

**RECOMMENDATION OF
LIGHTSQUARED
SUBSIDIARY LLC**

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I. EXECUTIVE SUMMARY

After a five-month effort, LightSquared, in cooperation with interested federal agencies and the commercial GPS device industry, has issued a Report on the results of intensive testing of the interaction between LightSquared's planned terrestrial operations and a variety of GPS devices. Other entities, such as RTCA – an aviation-related Federal Advisory Committee – Qualcomm, the Department of Defense and others, have also performed tests. Although the results vary among devices, the overall conclusion is that transmissions in the 10 MHz band at the top of LightSquared's downlink frequencies – the band nearest to the GPS frequencies – will adversely affect the performance of a significant number of legacy GPS receivers.¹

The reason for this is not because LightSquared would be improperly transmitting in the GPS band. Rather it is because legacy GPS receivers do not adequately reject transmissions from base stations operating in the adjacent frequency band because the GPS receivers have been deliberately or, sometimes, inadvertently, designed or manufactured with the assumption that there would

¹ This 10 MHz band, referred to as the upper 10 MHz or upper channel in this document, refers specifically to the 1545.2-1555.2 MHz channel in the L-Band authorized for operation by LightSquared.

be no adjacent-band terrestrial transmissions – ignoring regulations first adopted in 2003 that permit such transmissions. While the GPS device manufacturers have offered many justifications for this assumption – justifications that are not supported by the plain facts of the FCC record or, for that matter, by the FCC – it is inescapable that it is their disregard for the Commission’s policies regarding the immunity of receivers to transmissions in nearby frequency bands that is the source of the technical problem.²

Another, and equally important fact revealed by the test results of the Working Group and others, is that transmissions in the 10 MHz band at the bottom of LightSquared downlink frequencies³ – the band farthest away from the GPS frequencies – will not adversely affect the performance of over 99 percent of GPS receivers. Exceptions are mostly limited to those precision measurement devices used largely in agriculture, mining and construction that have been designed, in effect, to receive MSS augmentation signals transmitted on LightSquared frequencies in order to improve the accuracy of GPS signals.⁴

These facts present the FCC, NTIA, and government policymakers with a number of choices, none of which is ideal. Government could decide that the

² See n.5, *infra*.

³ This 10 MHz band, referred to as the lower 10 MHz or lower channel in this document, refers specifically to the 1526-1536 MHz channel in the L-Band.

⁴ As discussed in greater detail below, network GPS devices are similar to precision measurement devices in their design and susceptibility to LightSquared’s planned operations, and the mitigation measures discussed in Section V below encompass these devices. In fact, because network GPS devices are at fixed locations, they are even more easily accommodated by the frequency coordination measures discussed in Section V.

problem is of the commercial GPS device industry's making and there will be no bail-out, continuing the Commission's long-standing policy of allowing market forces to motivate receiver manufacturers to ensure that their devices are adequately immune to signals in nearby frequency bands.⁵ That choice, however, could lead to widespread interference to governmental and public use of legacy devices, while the device manufacturers correct their mistake.

At the other extreme, the commercial GPS device industry now argues that LightSquared should not be permitted to operate its L-band terrestrial network on its authorized frequencies but, rather, should have to find or buy new frequencies while LightSquared's authorized frequencies are relegated to a fallow guard band or actively used by GPS manufacturers. This choice would doom an innovative American start-up company that has devoted more than 10 years of effort and billions of dollars in reliance on explicit regulations and authorizations permitting it to proceed as planned with a vital new wireless network.

⁵ *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, Memorandum Opinion and Order and Second Order on Reconsideration, IB Docket No. 01-185, FCC 05-30, at 21, ¶ 56 (rel. Feb. 25, 2005) ("*2005 ATC Reconsideration Order*") ("Generally, we do not regulate the susceptibility of receivers to interference from transmissions on nearby frequencies. Rather, we rely on the marketplace – manufacturers and service providers – to decide how much susceptibility to interference will be acceptable to consumers. In addition, we generally do not limit one party's ability to use the spectrum based on another party's choice regarding receiver susceptibility.").

Despite a sluggish economy and increasing concentration in a vital broadband industry that is becoming more essential and more strapped for spectrum by the day, the commercial GPS device industry wants the Commission to shut down an unprecedented effort to establish a nationwide wireless broadband network built with private funding. Indeed, with an innovative wholesale business model that will draw new entrepreneurs into providing wireless services, the LightSquared network will provide a boost to the economy, jobs at a time of need and competition and innovation that would not otherwise exist – an estimated \$120 billion in benefits to consumers that would be lost. If this opportunity is lost, the unmistakable message would go out to entrepreneurs and the financial community that the government can arbitrarily change long-established ground rules without warning and devalue a settled investment. This choice, too, is unacceptable.

LightSquared is proposing a middle ground that would permit it to commence operations on the lower 10 MHz portion of its spectrum that poses no risk to the users of over 99 percent of GPS devices and to coordinate and share the cost of underwriting a workable solution for the small number of precision measurement and other devices that may be at risk. While LightSquared intends ultimately to deploy a network using a full complement of terrestrial frequencies operating at appropriate power levels, in order to provide LTE capacity and service levels to its customers, it will delay incorporating into its terrestrial

network the upper 10 MHz of its frequencies in which transmissions may jeopardize legacy GPS usage. During that time LightSquared will work with the FCC, NTIA, and other government agencies to explore all options for using a full complement of terrestrial frequencies operating at appropriate power levels needed to provide LTE capacity and service levels to the public.

