo Yuden Mobile Technology Co., Ltd. (February 2011) and Avago Technologies (April 2011)).

[32] The existence of hardware for testing is important not only to ascertain the efficacy of the part, but also to allow for an assessment of the practicality of its integration into GPS receivers (based on actual size, weight, configuration, and other technical characteristics) and whether undesirable or unintended performance impacts would result from its use.

[33] The conclusion on this point of the GPS participants in the High Precision, Timing, and Networks sub-teams is reported in note 26 above. The GPS participants on the General Location and Navigation sub-team noted that simulated filters had been proposed as options for GPS receivers, but "no testing could be performed since these parts do not exist." TWG Final Report at 19. A similar view was stated by the Aviation sub-team, with the additional note that "[t]his mitigation strategy could take many years to design, obtain FAA airworthiness certification, and install new airborne equipment in a manner consistent with FAA requirements. *Id*. at 16. The Cellular sub-team noted that filter specifications have yet to be proposed or evaluated. *Id*. at 17.

2. The TWG Final Report Clearly Reflects the Expectation That Increases in Filtering Would Negatively Impact GPS Receiver Performance, and Would Degrade the Accuracy of GPS Receivers.

The unavailability for testing of any filters, which by itself is a sufficient basis on which to conclude that additional filtering is not a viable mitigation technique, is not the only reason stated in the TWG Final Report for rejecting additional filtering. An equally important point is the fact that the inclusion of additional filtering would impose performance penalties on GPS receivers, including reduction in battery life, increase in size and weight, and diminution in accuracy due to reduction in the number and quality of GPS/RNSS signals that are available to the receiver.

In looking at a potential filter candidate advanced by LightSquared, the Aviation sub-team noted that the filter, as described, would supply some of the rejection required, but not all, and would require more input power than is currently provided by fielded GPS receivers.[34] The majority of participants on the High Precision, Timing, and Network sub-teams noted that for high precision and network receivers, filters capable of meeting the discrimination/rejection requirements would be "of very large size – larger and more expensive than the rest of [the] GPS receiver – which would not be appropriate for portable equipment."[35] The General Location/Navigation sub-team's GPS participants also emphasized that:

> Many variables must be weighed carefully in the design process to ensure that GPS performance is not compromised[, including], but not limited to, insertion loss, bandwidth, stop-band rejection, group delay, pass-band ripple, temperature stability, manufacturing variation, physical size (in relation to available space on the [circuit board]), and cost. The filter design process almost always takes many months and even years. Once a

[34] TWG Final Report at 53, Section 3.1.11.2. The Aviation sub-team goes on to note several other considerations, practical and technical, that negatively affect the feasibility of filtering as a mitigation technique viable for aviation receivers. *Id*.

[35] *Id*. at 289, Section 13.3.1.

> suitable filter has been realized, it can take several more years to integrate it into an actual product.[36]

In describing the performance impacts of theoretical filters LightSquared presented to the General Location/Navigation sub-team, the GPS industry participants' perspective (*i.e.*, the perspective of all sub-team members other than LightSquared) was that "while the proposed filter simulations endeavored to ameliorate LightSquared interference they also caused degraded performance in the GPS band. Specifically, the filter simulations caused increased roll-off on the low-side to the GPS pass-band and increased insertion loss in the pass-band."[37] The reduction in accuracy and other negative performance effects would be tantamount to harmful interference all by itself, as if it were a direct product of radiofrequency interference produced by LightSquared (rather than an indirect effect).

In the end, of course, neither the performance reductions nor the accuracy degradations associated with potential filtering options could be tested by the TWG due to the non-existence of even prototype filters. This means, once again, that the TWG Final Report determinations of participants other than LightSquared that filtering is not an appropriate and feasible mitigation technique are correct.

3. GPS Innovation in Positioning, Navigation, and Timing is Proceeding in the Direction of Wideband GPS Signals and Wider Band Use of the GPS Allocation.

The trend in GPS, as newer-generation satellites are brought on line, is for more wideband GPS signals to be available to users. Wideband signals exist now in the GPS M-code

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[36] *Id*. at 178, Section 3.3.11.1.

[37] *Id*.

used by the military and the GPS P-code, and will be in the new GPS L1C code.[38] The USGIC also understands that wideband signals are to be broadcast by the forthcoming European Galileo and Chinese COMPASS RNSS systems that will also operate in the 1559-1610 MHz band.

The new GPS L1C signal in particular is a wideband signal that portends a welcome continuation of the improvements that GPS operators and the GPS industry have made in positioning, navigation, and timing ("PNT") accuracy over recent years. These improvements are reflected in and incorporated into proven applications throughout all aspects of the U.S. economy and infrastructure.[39]

The increased filtering that would be required to reject the new, dense, high-power terrestrial broadband signals of the type LightSquared is seeking to introduce into the band adjacent to the GPS spectrum at 1559-1610 MHz would impede this GPS innovation trend. It would penalize GPS use of its own RNSS band and force a narrower band use as a result of requiring this filtering. In other words, the gains in accuracy and precision would be lost, and productivity across society would suffer.[40]

The USGIC maintains that any mechanism or measure that constrains the accuracy and performance of GPS receivers would inhibit future innovation, effectively freezing in place or

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[38] The new GPS L1C wideband signal will be on all GPS III satellites, the first of which is slated for a 2013 launch. The new signal will enhance the robustness of GPS in terms of signal acquisition and tracking, code and carrier measurements, spreading code correlation performance, and data demodulation (both speed and threshold).

[39] For example, GPS equipment increases production in construction industries by providing accurate machine guidance and measurement technology, and fleet management for any business with one or more vehicles has been substantially enhanced by GPS, with resulting significant labor, capital and fuel savings. *See* Pham, "*The Economic Benefits of Commercial GPS Use in the U.S. and The Costs of Potential Disruption*," at 7, 8-9 (June 2011) ("Pham Study").

[40] *See Amending the Definition of Interconnected VoIP Service in Section 9.3 of the Commission's Rules, et al.*, NPRM, Third R&O, and Second FNPRM, FCC 11-107, slip op. at ¶¶ 14-19 (released June 13, 2011) ("*E911 Report*") (FCC relies heavily on improvements to GPS capability in mobile handsets to address location-accuracy requirements, and notes in particular, that continued refinements in GPS receiver performance and location algorithms, and the likely availability of additional navigation satellite systems, will improve A-GPS capabilities).

even reducing the utility of GPS, and is unacceptable. It would be particularly unacceptable if GPS development were precluded from continuing its current trend toward utilizing wideband GPS signals in increasing numbers of applications just because a high-power terrestrial signal is proposed to be provided in the adjacent band. The use of wideband GPS signals allows GPS receivers to maximize the use of their own spectrum and deliver continuing improvements in PNT accuracy to a growing number of applications.

4. The TWG Final Report Confirms That Filtering Does Nothing To Protect the Hundreds of Millions of Direct GPS Users in the Installed Base, and the Many More Who Benefit Indirectly from GPS.

Perhaps the most damning argument against the feasibility of increased filtering as a mitigation technique lies in the fact that all current users of GPS and indirect beneficiaries of GPS technology and applications will be completely unaided by the inclusion of additional filtering in future GPS receivers. This glaring defect was recorded by most of the TWG sub-teams, and is inescapable.[41]

For example, the Aviation sub-team observed that "[n]ew standards would need to be established, equipment developed and certified to those standards, and this equipment would need to be installed by the user base, and could take many years."[42] The Cellular sub-team stated that "even assuming the capability to incorporate adequate filtering in future devices, the large embedded volume of existing devices will remain active in the field for at least several years. Experience demonstrates that it takes years for the embedded device base to turn over."[43]

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[41] This concern was echoed in comments filed into the *LightSquared* proceeding by the National Public Safety Telecommunications Council ("NPSTC"). In a June 15 submission, NPSTC stated that "upgrading units already in the field is not practical. Even if such antennas were designed, portable devices are power drain-sensitive. Any improved antenna design will consume more power from the portable device yielding a shorter battery life." Letter dated June 15, 2011, from R. Haller, NPSTC Chair, to J. Genachowski, FCC Chairman, at 5.

[42] TWG Final Report at 53.

[43] *Id*. at 120.

Indeed, the normal replacement cycle for the installed user base is up to 15 years in many applications, and in some scientific applications (*e.g.*, earthquake/geomovement uses), it is critical that the specific device used to take initial measurements also be used to take later measurements to assure integrity of results and eliminate testing variables. There is no question, however, that any acceleration of the normal product replacement cycle for GPS receivers and GPS-dependent applications would significantly increase the costs to all GPS users and indirect beneficiaries.

B. The TWG Final Report Confirms That LightSquared 4G LTE Terrestrial Broadband Operations Using Only the Lower 10 MHz Channel at 1526-1536 MHz Would Cause Harmful Interference to GPS Receivers and GPS-Dependent Applications.

1. No TWG Sub-Team Concluded That LightSquared 4G LTE Operation on Only the Lower 10 MHz Channel Would Be a Viable Mitigation Technique.

TWG sub-teams were able to accommodate a late LightSquared request and test some or even all of their subject devices for interference impacts from reduced-power LightSquared transmissions on either a single 5 MHz carrier or a 10 MHz carrier in the 1526-1536 MHz range. The laboratory testing of this option was done at the transmitter output power level (32 dBW EIRP) that LightSquared identified as the “reduced” power to which its base stations would be limited under the proposals in its Response. The TWG was unable to conclude – for *any* sub-team – that LightSquared 4G LTE operation on only the lower 10 MHz channel is a viable mitigation technique.

Nearly all GPS receivers in tests conducted by four of the seven TWG sub-teams – including General Location/Navigation, High Precision, Timing, and Network receivers – experienced harmful interference when tested against a LightSquared 32 dBW EIRP 4G LTE

signal in the 1526-1536 MHz band.[44] The Aviation sub-team, mindful of the possibility of negative margin during satellite signal acquisition in the vicinity of a LightSquared transmitter operating on the lower 10 MHz channel, stated that a compatibility finding could not be made without further testing.[45]

The results of lower-channel testing in the Cellular sub-team's report belie the claim in LightSquared's Response that lower 10 MHz-only operation will be compatible with cellular devices. Although the Cellular sub-team reported that there were narrowband GPS receivers that could operate in the presence of the LightSquared lower 10 MHz-only configuration, examination of the sub-team report and test results reveal that more than 15% of devices tested (*i.e.*, 6 of 39 devices) would suffer harmful interference from the lower 10 MHz-only LightSquared configuration.[46] These findings establish that tens of millions of currently-

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[44] The non-LightSquared participants in the General Location/Navigation sub-team stated that "[l]ab testing revealed that many devices suffered from harmful interference from the lower 10 MHz channel; specifically, 20 out of 29 devices experienced harmful interference." TWG Final Report at 177. All participants in the High Precision, Timing, and Networks sub-teams recognized that LightSquared operation at 32 dBW EIRP on the lower 10 MHz channel would harmfully interfere with GPS receivers – both those that include MSS augmentation and those that do not. *Id*. at 293. This certainly is so for all modern receivers that employ wideband signals. The LightSquared and non-LightSquared participants disagree only on the ability for future precision receivers to be made immune from this harmful interference. *Id*.

[45] *Id*. at 51. The USGIC notes that the Aviation sub-team made the comment regarding required further study due to the possibility of negative margin during satellite signal acquisition in the vicinity of a LightSquared transmitter operating on the lower 10 MHz channel. *See infra*, at Section IV.

[46] *See* TWG Final Report at 77 (Figure 3.2.1) (showing that 6 out of 39 devices did not pass lower 10 MHz-only tests at blocker levels below -15 dBm). The USGIC notes that the assumptions that led to these results are not worst-case assumptions, and used some optimistic assumptions promoted by LightSquared regarding propagation models, typical deployment, and more that cannot be assured in final implementation. Depending on the accuracy of the assumptions, the number of affected devices could well be higher. For purposes of determining compatibility of GPS-enabled mobile phones with LightSquared 4G LTE transmissions, it would have been preferable to use worst-case (or at least very conservative) assumptions.

deployed cellular devices would experience harmful interference from a LightSquared 4G LTE service using only the lower 10 MHz of the 1525-1559 MHz band.[47]

In addition, the USGIC cautions the Commission against relying too heavily on the Cellular sub-team's finding of robustness in the face of a lower 10 MHz-only LightSquared signal for some cellular devices with narrowband GPS receivers. First, increasing numbers of GPS applications in cellular devices such as smart phones and tablet computers have already made or will soon make use of wideband GPS signals.[48] Devices that maximize pass bandwidth to take advantage of the capabilities presented by these signals would have the same vulnerability to harmful interference from a lower-10 MHz-only LightSquared signal as current GPS receivers using wide-band signals (*e.g.*, precision receivers).[49] Moreover, the 3GPP standards that guided the Cellular sub-team's analysis do not represent the worst-case scenario for GPS; devices that "pass" the 3GPP conformance pass/fail evaluation metric may nevertheless suffer degradations in GPS performance that constitute harmful interference.[50]

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[47] If there are currently 300 million mobile phones and related devices in this country, as LightSquared suggests, the number of devices harmfully interfered with by LightSquared's lower 10 MHz-only operation could total more than 45 million (15 % of 300 million). With more than 200 million GPS-enabled mobile phones currently deployed in the United States, a conservative estimate of the number of devices that would experience harmful interference from LightSquared's 4G LTE service is 30 million (15% of 200 million).

[48] At present, the multi-GNSS cellular standards in 3GPP GERAN ("GSM"), 3GPP RAN ("UMTS") and OMA SUPL 2.0 (Application Layer) support only GPS L1 C/A-code–based Standard Positioning Service and all Galileo Open Service signals. However, work is underway in the standard-setting bodies to include other GPS signals such as L5, L2C, and the new L1C signals, along with signals from such other RNSS systems as Russia's GLONASS, satellite-based augmentation systems (SBASs), and Japan's regional Quasi Zenith Satellite System (QZSS). *See GNSS Solutions: Quantifying the Performance of Navigation Systems and Standards for Assisted-GNSS*, Inside GNSS, September/October 2008, at 23, available at http://www.insidegnss.com/auto/sepoct08-gnsssolutions.pdf (last visited July 28, 2011). *See also* 3GPP TS 34.172

[49] These wide-band receivers would also be more vulnerable to aggregate interference from user equipment operating in the MSS uplink band at 1626.5-1660.5 MHz.

[50] Current 3GPP tests do not demand the greatest accuracy for GPS receivers. *See* 3GPP TS 34.172 and 34.171.

2. The Commission Must Reject LightSquared's Attempt To Reduce the Number of Affected GPS Receivers and GPS-Dependent Applications by Introducing New, Unsupported Harmful Interference Criteria.

One of the major areas of disagreement between LightSquared and the rest of the TWG participants concerned LightSquared's assertion that a much more lenient interference metric than the 1 dB reduction in the receiver's carrier-to-noise ratio ("C/N_0") coupled in many cases with a free-space propagation model that was used by the other sub-teams should be used to assess interference to General Location/Navigation receivers caused by LightSquared operation on only the lower 10 MHz.[51] Under the 1 dB C/N_0 degradation criterion that has scientific and regulatory precedent behind it, 20 out of the 29 devices tested by the General Location/Navigation sub-team would suffer harmful interference from LightSquared's use of a single 10 MHz channel at 1526-1536 MHz[52] With the new, more relaxed LightSquared metric, 28 of 29 tested devices would ostensibly became compatible with LightSquared 4G LTE transmissions that are confined to a single 10-MHz channel at 1526-1536 MHz.[53] The debate has broader significance, than just within the General Location/Navigation sub-team results,

[51] After the testing was complete, and just a matter of days before the initial June 15 deadline for completion of the TWG report, LightSquared introduced to the sub-team the idea that General Location/Navigation sub-team devices should be assessed for harmful interference on the lower 10 MHz channel using a C/N_0 degradation criterion of 6 dB, coupled with a probabilistic propagation model, rather than the 1 dB C/N_0 degradation criterion coupled with free-space propagation that all members of the sub-team other than LightSquared deemed appropriate.

[52] TWG Final Report at 177.

[53] In fact, the USGIC disagrees with this characterization by LightSquared. The number of devices that "fail" depends on where the line is set for "permissible" interference power. To reach its conclusion that the lower 10 MHz channel operation would be compatible with 28 of 29 tested General Location/Navigation devices, LightSquared, drew the line at -25 dBm and said all devices passed at a 6 dB drop in C/N_0. The majority of the sub-team (again all participants other than LightSquared) drew the line at 0 dBm (or -2 dBm) and determined that 20 out of the 29 tested devices failed at a 1 dB drop in C/N_0.

because the GPS noise floor is constant across receiver types. It is not possible for the GPS noise floor to differ among devices.[54]

The USGIC maintains that the LightSquared metric was created after the General Location/Navigation sub-team test results had been compiled, with a view to converting tens of millions of the deployed/installed receivers in this category from "harmfully interfered with under the LightSquared lower 10 MHz-only" list to the "not harmfully interfered with under the LightSquared lower 10 MHz-only" list. Only if all General Location/Navigation receivers are able to be included on the latter list, as LightSquared urges, is LightSquared able to advance its argument that by sheer numbers, the lower 10 MHz-only option does not cause harmful interference to most GPS receivers and GPS-dependent applications in the installed use base.[55]

First of all, there is no basis for the last-minute attempt by LightSquared to change the harmful interference metric for these receivers. As the majority of participants on the General Location/Navigation sub-team noted, the use of a 1 dB reduction in effective C/N_0 (also referred to as a rise in the total noise floor of 1 dB over the environmental noise floor) as a quantification of harmful interference to GPS has a well-recognized basis in the products of seven years of U.S.-supported technical work on protection of radionavigation-satellite service (including GPS) receivers that are now pending final approval within the International Telecommunication

[54] The USGIC notes in this last regard that LightSquared has understated the number of affected high precision receivers as well. Right now, there are well over half a million high precision GPS receivers in use (not 200,000 as LightSquared asserts without attribution), of which a very large percentage are capable of receiving MSS augmentation.

[55] *See* LightSquared Response at 4 (representation as to the number of GPS receivers affected includes no General Location/Navigation receivers).

Union's Radiocommunication Sector.[56] This view was echoed in nearly the same words by the majority of High Precision, Timing, and Network sub-team participants.[57] Interestingly, where LightSquared sought to change the General Location/Navigation criterion to a 6 dB reduction in effective C/N_0, it did not push for a change in criterion in the High Precision, Timing and Network sub-teams' report, opining instead that "[t]est results indicate that a 1 dB reduction in C/N_0 may be unduly conservative …."[58] The Space-based sub-team agreed without dissent that a 1 dB degradation in C/N_0 is the proper criterion for assessing harmful interference to space-based receivers.[59]

The TWG majority view that a 1 dB degradation in C/N_0 is the proper criterion for assessing harmful interference to General Location/Navigation receivers is supported as well in Commission decisions. When considering the interference criteria to protect GPS from ultra wideband transmissions, the Commission adopted a model based on a 1 dB increase in the noise floor of the GPS receiver (*i.e.*, a 1 dB reduction in C/N_0).[60]

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[56] TWG Final Report at 129. The sub-team's non-LightSquared participants went on to note that the protection levels for various types of receivers that operate with RNSS systems – including GPS – in the 1559-1610 MHz band that are provided in Draft New ITU Recommendation ITU-R M.[1477_New] are based (in combinations of technical parameters such as "system noise temperature" and "acquisition mode threshold power density level of aggregate wideband interference at the passive antenna output") on a maximum permissible increase in the noise floor from interferers of 1 dB. *Id*.

[57] *Id*. at 188.

[58] *Id*.

[59] TWG Final Report at 302. The contemporaneous study by the National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum ("NPEF") of the interference potential of the LightSquared terrestrial mobile broadband proposal to GPS (*see* Section IV, *infra*), also relied upon the use of a 1 dB degradation in C/N_0) as the operative criterion. NPEF determined that the 1 dB degradation in C/N_0 point represented an approximately 25% loss in effective signal power. While the criterion did not necessarily signify that even a 1 dB reduction was tolerable by GPS receivers, NPEF agreed that it was useful to highlight the onset of severity associated with these emissions. *See* NPEF Report (n. 62, *infra*, at 4).

[60] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, 18 FCC Rcd 3857, 3863 (2003). The fact that the model was recognized by the Commission to be "conservative" was not an impediment to its adoption. *Id*. A conservative approach is certainly warranted here as well given the intensive adoption of GPS as well as the many safety of life applications using GPS.

By contrast, there is no basis whatsoever in any technical literature anywhere for the C/N_0 criterion/ propagation model combination that LightSquared selected and urged after the testing was complete. In fact, LightSquared's argument is not even supported by its own graphics. In the graphics LightSquared chose to illustrate its claimed lack of harmful interference at the 6 dB C/N_0 degradation level in dynamic tests, the illustration for the 6 dB degradation case shows several instances of GPS errors that range from one to three city blocks, as contrasted with the 1 dB degradation case.[61] LightSquared's claims that the differences in performance are "almost indistinguishable" and "caused no user perceptible degradation" thus are unsupported even by its own material.[62]

The Commission should reject the LightSquared minority view on harmful interference criteria for the General Location/Navigation sub-team. It must instead accept as credible the TWG majority conclusion that, based on the testing results, nearly 70% of the 100 million General Location/Navigation GPS receivers in use today would be harmfully interfered with if LightSquared were to operate its proposed 4G LTE systems only on the lower 10 MHz channel of its MSS downlink band.

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[61] *See* TWG Final Report at 157-158 (Figures 3.3.20-3.3.22); LightSquared Response at Technical Appendix, pp. 11-12.

[62] An additional factor that weighs in favor of using the established criteria rather than the newly-created criteria that LightSquared is pushing, consistent with its agenda, is the fact that some of the LightSquared parameters and characteristics are indeed too lenient. As noted above, the understatement of electrical antenna beam downtilt (by 10 degrees) will increase the interference effects from LightSquared in urban cores where many general location/navigation devices operate. In this type of compatibility analysis, with hundreds of millions of deployed devices requiring protection, it will not do to be overly optimistic about the interference effects.