This solution already has cost LightSquared over a hundred million dollars to shift the timing of its access to portions of the frequency bands it shares with Inmarsat that serve as a critical component of the LightSquared network. It will cost LightSquared even more in disruption to its operations and uncertainty regarding the timing and composition of its full complement of terrestrial frequencies operating at appropriate power levels. LightSquared is willing to bear that expense and disruption in order to move forward with its network.

Significantly, LightSquared's proposed solution is identical to the primary mitigation measure suggested by the commercial GPS device industry when it raised the receiver overload issue with the Commission in September 2010 – then, the U.S. GPS Industry Council proposed “[i]ntroducing new terrestrial broadband transmitters as far from [the RNSS L-1 band at 1559-1610 MHz] as possible” and having a “modest amount of margin around the edge of satellite services to protect their fundamental operations and utility to . . . L-band RNSS services and devices.”⁶ While it is unclear when or why its position changed, the

⁶ Comments of the U.S. GPS Industry Council, ET Docket No. 10-142, at 13-14 (filed Sep.

commercial GPS device industry’s apparent position in this proceeding today and its initial reaction to LightSquared’s proposed compromise solution – that LightSquared should simply “go away” – is both ironic and troubling.⁷ The commercial GPS device industry has built an entire business based on a large subsidy from taxpayers – estimated to be worth \$18 billion – in the form of free access to the government’s GPS satellite infrastructure and frequencies. Since

15, 2010) (“USGIC Sep. 2010 Comments”).

⁷ This refusal to participate in a cooperative solution is also starkly at odds with the stated position of the commercial GPS device industry just a few months ago. When it first raised the issue of GPS receiver overload with the Commission, the U.S. GPS Industry Council (“USGIC”) expressed its desire to find collaborative solutions and its belief that such solutions exist:

A full range of available communication technologies and services are already deployed throughout the installed user base for existing and planned GPS products and services. The introduction of new communication technologies and services offers benefits to these GPS users and growth opportunities for everyone. MSS operators already include GPS in their products and services. In situations where the introduction of new communication services has the potential for adverse operational effects on GPS use, the Council has proactively sought collaborative solutions that help to ensure the smooth introduction of the new service while also protecting the continued availability of the GPS positioning, navigation, and timing information utility. In fact, since the introduction of ATC, working collaboratively with MSS operators of ATC in the L-band has resulted in several mutual agreements to facilitate successful operations free of harmful interference. The Council believes that collaborative solutions are available to mitigate the otherwise unavoidable harmful effects described in these Comments.

. . . The Council looks forward to continued constructive collaboration to achieve a mutually acceptable positive outcome.

Id. at 14-15. Two-and-a-half months later, in December 2010, USGIC reiterated its intent to work cooperatively to find a solution, stating: “The Council believes that cooperative solutions continue to be available to mitigate harmful impact to existing services, as outlined in its [September] Comments” Comments of USGIC filed Dec. 2, 2010, at 9-10, File No. SAT-MOD-20101118-00239 (“USGIC Dec. 2010 Comments”). It is impossible to reconcile this spirit of cooperation from just a few months ago with the recent statements by the Save Our GPS Coalition and the vitriolic public relations and lobbying effort against LightSquared by this coalition.

2003, the commercial GPS device industry has not only known about plans to develop a terrestrial wireless network in L-band spectrum, it actually approved those plans. Some in the GPS industry apparently ignored years of advance knowledge and continued to design, build, and sell devices to consumers that they knew were incompatible with an L-band terrestrial wireless network. Some in the GPS industry have also attempted to deflect public attention from their own failures by subjecting LightSquared to a massive, vitriolic public relations and lobbying effort outside the scope of this proceeding. Despite this campaign of distortion and obfuscation, the record clearly establishes that the commercial GPS device industry must accept the fundamental responsibility of using the radio spectrum efficiently and not undermining the value of adjacent frequency bands.

If the LightSquared opportunity is lost, consumers would lose, rural America would lose, entrepreneurs and innovators would lose, and even the GPS industry would lose because it would continue uncorrected on a path of vulnerability to the development of nearby spectrum. The only beneficiary would be the wireless carrier oligopoly that would not have to face the challenge of a disruptive and motivated competitor.

II. WORKING GROUP TESTING AND RESULTS

LightSquared, working cooperatively with the commercial GPS device industry and federal agencies, convened a Technical Working Group (“TWG”) to

study the susceptibility of legacy GPS devices to LightSquared network operations.⁸ The TWG, co-chaired by LightSquared and the U.S. GPS Industry Council (“USGIC”), comprised 37 individuals with strong technical expertise representing a full range of GPS receiver categories, installed user groups, and other interested parties.⁹ The TWG also relied on advisors representing a full range of stakeholders including manufacturers, user groups and individual experts in the GPS field.¹⁰ Over a three-and-a-half month period, the TWG tested over 130 representative devices across seven GPS receiver categories – aviation, cellular, general location and navigation, high precision, networks, space-based receivers, and GPS timing receivers. The TWG operated in a transparent and inclusive manner, accepting all timely requests for participation by interested parties. The final TWG Report, including detailed descriptions of the test plans,

⁸ The Commission required LightSquared to help organize a working group that was to “focus on analyzing a variety of types of GPS devices for their susceptibility to overload interference from LightSquared’s terrestrial network of base stations, identifying near-term technical and operational measures that can be implemented to reduce the risk of overload interference to GPS devices, and providing recommendations on steps that can be taken going forward to permit broadband wireless services to be provided in the L-Band MSS frequencies and coexist with GPS devices.” *LightSquared Subsidiary LLC; Request for Modification of its Authority for an Ancillary Terrestrial Component*, SAT-MOD-20101118-00239, DA 11-133, at 21, ¶ 42 (rel. Jan. 26, 2011) (“*Waiver Order*”).