C. Based on the TWG Final Report, It Is Evident That the Harmful Interference Concerns Raised with Respect to LightSquared's Proposed 4G LTE Terrestrial Broadband Operations in the 1525-1559 MHz Band Have Not Been Resolved.

There are two core truths in the TWG Final Report. First, the proposed LightSquared deployment of two 10 MHz, 32 dBW EIRP per sector, 4G LTE channels of terrestrial broadband mobile service in the 1525-1559 MHz and 1626.5-1660.5 MHz MSS bands will cause harmful interference to virtually every type of GPS receiver and GPS-dependent application. Second, the TWG Final Report does not provide any technical basis for concluding that the harmful interference can be mitigated either by changing the LightSquared deployment plans to use only the lower 10 MHz channel or by incorporating additional filter technology into future generation GPS receivers.

In reviewing the TWG Final Report, it is important for the Commission to concentrate on the data and results that have been gathered from across the GPS universe, and disregard expressions of conjecture. Because it must find that the harmful interference concerns are confirmed, and that GPS receivers and GPS-dependent applications will suffer harmful interference if LightSquared were to commence any kind of 4G LTE operations in its MSS spectrum, the Commission has no basis for lifting the condition the Bureau adopted in *LightSquared* and should rescind the order.

IV. The TWG Final Report Results, Endorsed By All Parties Other Than LightSquared, Are Consistent with Findings Made in Other Contemporaneous Studies of Potential LightSquared Harmful Interference to GPS Receivers and GPS-Dependent Applications.

Several studies of the impact of potential LightSquared 4G LTE transmissions on GPS receivers and GPS-dependent applications were made by government organizations over the last few months. One of those studies was conducted by the National Space- Based Positioning, Navigation, and Timing Systems Engineering Forum ("NPEF"), which issued its "Assessment of

LightSquared Terrestrial Broadband System Effects on GPS Receivers and GPS-Dependent Applications" ("NPEF Report") on June 1, 2011.[63]

In its Report, the NPEF recommended that "LightSquared should not commence commercial services per its planned deployment for terrestrial operations in the 1525 – 1559 MHz Mobile-Satellite Service (MSS) Band due to harmful interference to GPS operations."[64] With respect to the potential mitigation technique of limiting LightSquared 4G LTE operation to the lower 10 MHz, NPEF stated that while some improvement was observed for aviation receivers (which operationally have greater selectivity than is required for the functionality of ground-based receivers (including high precision and general location/navigation receivers), "for other applications, GPS loss of function still occurs at unacceptable distances to LightSquared towers."[65] On the subject of additional filtering, the NPEF study reached the following conclusion that is very similar to the position taken in the TWG Final Report by several of the sub-teams' GPS participants:

> Possible mitigations for GPS applications were identified and evaluated but were deemed impractical as they would require significant modification or complete redesign and replacement of currently fielded GPS equipment. The timeline to field new GPS receivers for some applications, from initial concept development through production, can take 10-15 years. Finally, there remain certain applications (*e.g.*, high precision) that, even with modification, may not be able to perform their current mission in the presence of LightSquared's network transmitting in the 1525 – 1559 MHz band.[66]

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[63] A public version of the NPEF report was submitted into the LightSquared proceeding by NTIA on July 6, 2011. *See* Letter dated July 6, 2011, from L. Strickling, NTIA Administrator, to J. Genachowski, FCC Chairman in LightSquared proceeding, FCC File No. SAT-MOD-20101118-00239, at Enclosure.

[64] NPEF Report, Exec Summary at i.

[65] *Id*. at ii.

[66] *Id*. at i.

The NPEF concluded that on the basis of its analyses, "significant technical concerns remain that operation of an ATC service can successfully coexist with GPS."[67] It noted that the nonexistence of relevant ATC equipment had heretofore made rigorous analysis of potential interference to GPS impossible, and that there now "is a need for additional analysis to determine if ATC architectures can be accommodated in the MSS L-band without impacting GPS."[68]

These are serious conclusions from an independent technical expert forum. The results of the studies reported by the NPEF also happen to correlate very closely with the data and analysis performed by the TWG sub-teams and reflected in the results and conclusions embraced by all TWG members other than LightSquared and its affiliates. The Commission should accord significant weight to the NPEF Report and its corroboration of the TWG results.

A separate study of the impact of LightSquared's proposed 4G LTE transmissions in the 1525-1559 MHz and 1626.5-1660.5 MHz MSS bands on GPS receivers used in aviation (including ground-based GPS receivers associated with the GPS Wide Area Augmentation System) was performed by a technical subcommittee of RTCA, Inc. ("RTCA"), a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management (CNS/ATM) system issues.[69] The technical data generated by the RTCA study was, by agreement of the TWG, used as the basis for the Aviation sub-team's report in the TWG Final Report.

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[67] *Id*. at ii.

[68] *Id*.

[69] The RTCA study, performed by the Global Positioning System sub-committee of RTCA (Special Committee 159), was released on June 3, 2011 in RTCA DO-327, and is entitled, "Assessment of the LightSquared Ancillary Terrestrial Component Radio Frequency Interference Impact on GNSS L1 Band Airborne Receiver Operations."

In its report, the RTCA stated that:

> The impact of a LightSquared upper channel spectrum deployment is expected to be complete loss of GPS receiver function. Because of the size of the single-city station deployment, GPS-based operations below about 2000 feet will be unavailable over a large radius from the metro deployment center (assuming no other metro deployments are nearby). Given the situation in the high altitude U.S. East Coast scenario, GPS-based operations will likely be unavailable over a whole region at any normal aircraft altitude.[70]

With respect to the prospect of limiting LightSquared's 4G LTE operation to a single 10 MHz channel at 1526-1536 MHz at 32 dBW EIRP, RTCA's study indicated that there was a small positive margin for GPS tracking, but not necessarily for initial acquisition.

The RTCA conclusions track with those of the TWG's Aviation sub-team, including the observation that LightSquared operation limited to the lower 10 MHz could jeopardize aviation receivers' ability to acquire GPS satellite signals. Clearly, RTCA did not endorse operation by LightSquared even on the lower 10 MHz channel. The Commission should accord significant weight as well to the RTCA Report and its corroboration of the TWG results reported by the Aviation sub-team.

V. The LightSquared Response Is Out of Step with the TWG Final Report.

A. LightSquared's Attempts to Distance Itself from the TWG Final Report's Conclusions by Accusing GPS Manufacturers of Producing Deficient Products Are Fallacious.

In its Response, LightSquared tried to deflect attention from the TWG Final Report's conclusions. Recognizing that the TWG Final Report does not provide a technical solution to the now indisputable harmful interference threat LightSquared's proposed 4G LTE operations in the MSS spectrum at 1525-1559 MHz presents, LightSquared launched a strident attack against GPS manufacturers. It attempted to blame the victim by insisting that the GPS community's

[70] RTCA Report at 1.

"disregard for the Commission's policies regarding the immunity of receivers to transmissions in nearby frequency bands … is the source of the technical problem."[71] It also accused GPS manufacturers of deliberately designing receivers that do not adequately reject transmissions from base stations operating in the adjacent frequency band.[72]

LightSquared's tactic here, while an understandable reaction to the devastating blow the TWG Final Report provides to LightSquared's plans to use the MSS L-Band for terrestrial mobile broadband operations, is fallacious. For more than 30 years, GPS manufacturers have designed receivers to operate within the overall spectrum allocation environment around the 1559-1610 MHz band used by GPS – an environment that includes the MSS bands immediately above and below the GPS band. The ITU and FCC Tables of Frequency Allocations have never included – and do not today include – allocations to terrestrial services in the United States in the 1525-1559 MHz and 1626.5-1660.5 MHz bands. When the Commission, some ten years ago, started consideration of a terrestrial adjunct to MSS systems that would expand the utility of MSS by allowing repeaters to produce MSS-like signals in urban canyons and other locations with spotty MSS reception, the USGIC and the GPS community weighed in and worked with the MSS providers at the time (including LightSquared's MSS predecessors) to identify and articulate the criteria that would allow the back-fill ancillary terrestrial use desired by the MSS community without causing harmful interference to GPS or MSS in the 1525-1559 MHz band. Those actions are reflected in the Commission's rules and licensing decisions for MSS ATC.[73]

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[71] LightSquared Response at 2.

[72] *Id*. at 1.

[73] *See* Section V.B, *infra* for further discussion on the regulatory considerations behind ATC.

MSS ATC, as developed prior to the instant LightSquared application proceeding, is consistent with the overall L-Band spectrum plan, as reflected in the FCC and ITU spectrum allocation tables. The ITU spectrum allocation table, which is implemented in the U.S. in Section 2.106 of the FCC's Rules, groups several different satellite uses together in the 1525-1660.5 MHz range with the object of avoiding interference that would result from having inconsistent spectrum uses in adjacent frequency bands. In the frequency range 1525-1660.5 MHz, there is no allocation of spectrum for any primary terrestrial use of any kind in the United States or the Americas region.[74] This arrangement of like-kind frequency allocations limits the potential for interference from ubiquitously-deployed, high-powered, mobile terrestrial transmitters to space-based services, including GPS receivers, which must be highly-sensitive in order to detect faint satellite signals across a range of frequencies.[75]

The fact that LightSquared begins its Response with several pages of text complaining that the interference issues from LightSquared that threaten the very operation of GPS receivers and GPS-dependent applications is of the GPS manufacturers' own making demonstrates that LightSquared would have the Commission simply ignore long-standing principles of sound spectrum management policy. LightSquared's attack requires subscription to the credulity-stretching premise that every manufacturer of GPS equipment systematically ignored or disregarded all of the signs LightSquared claims, and that no parts supplier saw the opportunity

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[74] *See* 47 C.F.R. § 2.106 (Table of Frequency Allocations). *See also* ITU Radio Regulations, Article 5.

[75] To the extent that LightSquared's criticism here may derive at least in part from LightSquared's assertion that "GPS receivers deliberately 'listen in'" to the MSS bands (*see* LightSquared Response at 18, 29-31, and Technical App. at 15), for the provision of MSS-augmented GPS service, LightSquared is on particularly thin ice. As the USGIC explains below in Section V.C, GPS receivers that utilize the MSS band for augmentation communications do so via service provision agreements with LightSquared and other MSS providers in the 1525-1559 MHz band. The MSS providers are paid for this service, and contractually require that MSS-augmented GPS receivers be able to move to any other frequency in the entire MSS band on short notice – which means that the front ends of such receivers must be open to the entire band.

for developing enhanced filters or other measures that could help GPS receivers survive the heightened interference that was coming. This is incorrect. The actual explanation is that there never has been, nor will there be in any meaningful time frame, technology that can accommodate LightSquared's ubiquitous, free standing terrestrial use. More fundamentally, LightSquared's account of prior Commission decisions, and its predecessors' plans and proposals, is revisionist history at its worst.

Where the ATC concept allowed terrestrial signals with received power levels operationally similar to the authorized MSS signals they were designed to supplement, LightSquared is now proposing to put into the MSS band at 1525-1559 MHz a terrestrial transmission that produces received power levels that are ONE BILLION times stronger.[76] This is not a signal that is typical of the satellite neighborhood at 1525-1660.5 MHz; it completely overwhelms any satellite signal in the area – including the MSS signals – where the transmission is made.[77] Under LightSquared's vision, the MSS, which cannot operate where terrestrial use occurs, has become ancillary to the terrestrial. The intractable problem lies in the fact that not only does this new, powerful terrestrial signal prevent co-located MSS reception, it wipes out nearby GPS as well – and GPS, unlike MSS, must be able to operate in the areas where the new terrestrial service is deployed.