⁹ The TWG members included representatives from John Deere and Co., Trimble Navigation Ltd, Garmin International, NovAtel, AT&T, Verizon, Sprint Nextel, Boeing, Rockwell Collins, Lockheed Martin, MITRE, and APCO, as well as representatives from federal government agencies such as the Federal Aviation Administration, NASA, and the U.S. Air Force.

¹⁰ Advisors to the TWG included representatives from OnStar, TomTom, Motorola Solutions, Motorola Mobility, T-Mobile, U.S. Cellular, Alcatel-Lucent, Qualcomm, Samsung, Ericsson, Symettricom, True Position, Leica Geosystems, various state and local governments/public safety entities, and NIST.

testing results, analysis based on operational scenarios, and discussion of mitigation options, is being filed concurrently.

The TWG process examined the performance of GPS receivers in the presence of LightSquared's terrestrial operations. The TWG testing, discussed in detail in the TWG Report, shows a wide range of individual GPS receiver performance, illustrating conclusively that the problem is one of GPS device design and characteristics, rather than an issue of fundamental incompatibility between LightSquared's planned transmissions and all GPS receivers. The tested GPS receivers had varying abilities to reject LightSquared's transmissions depending on the nature of the filtering employed in the receivers and other aspects of receiver design.

Although the results vary among devices, the overall conclusion of the testing is that transmissions in the upper 10 MHz channel – the channel nearest to the 1559-1610 MHz GPS band – will adversely affect the performance of a significant number of legacy GPS receivers. The tests confirm that this problem is not caused by emissions from LightSquared's base stations into the GPS band, but from the failure of these legacy GPS receivers to reject transmissions from LightSquared's licensed frequencies, which are adjacent to the spectrum allocated for use by GPS.¹¹ This kind of interference is often referred to as overload, blocking, or desensitization.

¹¹ Out-of-band emissions ("OOBE") from LightSquared's transmissions into the GPS frequencies are not a concern following an agreement reached between LightSquared's

The process of testing the lower 10 MHz channel began after the TWG initiated its efforts to test LightSquared's originally-planned deployment, in order to supplement that effort and consider potential transmitter-side mitigation alternatives. To test the lower 10 MHz channel, the TWG developed test plans, selected representative devices in seven major civilian receiver categories, and tested over 130 devices, using eight laboratories and a nearly two-week field trial. In the process, the TWG collected an enormous amount of data. That data demonstrates that, while additional analysis needs to be done by the FAA with respect to its airborne receiver standards, of the approximately 400 million GPS devices in use today in the United States, well over 99 percent, including 100 percent of GPS-enabled mobile phones and general location and navigation devices, can be expected to experience no meaningful interference from LightSquared operations in the lower 10 MHz channel.

Before proceeding with a description of LightSquared's proposed solution to this problem, and particularly in light of the vitriolic lobbying campaign that has been directed against LightSquared by the commercial GPS device industry, we should review how we have reached a point at which the commercial GPS device industry is telling government decision makers that it is a zero sum game – they have to choose between LightSquared and GPS.

predecessor and USGIC in 2002. As the FCC stated in mandating the Working Group process, "the GPS interference concerns stem from LightSquared's transmissions in its authorized spectrum rather than transmissions in the GPS band" *Waiver Order* at 21, ¶ 42.

III. BACKGROUND OF LIGHTSQUARED TERRESTRIAL NETWORK PLANS

- A. **LightSquared has participated in open, public proceedings to determine its network's technical parameters and has worked with the GPS industry throughout to ensure that its network did not interfere with GPS.**

Beginning in early 2000, LightSquared's predecessor companies¹² realized that the rapid development of cellular networks doomed the mobile satellite service to a niche market – albeit important for public safety and government services – that would never make full, efficient use of the potential 66 MHz of L-band spectrum resource in the United States. At the time, the L-band was not conducive to terrestrial operations because there were no assigned, contiguous blocks of spectrum. Rather, the L-band in North America was shared among Inmarsat and systems sponsored by the U.S., Canada, Mexico, and Russia, subject to complex coordination agreements among the national administrations that divided the frequencies into narrow slivers that were virtually impossible to use for terrestrial networks. LightSquared, with the FCC's encouragement, then undertook the lengthy and expensive effort to pay Inmarsat almost \$500 million (plus annual cash payments) to rationalize the L-band spectrum into frequency blocks that would be usable for a terrestrial network. LightSquared also petitioned the FCC for rule changes that would permit the development of such a network.

¹² For convenience, these predecessors and LightSquared will be designated "LightSquared."

Obviously, this effort was not done without the knowledge of the government users of L-band and GPS services, or without the full awareness of the commercial GPS device industry. In fact, through the NTIA's interdepartmental coordination process, the government users were informed and approved of this development at each decisional stage. The commercial GPS device industry participated fully at each stage as well; they expressed concern about out-of-band emissions but not about the performance of their receivers in the presence of LightSquared signals operating in its own licensed spectrum.¹³

Indeed, the only interest group that opposed the development of the L-band spectrum for terrestrial use was the incumbent wireless network operators – going as far as taking the FCC to court to seek to overturn the decision permitting such terrestrial use. The anticompetitive impetus for the wireless carriers' position was and is obvious.

LightSquared made detailed disclosure of the technical characteristics of its planned terrestrial network in FCC application proceedings dating back to 2001.¹⁴ These were public proceedings that ran in parallel with proceedings in

¹³ The one exception was Deere & Company which raised, but then let drop, the receiver overload issue. See p. 14 & n.19, *infra*.

¹⁴ Before issuing LightSquared's various ATC authorizations over the years, the FCC sought comment at every step, including on: the 2001 ATC Application (Application of Mobile Satellite Ventures Subsidiary LLC, File Nos. SAT-ASG-20010302-00017 et al. (Mar. 1, 2001)); the 2003 ATC Application, submitted after the ATC rules first became effective (Application of Mobile Satellite Ventures Subsidiary LLC, File Nos. SAT-MOD-20031118-00333 et al. (Nov. 18, 2003)); the 2005 ATC Modification Application, submitted after the ATC rules were revised on reconsideration (Application of Mobile Satellite Ventures Subsidiary, LLC, File Nos. SAT-MOD-20051104-00211 et al. (Nov. 4, 2005)); the 2008 Transfer of Control Application (Application of Mobile Satellite

which the FCC developed rules for such terrestrial networks.¹⁵

Once the commercial GPS device industry reached agreement with LightSquared regarding out-of-band emissions, the industry submitted a letter urging the Commission to grant the applications “as soon as possible” and stating that LightSquared was “to be commended for its proposal to use its spectrum in a responsible manner.”¹⁶

LightSquared’s ATC application was granted in late 2004, and there have been no material changes to the technical characteristics of LightSquared’s network since 2005, when the Commission approved the higher EIRP for ATC base stations at which LightSquared intends to operate.¹⁷ As the commercial

Ventures Subsidiary, LLC, File Nos. ITC-T/C-20080822-00397 et al. (Aug. 22, 2008)); and the 2009 ATC Modification Application (Application of SkyTerra Subsidiary LLC, File Nos. SAT-MOD-20090429-00046 et al. (Apr. 29, 2009)).

¹⁵ See *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, Notice of Proposed Rulemaking, 16 FCC Rcd 15532 (2001) (“2001 ATC NPRM”); *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, 01-185, Report and Order and Notice of Proposed Rulemaking, 18 FCC Rcd 1962 (2003) (“2003 ATC Order”); *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, IB Docket No. 01-185, Memorandum Opinion and Order and Second Order on Reconsideration, 20 FCC Rcd 4616 (2005) (“2005 ATC Reconsideration Order”).

¹⁶ Letter from USGIC to FCC, FCC File Nos. SAT-MOD-20031118-00333 et al. (Mar. 24, 2004). In its letter, USGIC indicated that the OOB limits that had been agreed to “ensure[] the continued utility of GPS receivers operating in the vicinity of MSV ATC stations.” *Id.* USGIC also stated that expeditious grant of the ATC application “would validate MSV’s adherence to best commercial practices” and would “advance the public and national interests in promoting the responsible use of spectrum.” *Id.*

¹⁷ The *2005 ATC Reconsideration Order* authorized base station EIRP of 31.9 dBW, equivalent to those planned for the current deployment. See *2005 ATC Reconsideration Order*, at 4636 ¶ 55. The FCC later authorized LightSquared to employ higher base station power in 2010. See *In the Matter of SkyTerra Subsidiary LLC*, 25 FCC Rcd 3043, at 3046-47 ¶ 10 (2010) (approving base station EIRP of 42 dBW). However, as discussed in Section V.A, LightSquared plans to operate using the lower EIRP approved in 2005.

GPS device industry already had recognized by that point, it needed to be prepared to co-exist with tens of thousands of LightSquared base stations.¹⁸

In a 2001 filing on LightSquared's original terrestrial application, Deere & Company expressed concern about the potential receiver overload problem, but Deere did not pursue the issue in the ATC rulemaking proceeding or in LightSquared's 2004 ATC application proceeding.¹⁹ The issue was not raised again by the GPS industry until nine years later, in September 2010,²⁰ in a filing responding to an FCC Notice of Inquiry/Notice of Proposed Rulemaking

¹⁸ In an FCC filing, USGIC stated that the limits it had agreed to with LightSquared in 2002 were necessary to protect GPS against "[t]he increased user density from potentially millions of MSS mobile terminals operating in ATC mode . . . [and] **potentially tens of thousands of ATC wireless base stations.**" Reply Comments of USGIC, IB Docket No. 01-185, at 2 (Sep. 4, 2003) (emphasis added). See also *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*, ET Docket No. 10-142, Report and Order, FCC 11-57, ¶ 28 (rel. Apr. 6, 2011) ("*MSS Spectrum Order*") ("extensive terrestrial operations have been anticipated in the L-band for at least 8 years").

At various times since raising the receiver overload issue late last year, commercial GPS manufacturers have claimed that they could not have foreseen any problem based on the original licensing and rulemaking process, which they claim they perceived to be for only a few thousand base stations that would operate at relatively low power, never mind the higher power levels that were approved first in 2005 and later in 2010 after an open FCC process including interagency consultation via NTIA and without any challenge at the time by the GPS industry. However, the analysis done by the TWG show that certain GPS receivers would overload if LightSquared were to operate in the upper 10 MHz channel even at this lower power and even if LightSquared deployed a few hundred base stations. Particularly given that aviation receivers are among the receivers that would have been affected by such a limited deployment, it is not plausible that the GPS manufacturers knew about this interference potential and were willing to accept it. The reality is that these manufacturers, despite being in the best position to understand the design and vulnerability of their receivers, failed to build receivers that would be compatible with LightSquared's planned operations and are now re-writing history in an attempt to deflect attention from such failures.