Although LightSquared is completely wrong to blame GPS manufacturers for not predicting that anyone would ignore the allocation scheme and rules in such a way as to bring a

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[76] The minimum guaranteed signal strength for GPS L1 C/A receivers received power, per the GPS signal specification as detailed by the GPS Directorate, is -158.5 dBW. A 32 dBW transmitter at 1650 meters has a power of -68.5 dBW. The difference is 90 dB, which makes the 4G LTE transmission at least one billion times more powerful at a GPS receiver within the LTE coverage area than the GPS satellite it is trying to receive.

[77] In its November 2010 modification of license application in File No. SAT-MOD-20101118-00238, LightSquared acknowledged that its satellite signal would not be available in areas that are "within range of LightSquared's base stations." LightSquared Subsidiary LLC Modification of License Application, File NO. SAT-MOD-20101118-00238, Narrative Statement, at 9.

satellite-killing application into a satellite frequency range, the fact of the matter is that the responsibility to resolve interference issues rests exclusively with LightSquared.[78] From the outset of the MSS ATC concept, the Commission recognized that it was introducing a limited terrestrial use into the established satellite spectrum environment in the 1525-1660.5 MHz bands and made plain that the ancillary terrestrial operations it was authorizing would be required to protect GPS receivers. In the initial MSS ATC Notice of Proposed Rule Making, the Commission stated:

> The L-band MSS satellite transmitters operate [in] the lower adjacent band to the Global Positioning System ("GPS") and other Radio Navigation Satellite Services. Unwanted emissions from terrestrial stations in the MSS will have to be carefully controlled in order to avoid interfering with GPS receivers.[79]

This obligation of MSS ATC operators to protect all spectrum users providing allocated services from *all* harmful interference was in fact codified into the Commission's rules. In 2003, the Commission stated that "[i]f harmful interference is caused to other services by ancillary MSS ATC operations, either from ATC base stations or mobile terminals, *the ATC operator must resolve any such interference*."[80]

In the past, LightSquared has recognized and accepted this responsibility. Just last year, in comments on the Commission's rulemaking proposal to allow terrestrial mobile broadband use of the MSS spectrum at 2 GHz, LightSquared stated that "ATC in the L-band, because it lacks a primary allocation in the United States, may have to protect other services and to accept

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[78] *See* 47 C.F.R. § 25.255.

[79] *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, Notice of Proposed Rulemaking, 16 FCC Rcd 15532, 15559 (¶ 68) (2001) ("*MSS ATC NPRM*").

[80] 47 C.F.R. § 25.255 (emphasis added).

interference from other services . . . ."[81] Now, LightSquared has changed its tune and blames GPS manufacturers for not designing receivers that adequately reject the same signals the Commission has said LightSquared (as the ATC operator) must resolve.

This is not an issue of the GPS industry's making. The LightSquared proposed 4G LTE terrestrial broadband signals are at variance with the allocation tables and are inconsistent with long-standing spectrum policy and principles of sound spectrum management. The International Bureau's January 2011 *LightSquared* order effectively converted what was supposed to have been a secondary, strictly non-interfering and limited spectrum use to a co-primary status when it waived the integration requirement without first determining technical compatibility. LightSquared 4G LTE operations have no rights, and must be provided, if at all, on a non-protected, non-interference basis vis-à-vis all spectrum users providing services that have primary or secondary allocations. So far, no basis has been found for determining that LightSquared is capable of operating a 4G LTE terrestrial mobile broadband system in the 1525-1559MHz band on a non-harmful interference basis. It therefore is time for the Commission to rescind the waiver the International Bureau granted LightSquared in January.

B. LightSquared's Assertion That GPS Manufacturers Should Have Anticipated "Adjacent Band Terrestrial Transmissions" Is Wrong.

In its Response, LightSquared repeats its now-familiar revisionist refrain that GPS should have known for the last eight years that high-power stand-alone terrestrial mobile broadband service was coming to the MSS bands licensed to LightSquared, and thus any failure to prepare for the invasion rests solely with GPS.[82] This argument is flawed on multiple levels. First of all, exactly who in LightSquared's view is it that "failed" to prepare for the conversion of the MSS

[81] LightSquared Comments, ET Docket. No. 10-142, at 12 (Sept. 15, 2010).

[82] LightSquared Response at 16-17.

band to a terrestrial mobile broadband operation? Is LightSquared seriously contending that every one of the dozens of GPS equipment manufacturers, all of whom are technically savvy spectrum users, coincidentally missed the same signposts over the last decade or so? Is LightSquared propounding instead that all of the government, civil, and user communities together and individually erred when they relied on the Commission's repeated reiteration of the importance of the ATC gating requirements and other limitations and express prohibitions against untethered terrestrial service in the LightSquared MSS bands? The answer to both questions is that no one missed anything, because the signals LightSquared suggests were never given. MSS ATC was, until the January 2011 *LightSquared* decision, an ancillary and limited terrestrial adjunct to LightSquared's MSS system that would be a "gap filler" to permit ubiquitous service *by MSS operators* in circumstances where satellite service might be degraded by man-made or natural barriers.[83]

Second, the notion that "the GPS industry" endorsed or approved what LightSquared now says are its long-standing plans is a ridiculous one, and a cynical attempt to portray nearly two decades of USGIC cooperation with MSS over unwanted emissions issues from handsets and ATC compatibility as some kind of liability or weakness. The USGIC, as a representative of responsible spectrum users, has a history of working with LightSquared's predecessors to help establish conditions for the ancillary terrestrial component of MSS in the 1525-1559 MHz and 1626.5-1660.5 MHz bands, and on unwanted emissions issues from MSS handsets before that. The USGIC has, in fact, continuously supported the use of *ATC* in the MSS band for its original

[83] The fact that the Commission itself seems to have accepted LightSquared's creative reinterpretation of the history of ATC changes nothing. The USGIC has responded to the Commission's contention that "extensive terrestrial operations have been anticipated in the L-band for at least 8 years" (*i.e.*, since 2003) by seeking reconsideration of the otherwise unrelated Commission Report and Order in *Fixed and Mobile Services in the Mobile-Satellite Service Bands at 1525-1559 MHz and 1626.5-1660.5 MHz, 1610-1626.5 MHz and 2483.5-2500 MHz, and 2000-2020 MHz and 2180-2200 MHz*, 26 FCC Rcd 5710, 5728 (2011) ("*2 GHz MSS R&O*"). *See* USGIC Petition for Reconsideration of the *2 GHz MSS R&O*, at 4-7 (filed June 30, 2011).

intended purpose (as LightSquared itself noted).[84] The position of the USGIC and the GPS industry has not changed; instead, LightSquared is the entity that fundamentally altered the intended use of ATC when it sought, in November 2010, to operate a stand-alone high-power co-primary terrestrial signal in its MSS bands instead of an ancillary gap-filler. The USGIC understands that the new LightSquared is desperate to make its terrestrial mobile broadband dreams come true, but LightSquared's desires cannot be allowed to turn the USGIC's long history of cooperation and good-faith resolution of interference concerns back on the USGIC.

To be clear, LightSquared's contention that for eight years, signs have existed that MSS ATC really means high-power terrestrial mobile broadband is dead wrong. As noted above, in August 2001, the FCC issued a Notice of Proposed Rule Making inviting comment on proposals from LightSquared's predecessors and others to add a terrestrial component to MSS.[85] At that time, the Commission made plain that terrestrial use would be fully integrated with MSS operations. The 2001 NPRM quoted at length from the petition for rule making filed by Motient Services, Inc. (a LightSquared processor), where it described the ATC service it was proposing as "integrated with the satellite network" and as enabling "co-channel reuse of the satellite service link frequencies in adjacent satellite antenna beams to provide coverage to areas where the satellite signal is attenuated by foliage or terrain and to provide in-building coverage."[86] The rulemaking petition also noted that the "satellite path would be the preferred communications

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[84] LightSquared Response at 5.

[85] The USGIC presents a condensed version of the rebuttal to LightSquared's revisionist history claim here. For a more comprehensive version that is in the record of the *LightSquared* proceeding, *see* Letter dated June 30, 2011, from F. Michael Swiek, Executive Director, USGIC in File No. SAT-MOD-20101118-00239, submitting for the record the June 14, 2011 Letter from J. Kirkland, Vice President and General Counsel, Trimble Navigation Limited, to J. Knapp, Chief, OET.

[86] *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, Notice of Proposed Rulemaking, 16 FCC Rcd 15532, 15541 (¶ 15) (2001) ("*MSS ATC NPRM*").

link, but if the user's satellite path is blocked, the communications link would be sustained via the fill-in base stations."[87] These statements emphasize that MSS ATC was always intended to be a limited adjunct to satellite service to fill gaps in coverage.

When it subsequently adopted rules for integrated terrestrial use of L-band MSS, the Commission strongly cautioned that it was authorizing limited MSS ATC operations "subject to conditions that ensure that the added terrestrial component remains ancillary to the principal MSS offering."[88] It emphasized, "[w]e do not intend, nor will we permit, the terrestrial component to become a stand-alone service."[89] The Commission went beyond establishing limits on MSS ATC, and explained why any other approach, such as sharing between independent terrestrial and MSS use, was unworkable, making plain its carefully considered technical judgment that "shared usage between MSS and terrestrial services would likely compromise effectiveness to such a degree that neither service would prove cost-effective, and therefore would probably not be deployed."[90]

Further, when the International Bureau eventually granted the L-band integrated MSS ATC application of LightSquared's predecessor in 2004, it noted the Commission's

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[87] *MSS ATC NPRM*, 16 FCC Rcd at 15541 (¶ 15).

[88] *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, Report and Order and Notice of Proposed Rulemaking, 18 FCC Rcd 1962, 1964-65 (¶ 1) (2003) ("*MSS ATC R&O*"). The FCC explained further that:

> [W]e intend to authorize ATC only as an ancillary service to the provision of the principal service, MSS. We have established a number of gating requirements to ensure that ATC may only operate after the provision of MSS has commenced and during the period in which MSS continues to operate. . . . While it is impossible to anticipate or imagine every possible way in which it might be possible to "game" our rules by providing ATC without also simultaneously providing MSS and while we do not expect our licensees to make such attempts, we do not intend to allow such "gaming."

Id. at 1965 (footnote 5) (emphasis added).

[89] *MSS ATC R&O*, 18 FCC Rcd at 1965 (¶ 1).

[90] *MSS ATC R&O*, 18 FCC Rcd at 1995 (¶ 55).

unquestioned emphasis on the "ancillary" nature of the MSS terrestrial service, declaring that "[t]he Commission's decision to permit implementation of MSS ATC was based on the premise that ATC must be 'ancillary' to MSS operation."[91] The Commission subsequently considered this issue once again, and reiterated its prior conclusions in unequivocal terms, stating that "'integrated service' as used in this proceeding," and required by Section 25.149(b)(4) of the FCC's Rules, "forbids MSS/ATC operators from offering ATC-only subscriptions," and that it would "not permit MSS/ATC operators to offer ATC-only subscriptions, because ATC systems would then be terrestrial mobile systems separate from their MSS systems."[92] In the same order, the Commission stated that:

> In any channel that is coordinated for the exclusive use of an MSS/ATC operator, and where there is no other MSS operator's satellite within the visible arc as seen from the ATC geographic coverage area, the MSS/ATC operator is limited only by in-band and out-of-band emission limits *and the need to control self-interference sufficiently to maintain satellite service*.[93]

This paragraph shows that the FCC considered specifically that MSS ATC operators would be required to control self-interference to a level consistent with maintaining substantial satellite service, a necessity that also would maintain the spectrum environment critical for GPS.[94]

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[91] *See In the Matter of Mobile Satellite Ventures LLC*, 19 FCC Rcd 22144, 22150 (¶ 18) (2004) (footnotes omitted) ("To that end, the Commission established 'gating' requirements for ATC authorization and operation to ensure that ATC will augment, rather than supplant, MSS"). At that time LightSquared was known as Mobile Satellite Ventures, LLC. The Council uses the company's current name throughout these Comments when referring to the L-band MSS licensee.

[92] *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, Memorandum Opinion and Order and Second Order on Reconsideration, 20 FCC Rcd 4616, 4628 (¶ 33) (2005) (footnote omitted) ("*MSS ATC 2nd Recon. Order*").

[93] *MSS ATC 2nd Recon. Order*, 20 FCC Rcd at 4633 (¶ 46) (emphasis added).

[94] The FCC then used the limit on overall interference as the basis for eliminating the cap on the number of base stations, stating that "our overall limit on the interference an MSS/ATC operator may cause to other MSS systems obviates the need for a numerical limit on ATC base stations." *MSS ATC 2nd Recon. Order*, 20 FCC Rcd at 4634 (¶ 48).

Now, of course, with a proposed terrestrial power level that is more than one billion times more powerful than the satellite signals in either its own band or the adjacent GPS band, there is no way that any satellite receiver will function in the presence or proximity of a LightSquared terrestrial transmitter. All satellite service would be precluded and the band would be geographically segmented between terrestrial and satellite uses.

The only terrestrial operations that were understood to be permissible in the L-band over the past decade were those that remain ***ancillary to and fully integrated with MSS*** and which consequently protect reception of low-power L-band satellite signals by mobile Earth terminals.[95] Accordingly, LightSquared's assertion that the entire GPS industry deliberately ignored nearly a decade of regulation and decisional cues is baseless, and the house of cards it tries to build on this assertion – to and through the expectation that GPS should accept the LightSquared offer of a "standstill" to fix its supposed deficiencies before LightSquared occupies the entire 1525-1559 MHz band with its alien terrestrial signal – is without foundation.

C. LightSquared's Response Mischaracterizes the TWG Final Report in a Wholly Unsuccessful Attempt To Buttress the Prospects for its Last-Minute "Split the Baby" Proposal.

In its Response, LightSquared attempts to downplay the effects of its proposed 4G LTE terrestrial mobile broadband service on GPS receivers and GPS-dependent applications. For example, the TWG Report unanimously reveals that LightSquared's current three-phase deployment plan would have a devastating harmful interference impact on all GPS receivers, yet LightSquared euphemistically states that "the overall conclusion of the testing is that

[95] The fact noted above that filters that would allow for rejection of some of the high-power terrestrial signals at the GPS receiver do not exist and are not even in reasonably advanced states of development is another indication of the incorrectness of LightSquared's contention that the writing has been on the wall for years regarding high-power mobile broadband. *See* Section III.A above. If the signs were there as LightSquared asserts, it seems reasonable to expect that opportunistic filter manufacturers would have identified the opening and developed parts they could supply to the burgeoning GPS industry. That did not occur because the signs LightSquared claimed existed did not, in fact, exist.

transmissions in the upper 10 MHz channel … will adversely affect the performance of a significant number of legacy GPS receivers."[96] It goes on to claim erroneously that this interference is "not caused by emissions from LightSquared's base stations into the GPS band," but by GPS receivers themselves, for failing to "reject transmissions from LightSquared's licensed frequencies …."[97]

This LightSquared assessment has no basis in the TWG Final Report. It is absolutely certain, as recited above, that the only harmful interference to GPS would come from LightSquared's proposed emissions from its 4G LTE terrestrial mobile broadband system. It is equally clear that this problem arises solely because LightSquared opportunistically sought, apparently without comprehension or consideration of the consequences of its actions, and in derogation of domestic and international tables of frequency allocation, to introduce into a satellite band a terrestrial signal that is more than one billion times stronger than the GPS satellite signals.[98] Moreover, LightSquared's apparent belief that it can make any transmissions it wants in the MSS frequencies licensed to it reflects a fundamental myopia. LightSquared holds a license to use spectrum for the provision of MSS and, on an ancillary basis only, true ATC; it does not, by virtue of its licensure in the 1525-1559 MHz and 1626.5-1660.5 MHz bands, have free rein to offer any service it desires without regard to the allocation and service rules applicable to those bands.

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[96] LightSquared Response at 9. Clearly, the report's finding was not limited to "legacy" GPS receivers – itself a negative and biased reference (which was unfortunately embraced by the Commission in the June 30 Notice) that creates the false impression that the hundreds of millions of deployed GPS receivers with state-of-the-art technology are somehow instead a few outdated receivers that happen to be in use. The USGIC encourages the Commission to refer to the GPS installed user base rather than to "legacy" GPS receivers.

[97] *Id*.

[98] *See supra*, at n.76 and accompanying text.

LightSquared distorts the TWG Final Report in other ways – notably in claiming falsely and without attribution that the "data" demonstrates that "100 percent of GPS-enabled mobile phones and general location and navigation devices can be expected to receive no meaningful interference from LightSquared operations in the lower 10 MHz channel."[99] There simply is no basis for this assertion. The TWG Final Report demonstrates, using conservative assumptions, that more than 15% of cellular devices tested (*i.e.*, 6 of 39 devices) would suffer harmful interference from the lower 10 MHz-only LightSquared configuration.[100] This represents, as noted above, as many as 15-30 million mobile terrestrial devices with embedded GPS.[101] The TWG Final Report also demonstrates that all participants in the General Location/Navigation sub-team other than LightSquared believe that the data demonstrates that nearly 70% of the 29 tested general location and navigation receivers will suffer harmful interference from a LightSquared lower 10 MHz-only 4G LTE operation. It is undisputed that there are over 100 million general location/navigation devices in the installed base today, meaning that the number of affected devices in this category that were not reflected in LightSquared's analysis potentially exceed 70 million.

LightSquared's erroneous conclusions are the apparent basis for its claim that 99 percent of GPS devices in the current installed base would be free from harmful interference if lower 10

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[99] *Id*. at 10.

[100] *See* Section III.B.1, *supra*, citing TWG Final Report at 77 (Figure 3.2.1).

[101] *See supra*, at n. 47.

MHz LightSquared operation were permitted;[102] the reality, of course, is that the TWG Final Report requires that hundreds of millions of current GPS devices must be deemed susceptible to harmful interference from a lower 10 MHz-only LightSquared operation.[103] Thus, LightSquared has grossly underestimated the number of GPS receivers that would be harmfully interfered with by LightSquared lower 10 MHz-channel operations.

Other falsehoods and technical inaccuracies, including some relating to the TWG Final Report and data generated by the sub-teams, appear throughout the LightSquared Response. For example, LightSquared claims that it will deploy "an integrated satellite terrestrial network."[104] In fact, the signals broadcast by the two elements of this "network" are fundamentally incompatible. The power disparity means that they cannot be received in the same region; modulation on each signal could scarcely be more different from the other. With LightSquared's recent change of ATC from ancillary gap-filling terrestrial repeaters to a high-powered terrestrial mobile broadband system, there is nothing truly "integrated" about LightSquared's network – a fact that the FCC recognized when it granted LightSquared a waiver of the requirement to offer an integrated service.

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[102] LightSquared's assertion that there would be "no meaningful interference" is clearly unsupported in any way by the TWG Final Report and the data analyzed by the sub-teams. The USGIC believes that many more cellular devices than the 20% or so that would suffer harmful interference with lower 10 MHz-only operation would suffer some level of degradation (*i.e.*, meaningful interference) that does not arise necessarily or in all cases to the level of harmful interference. *See* TWG Final Report at 77-87 (showing interference impacts to increasing numbers of tested devices at levels between 0 dBm and -15 dBm. Some of the nine general location/navigation devices that were not harmfully interfered with on the lower 10 MHz-only channel likely suffered "meaningful" interference as well. The imprecision and casualness of LightSquared's supposedly technical-based assertions are troubling in their own right.

[103] In addition to the effects of harmful interference on direct GPS users in the current installed base – effects in terms of loss of life and property that could be huge – the indirect effects of these receiver failures in terms of lost productivity; and other consequences of unreliable or unavailable positioning, navigation, and timing information will ripple throughout society.

[104] LightSquared Response at 20.

Also inaccurate is LightSquared's oft-repeated assertion/accusation that "GPS receivers deliberately 'listen in'" to the MSS bands[105] or make other "unauthorized free access to LightSquared frequencies."[106] Those GPS receivers that utilize the MSS band for augmentation communications do so via service provision agreements with the MSS providers in the 1525-1559 MHz band – including LightSquared. The MSS providers receive an ongoing payment for this service, and contractually require that MSS-augmented GPS receivers be able to move to any other frequency in the entire MSS band on short notice, which means that the front ends of such receivers must be open to the entire band.[107] The deliberate use is thus by design, is not "free," and is plainly "authorized." It is at best disingenuous for LightSquared to both demand that MSS-augmented GPS receivers have this capability and then to vilify its own customers by characterizing this contractual requirement as "listening in" or engaging in "unfortunate design."[108] Moreover, the argument does not explain or help resolve in any way the fact that not only MSS-augmented GPS receivers are affected by LightSquared; all GPS receivers that make use of the wideband signals broadcast by GPS satellites are harmfully interfered with by LightSquared, as are many GPS receivers that make use only of the narrowband L1 CA code.

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[105] *Id*. *at* 18, 29-31, and Technical App. at 15.

[106] *Id*. at 36.

[107] This fact is confirmed in the TWG Final Report, at 277 (Section 12.3) ("[L]arge numbers of agricultural GPS receivers deployed across the United States depend on delivery of continuous real time differential (RTD) GPS correction data via L-Band Mobile Satellite Services in the 1525-1559 MHz band. Due to the contractual requirements of the MSS providers, receivers in this band have to be able to receive a signal anywhere within the band, as the providers reserve the right to move at short notice the frequency within the band being used to deliver any given signal").

[108] The fact that LightSquared, which required MSS-augmented GPS receivers to be capable of receiving across the entire MSS band, never alerted GPS manufacturers that their operations were going to be affected by the new primary terrestrial use suggests that LightSquared itself either did not know about the implications of its planned operations or that it did not formulate the plan until after the current owners acquired control of LightSquared in 2010. In either case, the current LightSquared argument that GPS manufacturers should have known about the *de facto* reallocation of the MSS band to high-power terrestrial mobile use appears to be a contrivance and is reflective of a broader indifference to MSS generally and its own paying customers specifically.