¹⁹ See Comments of Deere & Company, File Nos. SAT-ASG-20010302-00017 *et al.*, at 6 (May 7, 2001) ("Deere 2001 Comments").

²⁰ USGIC Sep. 2010 Comments at 11-12.

addressing measures that could be taken to facilitate the provision of wireless broadband using MSS frequencies.²¹

The *MSS Spectrum NOI/NPRM*, picking up on a recommendation in the March 2010 National Broadband Plan, expressed the FCC's intent to make mobile satellite frequency bands, including the L-band frequencies used by LightSquared, more conducive to terrestrial operations in order to relieve the serious shortage of spectrum for wireless broadband. In response to the commercial GPS device industry's filing, the FCC pointed out that the "responsibility for protecting services rests not only on new entrants but also on incumbent users themselves, who must use receivers that reasonably discriminate against reception of signals outside their allocated spectrum."²²

The commercial GPS device industry next raised the receiver overload concern in opposing a LightSquared request to use some terrestrial-only devices on its network²³ – a request that had nothing to do with the GPS receiver overload problem²⁴ as even a recent report by RTCA acknowledges²⁵ – thereby

²¹ See *In the Matter of 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*, ET Docket No. 10-142, Notice of Proposed Rulemaking and Notice of Inquiry, FCC 10-126 (rel. Jul. 15, 2010) ("*MSS Spectrum NOI/NPRM*").

LightSquared's above-referenced modification application was filed under the pre-existing rules, and was not dependent on the rule changes under consideration in the *MSS Spectrum NOI/NPRM*.

²² *MSS Spectrum Order*, at 13, ¶ 28.

²³ See USGIC Dec. 2010 Comments.

²⁴ The GPS receiver overload thresholds are a function of three factors: (1) the extent to which, because of receiver design, GPS receivers pick up non-GPS L-band signals; (2) the power at which LightSquared's ATC base stations transmit; and (3) the number and placement of LightSquared's ATC base stations. LightSquared's minor modification

triggering the present controversy.

The record is abundantly clear that LightSquared played by the rules. Over a period of eight years, LightSquared painstakingly developed a spectrum plan — at a cost of hundreds of millions of dollars — that worked to avoid interference with GPS devices. The GPS industry not only knew about those plans, but it gave its green light to those plans. Based on that effort and in reliance on a rulemaking process that was fair and included all stakeholders, LightSquared and its investors have already invested \$4 billion in the development of its business and it is prepared to invest an additional \$22 billion over the next seven years to develop its wholesale terrestrial network. The commercial GPS device industry is now complaining, at the eleventh hour, of plans about which it has had years of advance knowledge and of a technical issue it had more than sufficient time to resolve in its receiver designs. In short, the Commission should not countenance the commercial GPS device industry's

application, which sought authority to provide service to end users who are equipped with terrestrial-only devices, in lieu of LightSquared's previous plan to serve only end users equipped with dual-mode devices, had no impact on any of these factors. The application related to L-band end user devices, not GPS receivers, and LightSquared did not propose changes in the application to ATC base station power or to the number and placement of its ATC base stations.

²⁵ See RTCA, Inc., *Assessment of the LightSquared Ancillary Terrestrial Component Radio Frequency Interference Impact on GNSS L1 Band Airborne Receiver Operations*, Jun. 3, 2011, at Section 1.1.2 ("RTCA Report") ("On November 18, 2010, LightSquared applied to the FCC for a license modification that would permit the use of terrestrial-only devices on its ATCt network. *The application proposed no technical or operational changes to the ATCt network. In response, the GPS community first raised concerns to the FCC that high-powered LightSquared terrestrial transmitters adjacent to the 1559 MHz band edge would overload GPS signal reception.*") (emphasis added).

demand for squatter's rights.²⁶

B. GPS manufacturers could have made decisions beginning in 2003 that would have avoided the receiver overload problem.

Despite the commercial GPS device industry's best efforts to rewrite the record and obfuscate the nature of the problem, the simple fact remains that GPS receivers do not adequately reject base station transmissions in the adjacent band. The receivers have been designed, sometimes deliberately, with the assumption that there would be no adjacent-band transmissions.²⁷ While the commercial GPS device industry has offered many justifications for its design decision – justifications that are not supported by the plain facts of the FCC record or, for that matter, by the FCC – it is inescapable that this is the source of the problem of overload of GPS devices.

²⁶ The Commission's policies, of course, do not countenance such squatter's rights. As the Commission noted when it addressed a similar claim of receiver susceptibility in the *ATC Recon Order*, it "generally do[es] not limit one party's ability to use the spectrum based on another party's choice regarding receiver susceptibility." *2005 ATC Reconsideration Order* at 21, ¶ 56. In that Order, in response to similar concerns regarding the potential for overload of Inmarsat receivers, the Commission went on to conclude: "[I]t is clear from our testing and our knowledge of receiver design that [the party claiming its receivers would be overloaded] can deploy receivers in the future that can be less susceptible to interference from transmissions on nearby frequencies." *Id.*

²⁷ RTCA appears to acknowledge that it was aware of the regulatory developments with respect to LightSquared's L-band ATC deployment plans and its planned transmission power levels, but that it did not study the receiver overload issue previously. See RTCA Report at Section 1.1.1 (discussing the history of the ATC proceeding, including the relevant power levels adopted in 2005 for LightSquared's base stations, and noting that while RTCA took note of some of the regulatory developments and OOB emissions limits in an earlier study of interference relevant to the GNSS L1 frequency band, it "did not study fundamental emission overload effects" in the earlier study).