GPS receivers are properly designed to operate in the "satellite" neighborhood that exists in the domestic and international tables of frequency allocations in the 1525-1660.5 MHz range. There are no unaccounted for high-power terrestrial signals anywhere in the world that pose the threat of harmful interference to GPS and other RNSS users. The laws of physics are clear; LightSquared cannot provide 4G LTE service in the satellite neighborhood without causing harmful interference.

Moreover, GPS receivers and chipsets reflect state of the art technology, design, and manufacturing techniques. Millions of units and devices are manufactured every year, and all of them are exceedingly well designed to operate in the spectrum allocation environment created by the ITU and FCC regulations.[109] The proof is the ubiquity of GPS receivers in all of the equipment that is essential to run the country's communications, transportation, and public safety infrastructures.

In the "technical appendix" LightSquared attaches to its Response, LightSquared deviates even further from the objective studies of the TWG. In attempting to demonstrate that the probability of a LightSquared 4G LTE signal being at any particular level over a given percentage of the coverage area is sufficiently low that it would not cause harmful interference to GPS receivers, LightSquared relies at least in part on unspecified "independent studies by LightSquared" and "additional independent simulation work performed by LightSquared."[110] LightSquared cannot now rely to any degree on unspecified and unattributed technical material in a document that ostensibly is addressing the TWG Final Report. If LightSquared's assertions

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[109] In the absence of terrestrial allocations of current consequence in the ITU or FCC Tables of Frequency Allocations, it would have been a waste of time and money for GPS manufacturers to attempt to design receivers that reject high-power terrestrial services.

[110] LightSquared Response, Technical Appendix at 5.

at variance with the majority conclusions in the TWG Final Report (and corroborated in the NPEF and RTCA reports) have not been thoroughly discredited at this point, the reliance on supposed outside "technical" material that was not presented to or considered within the Working Group LightSquared was directed to establish should put a final nail in the coffin.[111]

Finally, LightSquared's contention that the percentage of a coverage area for a timing receiver that could receive harmful interference in the presence of LightSquared lower-channel signal at a level of as low as -40 dBm is limited[112] is unrealistically optimistic. To get this result, LightSquared relies on a predictive model that tends to give optimistic results, rather than the data generated during the laboratory tests.

All of these errors and mischaracterizations, and numerous others throughout LightSquared's Response, undercut the credibility of the LightSquared Response. Indeed, the distortions are all part of a wholly unsuccessful LightSquared effort to provide a basis for the proposal it makes to allow 4G LTE deployment on the lower 10 MHz channel. The Commission must not allow itself to be swayed by LightSquared's misrepresentations and distortions. The TWG Final Report, as noted above, does not provide any basis for concluding that LightSquared operation on the lower 10 MHz channel will be compatible with GPS receivers and GPS-dependent applications.

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[111] LightSquared's reliance on a cumulative distribution factor ("CDF") analysis drawn from some of the data generated during the Las Vegas "live sky" testing in May (*see id.)* is also questionable. A CDF analysis to show the probability of a -20 dBm signal at a particular point would be meaningful under two conditions – uniform geographic sampling of power measurements, and complete deployment of towers over the area sampled. Neither condition was met, so using CDF to identify the probability of any particular power level is meaningless.

[112] LightSquared Response, Technical Appendix at 14.

D. The Commission Should Reject Outright the Extraneous and Incorrect Non-Technical Factors LightSquared Includes in its Response.

The Commission should reject LightSquared's attempt to introduce a number of factors that are irrelevant to consideration and resolution of the GPS desensitization interference issue into the record of this proceeding as supposed justifications for implementation of its proffered "solution." For example, LightSquared's claims of its obligations to deploy its network and meet FCC-imposed milestones[113] are irrelevant in terms of the assessment of the impact of its proposed 4G LTE terrestrial broadband service in the MSS bands on GPS. The Commission must eschew any reliance on these claims.

1. LightSquared Expenditures Are Irrelevant.

The Commission must also reject all efforts by LightSquared to leverage its expenditures to date into an obligation by the Commission to act in its favor.[114] Indeed, the Commission should make emphatically clear, as soon as possible, that all LightSquared expenditures in pursuit of a 4G LTE, non-ancillary terrestrial service in the MSS bands have been and will be at LightSquared's exclusive risk, and are without prejudice to contrary Commission action. This type of condition is standard in satellite licensing actions that are taken while a major technical or regulatory issue remains unresolved.[115]

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[113] LightSquared Response at 20-21.

[114] *See, e.g.*, *id*. at 16, 26.

[115] *See, e.g.*, *Loral/Qualcomm Partnership, L.P.*, 10 FCC Rcd 2333, 2335 (¶ 18) (Int'l Bur. 1995) (applicant granted conditional authority to establish feeder links for mobile-satellite service system at its own risk where decision on availability of spectrum for feeder link operations was forthcoming); *Hughes Communications Galaxy, Inc.*, 10 FCC Rcd 10947, 10947 (¶ 5) (Int'l Bur. 1995) (applicant conditionally authorized, at own risk and without prejudice to adverse Commission action, to provide service to Latin America over a domestic satellite pending completion of rulemaking proceeding to address transborder service/separate systems). *See also Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, 18 FCC Rcd 1962, 2082-83 (¶¶ 249-250) (2003) (permitting construction of ancillary terrestrial component of mobile-satellite service systems at licensee's own risk prior to launch and operation of integrated satellite).

In issuing this admonition to LightSquared, it is critical for the Commission to keep in mind the overall context of the current proceeding. This proceeding arose because LightSquared, after years of mostly harmonious coexistence with its GPS/RNSS neighbors as an MSS licensee with a truly ancillary terrestrial gap-filling component, made the business decision to try to install a high-power terrestrial mobile broadband service in the MSS spectrum. It mattered not to LightSquared that the spectrum was not allocated for terrestrial use nor that the Commission's regulations made a very different use of the word "terrestrial" than what LightSquared now intends. LightSquared's claimed and alluded-to expenditures and projections are related to making this new terrestrial use happen.[116]

GPS is unique among satellite spectrum uses in terms of ubiquity (nationwide and worldwide), the number of users (500 million GPS receivers in use in the United States alone), and the importance of its role in the national infrastructure. Now, the overwhelming objective technical data confirms that the repurposing of the MSS/ATC spectrum that LightSquared has been seeking to do would result in harmful interference to GPS receivers and GPS-dependent applications. While the Commission has allowed LightSquared's proposal to proceed far down the track before considering the most important issue raised by the proposal (GPS interference), the fact remains that LightSquared made volitional business choices and must alone bear the consequences of those choices. LightSquared cannot be allowed to use its claimed expenditures to persuade or influence Commission decision making that should be immune from such influences. The Commission must thus make clear to LightSquared, its investors and others that Commission review of the technical issues from LightSquared's modification application, up to and including action contrary to LightSquared's desires, will not be clouded or influenced in any

[116] *See* LightSquared Response at 20 (referring to the $25 billion LightSquared expects to spend to 'deliver much-needed LTE broadband wireless services to the public").

way by actions LightSquared has taken or expenditures LightSquared claims to have made in pursuit of its 4G LTE aspirations.[117]

2. LightSquared's Proposed Terrestrial Services Mean Nothing for Unserved and Underserved Rural and Tribal Areas.

Next, LightSquared incorrectly asserts that the deployment of a terrestrial 4G LTE network will "bring service to underserved and unserved rural and tribal areas."[118] Under LightSquared's vision, remote areas such as Tribal Lands will not be served by 4G LTE terrestrial broadband service, as LightSquared intends to place its terrestrial transmitters in or near urban areas and population centers representing only 12 percent of the U.S. land mass.[119] Tribal Lands and other rural areas would be served only by the MSS component of the LightSquared system – just as they ostensibly are/would be today. Clearly, the introduction of 4G LTE terrestrial service in the MSS bands means absolutely nothing new for underserved and unserved rural and tribal areas; in fact, with the relegation of the MSS component of LightSquared's envisioned system to an afterthought, development and quality of that aspect of its service would be banished to secondary status, leaving those communities worse off than they would ever have been under the true MSS/ATC concept that existed until recently.

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[117] The one time where LightSquared acknowledged this point, it was evasive, and refused to accept that its expenditures are irrelevant. *See* LightSquared Consolidated Opposition to Applications for Review of the *LightSquared* Order, at 16 n.59 (filed March 14, 2011) ("There is no requirement in the Commission's rules or policies that such a statement be made, however, and independently of FCC requirements the investors, all of which are large and sophisticated companies, are required to be properly advised of risks relating to regulatory considerations").

[118] *See* LightSquared Response at 21 & n.34.

[119] *Id*. at 32.

3. LightSquared's Claim that GPS Manufacturers Have Been Subsidized by the Federal Government Is Incorrect.

LightSquared's assertion that GPS manufacturers have received an $18 billion U.S. Government subsidy[120] is false, and ignores a quarter century of Congressionally mandated studies on the management and future of GPS, Presidential announcements and decision directives, and Congressional statutes cementing the role of GPS as a national dual-use utility.[121] GPS was developed for national security and strategic military advantage. The U.S. military owns and operates the GPS system for the U.S. National policy made civilian signals available for safety-of-life following the 1983 downing of Korean Air Lines Flight 007 and the resulting tragic loss of life. U. S. private sector investment in R&D and user-driven innovation has turned GPS into a robust national utility.

There is no question that the Federal Government and the taxpayers of this country have made a substantial national investment in the GPS system over the last 40 years, and this

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[120] *Id*. at 19.