Manufacturers of narrowband GPS receivers could have avoided the receiver problem by incorporating appropriate filtering technology,²⁸ but did not do so, perhaps for cost reasons. In fact, had GPS device manufacturers simply used filters — whose cost could have been as low as \$0.05 per device²⁹ — beginning at the time that terrestrial operations were permitted in the L-band, this entire problem could have been avoided. Meanwhile, other GPS devices, such as wideband precision measurement receivers, deliberately use LightSquared’s L-band frequencies. Their receivers employ wideband front-ends in order to increase precision and in order to receive satellite augmentation signals throughout the 1525-1559 MHz L-Band.³⁰

By failing to build receivers resistant to lawful transmissions in an adjacent band, GPS manufacturers have effectively appropriated LightSquared’s L-band spectrum. It is particularly shocking that this is the conduct of an industry that has never invested in a satellite, but rides for free on the government’s 30-satellite GPS constellation and has free access to federal

²⁸ The Commission has acknowledged that the overload interference problem could have been addressed through appropriate receiver standards relating to GPS receivers’ “ability to reject interference from signals outside their allocated spectrum.” *MSS Spectrum Order* at 13-14, ¶ 28.

²⁹ See Ex Parte Presentation of QUALCOMM Inc., File No. SAT-MOD-20101118-00239, at 9 (May 3, 2011) (estimating the cost of filters “could be on the order of 5 cents [per unit], depending on volume”). Note that this estimate is for mobile phone handsets and general location and navigation devices, which represent the vast majority of the commercial GPS devices in the field. The cost estimate may be higher for other GPS applications, including those that require a higher degree of precision.

³⁰ One can only wonder why Deere & Company, which raised the desensitization issue in 2001 and failed to convince the FCC of the merits of their concern, continued to manufacture costly precision receivers using spectrum that LightSquared intended to use for an integrated satellite-terrestrial network. See n.19, *supra*.

frequencies, and, with explicit knowledge of LightSquared's plans, colonized LightSquared's spectrum without its permission or FCC authorization, and now will not take responsibility for its actions. It is insult added to injury that the current *mantra* of the commercial GPS industry is that LightSquared should vacate its spectrum and buy alternative spectrum while GPS continues to use devices that allow them to, in effect, camp for free on spectrum that LightSquared has spent years and billions of dollars developing for broadband with the support of national policymakers.

A study by the Brattle Group estimates that by relying on GPS signals being provided by U.S. government satellites, commercial GPS manufacturers have received a U.S. government subsidy worth \$18 billion.³¹ This amount includes the cost of satellite and other infrastructure that commercial GPS providers would have to invest private capital in were they not able to use the government-provided GPS network, as well as the estimated cost of the U.S. government-controlled spectrum. The Brattle Group study also notes that by failing to deploy receivers with sufficient filters, the GPS industry essentially uses LightSquared's L-Band spectrum even though it is beyond the spectrum allocated to GPS. Though addressing the receiver overload problem through the deployment of better filters in GPS devices will add some costs to the GPS

³¹ Coleman Bazelon, the Brattle Group, Inc., *GPS Interference: Implicit Subsidy to the GPS Industry and Cost to LightSquared of Accommodation* (Jun. 22, 2011), at 5-10, available at http://www.brattle.com/_documents/UploadLibrary/Upload957.pdf ("Brattle Group GPS Subsidy Study").

industry, those costs would only be a fraction of the \$120 billion in benefits that would be created by LightSquared's deployment of its LTE network.³²

IV. LIGHTSQUARED MUST BEGIN DEPLOYMENT OF MUCH-NEEDED WIRELESS BROADBAND SERVICES

LightSquared does not question the obvious importance of GPS services to critical activities such as aviation, defense, and public safety. However, the GPS industry ignores the substantial benefits to be gained by LightSquared's entry into the wireless broadband market. As discussed below, LightSquared's planned new network is vital to public welfare, public safety, and economic development at a critical time in our nation's history.

LightSquared will deploy an integrated satellite-terrestrial network costing more than \$25 billion that will deliver much-needed LTE broadband wireless services to the public, with a focus on underserved markets within America. The FCC has required LightSquared to provide terrestrial wireless coverage to at least 100 million people by the end of 2012, at least 145 million people by the end of 2013, and at least 260 million people by the end of 2015.³³ In order to meet these goals, and in order to begin satisfying important public interest goals, LightSquared must move beyond the planning stage and begin deploying its network as soon as possible.

³² Brattle Group GPS Subsidy Study, at 11-12.

³³ *SkyTerra Communications, Inc., Transferor, and Harbinger Capital Partners Funds, Transferee; Applications for Consent to Transfer of Control of SkyTerra Subsidiary, LLC*, Memorandum Opinion and Order and Declaratory Ruling, IB Docket No. 08-184, DA 10-535, at 27, ¶ 56, App. B (rel. Mar. 26, 2010).

LightSquared's planned deployment of broadband wireless services furthers the national goal of making broadband services available to Americans in all parts of the country, urban and rural.³⁴ In the last decade or so, broadband has become a critical driver of the U.S. economy. As the U.S. faces an increasingly global economy and continuing economic turmoil, broadband availability is critical to enabling the jobs and businesses of tomorrow, and to spurring innovation and new investment. Broadband expansion is an important component of our economic recovery.

LightSquared's planned deployment serves other important public interests as well. LightSquared has a long history of providing the public safety and homeland security community with satellite services, and as the Commission recently noted, these communities "will benefit from a broadband service that is readily available when they are operating in or transitioning between urban, suburban, or rural environments."³⁵

³⁴ LightSquared's plans, and its actions to date, have long involved bringing service to underserved and unserved rural and tribal areas. See *LightSquared and Open Range Partner to Expand Deployment of Nation's First 4G LTE Wireless Broadband and Satellite Network to Rural American Communities*, Press Release (rel. Mar. 11, 2011) ("This partnership underscores the goals of [the National Broadband Plan] by providing benefits to consumers, businesses, healthcare, tribal organizations, public safety and other government users located in or traveling to rural communities and who are seeking access to the latest generation of mobile services."); see also *Waiver Order* at 17, ¶ 34 ("[W]e expect LightSquared will actively market to rural areas that do not currently have access to broadband services."); Reply Comments of Rural Cellular Association, SAT-MOD-20101118-00239, at 4 (filed Dec. 9, 2010) ("LightSquared commitments, together with the attractiveness of an integrated MSS/ATC service to rural service providers, give ample assurance that the mobile broadband subscriber utilizing the service will continue to receive the benefits of an integrated MSS/ATC offering.").

³⁵ *Waiver Order* at 17, ¶ 34.

Moreover, LightSquared's network will enhance competition in the market for wireless broadband services,³⁶ not only by creating another facilities-based provider in an increasingly concentrated market, but also by enabling a variety of entities to provide retail broadband and other Internet-enabled services by purchasing capacity on LightSquared's wholesale-only network. LightSquared's business model will revolutionize the broadband industry by providing the opportunity for a diverse group of customers – including retailers, wireline and wireless communication service providers, cable operators, device manufacturers, online content providers, and many others – the opportunity to sell to their customers wireless broadband services on the LightSquared network. Through its wholesale-only business model, those without their own wireless network or who have limited geographic coverage or spectrum will be able to develop and sell their own devices, applications, and services using LightSquared's open 4G network – at a competitive cost and without retail competition from LightSquared. In other words, LightSquared will not just bring one competitor to the marketplace – it will enable dozens of competitors to bring broadband wireless services to American consumers.

³⁶ See Consolidated Opposition to Applications for Review and Petition for Reconsideration of New America Foundation, Media Access Project, Free Press and Public Knowledge, SAT-MOD-20101118-00239, at 7 (filed Mar. 14, 2011) (“The most likely outcome of large-scale ATC deployment by LightSquared is an increase in competition, which will then lead to further investment – not just by LightSquared, but also by existing carriers that will face greater competition. Greater competition and investment will drive deployment of higher-quality, lower-priced mobile broadband services, increasing the access to such services for a greater number of citizens, and opening the door to greater innovation at the edges of the network.”).

Moreover, because LightSquared plans to deploy a completely open network, its wholesale partners can develop their own devices, applications, and services that use the LightSquared network. The availability of wholesale capacity on LightSquared's network will give device manufacturers and application and service providers the certainty needed to invest in creating the next generation of wireless devices and applications. In May of 2011, LightSquared opened its "Innovation SandBox" in the heart of Silicon Valley in California and is engaging with hardware and application providers, big and small, to optimize, develop and launch new 4G and satellite services. This growing LightSquared ecosystem will not only have a profound effect on the wireless industry as a whole, but it will also positively transform other industries such as health care, automotive, transportation, education, media, entertainment, and energy.

These economic benefits at a time when growth in broadband and high-tech innovation has the potential to lift the U.S. toward an economic recovery must not be ignored. A Brattle Group study estimates that the LightSquared network would contribute \$120 billion in benefits to U.S. consumers.³⁷

Moreover, these benefits are needed now, not five or ten years from now. LightSquared is a startup company funded with private capital and attempting the unprecedented effort to create a new, nationwide broadband wireless network in a market characterized by huge fixed costs and facing competition

³⁷ Brattle Group GPS Subsidy Study, at 1 & n.2.

from dominant network operators that will use their substantial market power to crush an upstart competitor. LightSquared must begin to deploy its network immediately or it may not survive.

For this reason, LightSquared is prepared to take significant steps — at significant cost — in order to give the commercial GPS device industry additional time to co-exist with LightSquared’s network.

V. LIGHTSQUARED’S PROPOSED SOLUTION.

LightSquared is proposing a three-part solution. First, it will operate at lower power than permitted by its existing FCC authorization. Second, LightSquared will agree to a standstill in the terrestrial use of its upper 10 MHz of its frequencies immediately adjacent to the GPS band. During that time, LightSquared will work with the FCC, NTIA, and other government agencies to explore all options for using a full complement of terrestrial frequencies operating at appropriate power levels needed to provide high-quality LTE broadband service to the public.

Third, LightSquared will commence terrestrial commercial operations only on the lower 10 MHz portion of its spectrum, which poses no risk to the vast majority of GPS users, and will coordinate and share the cost of underwriting a workable solution for the small number of legacy precision measurement devices that may be at risk.