[121] In 1996, President Clinton approved a national policy on the future management and use of GPS that recognized that GPS was rapidly becoming an integral component of the Global Information Infrastructure and included the following policy goal: "We will continue to provide the GPS Standard Positioning Service for peaceful civil, commercial and scientific use on a continuous, worldwide basis, free of direct user fees." U.S. Global Positioning System Policy Fact Sheet, Office of Science and Technology Policy, National Security Council (March 28, 1996). In 2004, President Bush authorized a new national policy that establishes guidance and implementation actions for space-based positioning, navigation, and timing programs, augmentations, and activities for U.S. national and homeland security, civil, scientific, and commercial purposes. U.S. Space-Based Positioning, Navigation, and Timing Policy Fact Sheet (December 15, 2004). The first fundamental goal of this policy is to ensure that the United States maintains space-based positioning, navigation, and timing services, augmentation, back-up, and service denial capabilities that "provide uninterrupted availability of positioning, navigation, and timing services[.]" *Id*. at 1 (emphasis added). To achieve this goal, the President directed that "the United States Government shall . . . [p]rovide on a continuous, worldwide basis civil space-based, positioning, navigation, and timing services free of direct user fees for civil, commercial, and scientific uses, and for homeland security through the Global Positioning System and its augmentations, and provide open, free access to information necessary to develop and build equipment to use these services." *Id*. Most recently, the National Space Policy of the United States, as adopted by President Obama in June 2010, stated that it is a goal for the United States to "maintain its leadership in the service, provision, and use of global navigation satellite systems ("GNSS")." (*National Space Policy of the United States of America* at 5 (June 28, 2010)). NTIA has expressly informed the Commission that "a key element of that policy is taking necessary measures to sustain the radiofrequency ("RF") environment in which critical U.S. space systems operate." Letter from Karl B. Nebbia, Assoc. Administrator, Office of Spectrum Management, NTIA, to Julius Knapp, Chief, OET, ET Docket No. 10-142, at 1-2 (July 14, 2010).

investment continues today. To the extent that there are beneficiaries of the national investment in GPS, those beneficiaries are the GPS users – virtually everyone in the country and billions more around the world – who receive the benefits of GPS without ongoing service fees.[122]

There is no subsidy here. Anyone can become a manufacturer of GPS receivers or the provider of GPS-dependent applications. GPS manufacturers do not own the spectrum or have any claim on the spectrum beyond the expectation that signals at the quality-level determined by the operators of the system will continue to be available for civil and commercial use consistent with the ITU and FCC allocation tables and U.S. national policy. The success and scope of the GPS public/private partnership is perhaps unparalleled in recent decades.[123] LightSquared's attempt to besmirch that is wrong.[124]

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[122] The Federal Government also benefits immensely from the fact that manufacturers, through economies of scale, have borne the costs the government would otherwise have faced to develop GPS equipment and GPS applications that have become ubiquitous in the marketplace and inextricably integrated into every aspect of our society, economy, and infrastructure. A 1995 study, commissioned by Congress and conducted by the National Academy of Public Administration and National Academy of Sciences, deemed that provision of GPS civil signals free of direct user fees is in the national interest and supportive of GPS's primary national security role as a war fighting tool. *See The Global Positioning System - Charting the Future,* Joint report of the National Academy of Public Administration (NAPA) panel and the National Research Council (NRC) committee, at 77-78 and 91-92, National Academy Press, Washington, DC (May 1995). The study's recommendations to this effect were reflected in the subsequent policy directives noted above.

[123] President Obama included a note reinforcing this point in his 2011 State of the Union address to the nation. He stated that:

> Our free enterprise system is what drives innovation. But because it's not always profitable for companies to invest in basic research, throughout our history, our government has provided cutting-edge scientists and inventors with the support that they need. That's what planted the seeds for the Internet. That's what helped make possible things like computer chips and GPS. Just think of all the good jobs -- from manufacturing to retail -- that have come from these breakthroughs.

http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address (last visited July 21, 2011).

[124] The attempted besmirching is, of course, also quite ironic. LightSquared, after all, is attempting to become the only 4G LTE spectrum provider that would utilize spectrum not purchased for billions of dollars at a Commission auction. Moreover, and unlike GPS and GPS receiver manufacturers, LightSquared intends through its carrier customers to assess users a service fee for the use of the free spectrum it has received from the FCC.

4. Contrary to LightSquared's Claim, GPS Receivers Are Extremely Efficient Users of the Spectrum Resource.

LightSquared's assertion that GPS receivers do not efficiently use the spectrum resource is wrong. GPS directly serves hundreds of millions of users in the United States alone, and serves many times that number worldwide using civil signals. On an indirect basis – whether it is through mobile phone calls or banking transactions that receive a GPS-delivered time stamp, or through the use of new roads or newly-constructed buildings, or through volcano or tsunami warning/monitoring systems that are GPS enabled – GPS serves almost every person on the planet, many of them not even realizing the multiple ways they rely on GPS.[125] There is no question that GPS is one of the most efficient spectrum users on a user-per-megahertz basis, and that GPS is orders of magnitude more efficient that LightSquared will ever be.

Adding to the efficiency equation for GPS is the fact that the same frequencies that are used by GPS are also used by other providers of RNSS service (*e.g.*, the European Galileo system, the Russian GLONASS system, and the forthcoming Chinese COMPASS system). To improve the accuracy of navigation, positioning, and timing solutions, many receivers are designed to operate with one or more of these systems in addition to GPS. Like GPS, all of these systems are global and would be affected by LightSquared interference if receivers using their

[125] A recent study confirms that the economic benefits of GPS to the U.S. economy are substantial. GPS manufacturers create employment, provide earnings, add value, and generate tax revenues for governments. Importantly, GPS technology improves productivity and produces cost-savings for end-users. Overall benefits to the U.S. economy from GPS are estimated to be as high as $122 billion per year. *See* Pham Study, at 6, 15. Interestingly, LightSquared claims that deployment of its proposed 4G LTE network would generate "$120 billion in benefits." LightSquared Response at 20. That would almost replace the benefits that would be eliminated with the destruction of GPS – assuming that any 4G LTE system could work efficiently or even at all without GPS timing.

signals are operating in the United States.[126] Additional systems are expected to come on line, including some current and new space-based augmentation systems that provide enhanced navigation solutions to aviation, and all of these would also be affected by LightSquared's operations if it is allowed to proceed.

Through the number of individuals and institutions that are served and the fact that multiple RNSS systems use the 1559-1610 MHz band, GPS must be viewed as a very efficient user of the limited spectrum resource. LightSquared's contentions to the contrary are unfounded.

5. LightSquared Wrongly Tries to Portray the Interference Issue as a Battle Between GPS and Terrestrial Broadband Services.

The USGIC is not opposed to the Commission's efforts to facilitate additional broadband service, including its zealous pursuit of additional spectrum for mobile broadband services as an outflow from last year's decision adopting a National Broadband Policy. Nevertheless, the USGIC recognizes, and urges the Commission to agree, that a decision to reject LightSquared's proposal to provide high-power terrestrial broadband service in the 1525-1559 MHz MSS/ATC band because of confirmed projections of harmful interference to GPS receivers and GPS-dependent applications is not a decision to reject terrestrial broadband in favor of GPS. It is, instead, an exercise in sound spectrum management – one that recognizes, as shown above, that compatible spectrum uses should be grouped close together in frequency, and dissimilar and incompatible uses should be separated to ensure freedom for all from harmful interference and undue burdens. Even last year's Memorandum from President Obama on "Unleashing the

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[126] The USGIC notes that the European Commission has filed comments with the Commission in the above-reference proceeding reporting that LightSquared base stations have "considerable potential to cause harmful interference to Galileo receivers …." Letter dated July 19, 2011, from Heinz Zourek, Director General, European Commission Directorate General for Enterprise and Industry, to J. Genachowski, FCC, at 1 ("EC Letter"). The EC Letter reports that a study by the European Space Agency showed that interference effects to some Galileo receivers could be seen at distances of 1000 km from the LightSquared transmitter, and characterizes the interference as a "grave threat to the viability of a Galileo service covering U.S. territory …." *Id.*

Wireless Broadband Revolution" tempered the direction to find 500 MHz of broadband spectrum by requiring agencies to "take into account the need to ensure no loss of critical existing and planned Federal, State, local, and tribal government capabilities . . . ."[127]

The USGIC supports the Commission's policy for identifying additional spectrum that can be made available for terrestrial mobile broadband use. At the same time, the USGIC emphasizes that the unique success of GPS in terms of adoption and innovation relative to other satellite spectrum uses means that a Commission decision denying LightSquared the ability to proceed with its plans in the adjacent band is clearly unique; the TWG Final Report and related studies have confirmed that the spectrum for this use is somewhere other than the 1525-1559 MHz and 1626.5-1660.5 MHz frequency bands, and it does not compromise the Commission's broader plans to repurpose underutilized satellite spectrum elsewhere. There is simply no other band that presents a conflict remotely like this.

VI. LightSquared's "Proposed Solution" Is No Solution at All.

For all of the reasons that are presented and discussed in the foregoing sections of these Comments, the three-pronged "solution" LightSquared includes in the culmination of its Response is neither supported in any way by the TWG Final Report, nor viable as a practical matter. LightSquared's proposal must be rejected.

A. LightSquared Is Not Proposing a Power Level Lower Than That Considered in the TWG.

First of all, LightSquared's offer to use "lower power" is illusory.[128] All of the TWG laboratory testing was done, and analysis conducted, with the so-called lower power level

[127] Presidential Memorandum: Unleashing the Wireless Broadband Revolution, Released June 28, 2010.

[128] *See* LightSquared Response at 25.

LightSquared now proposes to use.[129] However, at least some of the "live sky" testing in Las Vegas was done at a power level that was 3 dB below the 32 dBW/channel EIRP power level LightSquared now proposes to use.[130] While indeed lower than the 42 dBW/channel EIRP power level the FCC authorized in 2010, the 32 dBW maximum EIRP per sector "for the single carrier" LightSquared is proposing to operate is not a reduction from what LightSquared told the TWG it intended to use for its 10 MHz channels throughout the TWG process.

Despite the vagueness of LightSquared's offer, it must be emphasized that even at the 32 dBW EIRP level per sector on the lower 10 MHz channel, the TWG Final Report showed there to be either substantial harmful interference to, or a need to study further the prospect for harmful interference to, GPS receivers and GPS-dependent applications in all seven GPS device categories that were examined. The low-power prong of the LightSquared "solution" is insufficient.

B. LightSquared's Proposal for a Standstill Period Incorrectly Presumes That GPS Receiver Mitigation Is Forthcoming.

Second, LightSquared's call for a "standstill period" is nothing more than an unacceptable attempt by LightSquared to presume that its use of the upper 10 MHz channel is still conceivable, and to shift its exclusive burden of mitigating harmful interference to GPS manufacturers and users. The TWG Final Report declared unanimously that any use of the upper 10 MHz channel will cause harmful interference to most or all GPS receivers and GPS-

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[129] *See, e.g.*, TWG Final Report, Appendix O.1, at p.1 ("LightSquared's present deployment plans call for approximately 36,000 transmit sites to be built that transmit a maximum of 62 dBm (32 dBW) EIRP per channel.").

[130] *See* May 23, 2011 Supplement to May 16, 2011 TWG Interim Progress Report, File No. SAT-MOD-20101118-00239, at revised Appendix G ("In LightSquared's initial deployment plan, the base station will emit L-band signals at 32dBW/carrier (29 dBW/carrier/MIMO branch) in all deployment phases. However this field test began with an EIRP of approximately 29 dBW (59 dBm) per carrier for dual-carrier tests because the base station software is not yet capable of transmitting two channels simultaneously from the same unit(see Table 2, Note 1)" (footnote omitted)).

dependent applications in all seven device categories. No viable mitigation technique was even identified, much less tested, and substantial negative factors make any possible increase in filtering very unlikely and impractical.

In proposing a "standstill" period and contemplating some near-term revisiting of the question of the upper 10 MHz channel, LightSquared is wasting everyone's time. LightSquared wrongly minimizes the extent of the interference issue. Beyond any doubt, all GPS devices, present and future, are at risk, and any future filtering possibility LightSquared may be awaiting will not allow GPS receivers to achieve the current accuracy and performance levels on which they already operationally depend. Moreover, the "standstill" proposal does not take into account the fact that modernized GPS signals are coming on line in the next few years, and these signals have a much wider bandwidth than the L1 C/A code that is used by some of the tested devices. In coming years, GPS use conditions will only be more challenging with respect to terrestrial service in the MSS band, not less so.

1. LightSquared's Proposal for a Standstill Period Would Improperly Shift the Burden of Mitigation from LightSquared to GPS Users.

The standstill proposal, with its implicit assumption that GPS receiver mitigation will be undertaken on some kind of accelerated timetable by GPS manufacturers, must be rejected for another reason. Specifically, the proposal seeks to place on GPS manufacturers and users the burden of mitigating interference that is, by FCC rule, LightSquared's alone. Section 25.255 of the Commission's Rules, as noted above, makes the obligation of resolving harmful interference to other services that is caused by MSS ATC operations the sole responsibility of the ATC operator.[131] Nominally, at least, even under the *LightSquared* order, LightSquared is still an ATC operator subject to Section 25.255. It cannot demand or insist that authorized users of

[131] 47 C.F.R. § 25.255.

another service take measures – especially measures deemed infeasible or inappropriate for a variety of very compelling reasons by a substantial majority of the TWG – to mitigate the harmful interference. This obligation, by rule and by policy, is LightSquared's alone.

In sum, LightSquared should be denied all access to the 1525-1559 MHz and 1626.5-1660.5 MHz bands for the provision of 4G LTE services until such time as it can demonstrate that it has completely mitigated all harmful interference to GPS. The record does not support some kind of temporary refrain; instead, the Commission should dismiss LightSquared's request without prejudice to its filing a new application with the proper demonstration.[132]

2. GPS Receivers Are State-of-the Art Machines That Include All "Appropriate Filtering."

It is now long past time to put to rest the offensive and glaringly incorrect LightSquared assertion that GPS receivers are susceptible to LightSquared interference because they either i) failed to see LightSquared coming; ii) deliberately constructed devices – many of which are used in myriad safety of life and property applications – with inadequate parts, leaving them vulnerable to LightSquared interference; or iii) are out to prevent the spread of terrestrial mobile broadband and service to unserved/underserved rural areas and Tribal Lands. The USGIC has shown above that none of these assertions is correct.[133] Indeed, LightSquared's suggestion (implicit or otherwise) that GPS manufacturers should be "improving their equipment" by adding "appropriate filtering" and other unspecified technology for the sole purpose of rejecting LightSquared signals reflects LightSquared's lack of understanding about GPS.

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[132] USGIC generally agrees with the suggestion from NPEF that "significant technical concerns remain that operation of an ATC service can successfully coexist with GPS[, and that] … there is a need for additional analysis to determine if ATC architectures can be accommodated in the MSS L-band without impacting GPS." The Commission should initiate a proceeding to determine the answer to this important question.

[133] *See, e.g.*, Section V.C, *supra*.

In short, GPS receivers use "appropriate filtering" now, and GPS manufacturers do not need to "improve" their equipment. It is time for the Commission to determine that it is LightSquared's new owners who are being "inappropriate" by trying to convert a low-power satellite band into a high-power terrestrial band without any regard whatsoever for who or what gets overrun in the process.

C. There Is Nothing in the Record or the TWG Final Report To Support the Idea That 4G LTE Terrestrial Broadband Service Can Ever Be Provided Anywhere in the 1525-1559 MHz Band Without Causing Harmful Interference to GPS.

The third prong of LightSquared's proposed "solution" involves allowing LightSquared to immediately commence the provision of 4G LTE terrestrial mobile broadband service on the lower 10 MHz channel at 1526-1536 MHz. The entirety of LightSquared's response, from the bashing of GPS to the distortion of TWG results, is designed to portray this "split the baby" approach as reasonable.

To the contrary, it is far from a reasonable approach. As emphasized above, the TWG participants other than LightSquared and its affiliates unanimously determined that there is not one category of tested and analyzed GPS devices that would be immune to harmful interference from a LightSquared lower 10 MHz-only 4G LTE operation.[134] When the more than 15% of the devices tested by the Cellular sub-team and shown to suffer harmful interference with lower channel operations,[135] and the nearly 70% of the devices tested by the General Location/Navigation sub-team and determined by LightSquared's self-generated interference

[134] *See* Section III.B.1, *supra*.

[135] It bears repeating that the trend in cellular/smart-phone devices is to incorporate wideband GPS signals. This means that even if some devices using narrowband GPS would be robust enough to operate in the face of LightSquared interference today (*i.e.*, are not in the 15% of currently impacted cellular devices), it is possible or even likely that future generations of those same devices would be found to suffer harmful interference.

criteria to be compatible with lower channel operations are properly categorized where the TWG majority had them, the picture for LightSquared is not so rosy.

There is no question that LightSquared's proposal to operate in any way on the lower 10 MHz channel would result in harmful interference to hundreds of millions of GPS receivers and GPS-dependent applications. LightSquared, in fact, acknowledges that there will be harmful interference to GPS users in the installed base, but offers no mechanisms that can mitigate that interference. Because LightSquared vastly understates the number of GPS devices that would be harmfully interfered with by a LightSquared lower 10 MHz-only operation – omitting tens of millions of cellular users and tens of millions more users in the general location/navigation sphere (including public safety and maritime users), and not accounting at all for indirect users of GPS high precision, timing, network, and public safety receivers[136] – the meager mechanisms it sketches out in the LightSquared Response are undeniably insufficient.

LightSquared's proposed mitigation measures are particularly inadequate with respect to the high-precision GPS receivers that will suffer harmful interference with lower 10 MHz-only operation.[137] The TWG Final Report emphasizes that additional filtering is not a feasible option in the foreseeable future due to the absence of suitable designs, the extended roll-over period (up to 15 years in some cases) and replacement costs, and the fact that increased filtering is not possible without degradations in performance.

LightSquared's proposed accommodations for the precision receivers that include MSS augmentation are limited to future receivers (*i.e.*, they ignore the installed user base of network

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[136] The impact to indirect users, of course, is not limited to loss of service or denial of access to GPS-dependent applications. The economic impact in terms of lost productivity, risk to property, increased inefficiency, and more would be huge and would ripple across all segments of society and our infrastructure.

[137] *See* LightSquared Response at 32-33.

and precision receivers as well as the huge pool of users nationwide who rely indirectly on the availability of GPS-dependent applications for which those receivers are used), and are very short on detail. First, they address only augmentation signals; GPS reception remains an unaddressed problem. Second, the interrelationship between this aspect of LightSquared's proposals and the fact that LightSquared intends to use the upper channel at its earliest opportunity remains unaddressed.[138] Use of the upper channel for 4G LTE operations, even if GPS receivers can somehow be protected, will inevitably not be compatible with an augmentation signal in the same region of the 1525-1559 MHz MSS band. Third, LightSquared's suggestion regarding the use of a dedicated pre-selector for the augmentation signal is insufficient.[139] The augmentation signal would still be open to the MSS band, meaning that the augmentation signal would not be protected at all from LightSquared interference. Fourth, LightSquared's outline of an offer to provide a "multimode module" that would automatically switch to the LightSquared terrestrial link before overload of the satellite signal occurs, even if feasible (which cannot possibly be determined from the mere description alone) would add cost and complexity and uncertainty to GPS-dependent equipment.[140] Under this approach, augmented GPS receivers would be required to carry three RF front-end receivers instead of one – one for the GPS component and two for the augmentation signals. Finally, LightSquared's suggestion to use a cellular or PCS-based modem for the augmentation link[141] suffers from the same cost and complexity defects as the multimode module suggestion, with the

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[138] *Id*. at 33.

[139] *Id*.

[140] *Id*.

[141] *Id*.

additional shortcoming that users of the augmented GPS equipment would have to pay two periodic service fees for connectivity (one for MSS and one for the cellular/PCS link).

The "frequency coordination" idea that LightSquared offers as a palliative for affected GPS receivers in the installed base is a complete non-starter even if the pool of affected receivers was limited to precision GPS receivers.[142] LightSquared wrongly assumes that precision receivers are used primarily in rural applications; in fact, many precision and network receivers are used in urban and suburban environments.[143] LightSquared's offer to establish a database is worthless without a commitment by LightSquared to shut down entire base stations (and perhaps multiple base stations) for days, weeks, or months at a time when major surveying or planting or fertilizing or harvesting operations take place nearby – and LightSquared makes no such commitment in its Response for obvious reasons. Once the overlooked cellular and general location/navigation devices are also considered, as they must be, the already unrealistic and impractical coordination suggestion must be rejected. GPS signals need to be available for these users full time in all urban areas.

In short, LightSquared has not provided information in its Response that will enable the Commission to overcome the TWG's conclusion that 4G LTE operation in the 1525-1536 MHz band will cause harmful interference to GPS receivers and GPS-dependent applications. LightSquared has not resolved the harmful interference situation as required in the *LightSquared* order, and its conditional authorization must now be rescinded.

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[142] *See* LightSquared Response at 35-36.

[143] *Id*. at 35.

VII. The Only Conclusion To Draw from the TWG Final Report and the LightSquared Response Is That LightSquared's 4G LTE Terrestrial Broadband Service Needs To Be Provided in a Different Frequency Band.

In these Comments, the USGIC, in full reliance on the TWG Final Report, has shown that the harmful interference that LightSquared's proposed three-phase deployment of 4G LTE transmitters in the 1525-1559 MHz band would cause to GPS cannot be successfully mitigated. The USGIC has also shown that LightSquared's Response does not provide any appropriate or feasible solution that allows the Commission to remove the condition put in place in the *LightSquared* order. The 1525-1559 MHz and 1626.5-1660.5 MHz bands thus need to be permanently removed from any consideration for use for by terrestrial mobile broadband services.

In this regard, the USGIC notes that several of the TWG sub-teams observed that the only mitigation technique for assuring that LightSquared's proposed 4G LTE terrestrial broadband service does not cause harmful interference to GPS and GPS-dependent applications is relocation of the terrestrial operations to a frequency band that is not adjacent to a frequency band used by GPS or other low-power radionavigation-satellite service systems.[144] The USGIC fully supports and endorses this conclusion. The U.S. national interest requires both the roll-out of terrestrial broadband applications in appropriate spectrum and the continuing availability and innovation of GPS in the frequency bands in which it has always operated.

VIII. Conclusion.

For all of the reasons stated above, the USGIC urges the Commission to affirm the conclusions of the TWG that LightSquared's proposed deployment plan will result in harmful

[144] *See, e.g.*, TWG Final Report at 19 (General Location/Navigation sub-team GPS participants state that "[t]he only option for coexistence with GPS is for LightSquared to move to another frequency band"). *Id*. at 26 ("NASA notes that one mitigation technique that would resolve interference to both space-based and terrestrial high precision GPS receivers is to relocate high power terrestrial operations to a different frequency band").

interference to GPS receivers and GPS-dependent applications in all deployment scenarios – with resulting huge negative consequences for the national infrastructure, the economy, and safety of life and property – and that no appropriate and feasible mitigation techniques have been shown to be available to mitigate the harmful interference. Nothing in the LightSquared Response allows any alteration or modification of these conclusions. As a result, the Commission must rescind the waiver that was issued in *LightSquared*, and determine that terrestrial mobile broadband services cannot be provided in the MSS frequencies licensed to LightSquared.

Respectfully submitted,

THE U.S. GPS INDUSTRY COUNCIL

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CERTIFICATE OF SERVICE

I, David S. Keir, hereby certify that on this 1st day of August, 2011, a copy of the foregoing "Comments of The U.S. GPS Industry Council" is being sent via first class, U.S. Mail, postage prepaid, to the following (except for deliveries by hand and electronic mail, as noted):

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