A. Lower Power

LightSquared hereby commits to operate its L-Band spectrum terrestrially at a power level significantly below the level permitted by the FCC in 2010. Specifically, consistent with the formula specified in Section 25.253(d)(1) of the rules that the FCC adopted in 2005, LightSquared's maximum base station EIRP per sector for the single carrier it is proposing to operate in its lower 10 MHz block will be 32 dBW.³⁸

B. Standstill Period

LightSquared recognizes that a significant number of legacy GPS receivers are at risk. At the same time, LightSquared needs a full complement of frequencies operating at appropriate power levels to provide broadband LTE capacity vital to national competitiveness and economic development. Nonetheless, to address the concerns of the commercial GPS device industry, LightSquared commits to a standstill period in which it will not deploy the upper 10 MHz band on its terrestrial network without receiving explicit approval from the FCC, acting in consultation with NTIA.³⁹

Six months into the standstill period, LightSquared will commence a process of working with the Commission and NTIA to explore options that ensure that GPS operations are protected and that enable LightSquared to meet

³⁸ For avoidance of doubt, LightSquared hereby clarifies that this base station EIRP limit will apply at all locations, including locations in the vicinity of airports and navigable waterways.

³⁹ These frequencies will continue to be used for satellite-only services.

its customers' anticipated demand for LTE capacity and service levels, as LightSquared has planned, using a full complement of terrestrial frequencies operating at appropriate power levels.

At the same time, GPS device manufacturers must begin the process of improving their equipment by adding the appropriate filtering and other technology necessary to reject signals that operate outside the GPS frequencies.⁴⁰

C. Initial Operations Restricted to the Lower 10 MHz Channel

Following preliminary studies of the impact of LightSquared's planned L-Band operations, LightSquared – at a cost of over \$100M – renegotiated, reengineered, and reconfigured its wireless channels to accelerate access to the lower 10 MHz L-Band spectrum, *i.e.*, to the 1526-1536 MHz band, rather than the upper 10 MHz as originally planned.

The top of this lower 10 MHz channel is a full 23 MHz away from the bottom of the GPS frequency band, providing sufficient separation from LightSquared's signals even for most of those GPS receivers without the filters needed to reject adjacent band signals. It should be stressed that this solution was suggested by the GPS industry in September 2010 when it first raised the receiver overload issue with the Commission.⁴¹ As explained in greater detail in

⁴⁰ Cf. *MSS Spectrum Order* at 13-14, ¶ 28 (“[The Commission is], of course, committed to preventing harmful interference to GPS and we will look closely at additional measures that may be required to achieve efficient use of spectrum, including the possibility of establishing receiver standards relative to the ability to reject interference from signals outside their allocated spectrum.”).

⁴¹ USGIC Sep. 2010 Comments at 13-14. After raising the receiver overload issue, the USGIC's primary proposed mitigation measure was to have a “modest amount of

the following section, restricting LightSquared's initial operations to the lower 10 MHz channel immediately solves the receiver desensitization problem for all but GPS precision measurement and certain network devices. GPS precision measurement and network devices present a special case because of their particular design characteristics, yet LightSquared is prepared to take steps to ensure that these devices can coexist with LightSquared's terrestrial operations in the lower 10 MHz channel, as discussed in greater detail in Section V.E below.

D. LightSquared's Solution Immediately Addresses Interference Concerns

LightSquared's solution of restricting initial operations to the lower 10 MHz channel at a lower power than currently authorized and with appropriate measures to accommodate precision and network devices addresses concerns about legacy GPS receivers. The upper end of the lower 10 MHz channel is a full 23 MHz removed from the bottom of the GPS frequency, providing sufficient separation for GPS receivers with even minimal ability to reject signals operating outside the GPS frequencies.

The tests performed by the TWG establish conclusively that GPS receivers in practically all mobile phones and personal navigation devices can be expected to function without any appreciable impact from the planned LightSquared terrestrial deployment in the lower 10 MHz channel. A more complete

margin" around the edge of the GPS frequencies by introducing terrestrial broadband transmitters as far from the RNSS L-1 band as possible. *Id.*

description of the test results is contained in the attached Technical Appendix and is summarized below:

Mobile phones. The TWG tested 41 mobile phones in three laboratories and 29 mobile phones in a field trial in Las Vegas, all for potential interference from operation on the lower 10 MHz channel, using industry standard metrics established for E911 compliance. The results of the lab tests demonstrate that all but two of the cellular devices tested will provide E911-compliant capability outdoors in the presence of LightSquared power levels that will be present over 99.9 percent of the LightSquared coverage area and those two outliers passed in the presence of power levels expected in over 99 percent of the coverage area. The field testing in Las Vegas showed no systematic impact of the presence of the LightSquared signal in any of the dense urban, urban, suburban, or rural morphologies.

Moreover, all of this analysis is without regard to the cellular triangulation function that provides an independent basis for position location when GPS is unavailable and in most mobile phones takes over automatically if a quality metric of the GPS positioning report is deemed too low. So, even in the truly extraordinary case in which a mobile phone is one of the few that is susceptible to interference in a tiny percentage of the LightSquared coverage area and the device experiences interference at a level significant enough to affect its accuracy by more than 50 meters, the cellular assist capability will be triggered and restore required accuracy.

General Location and Navigation. The TWG tested a total of 29 general location and navigation devices including 6 public safety devices for potential interference from operation on the lower 10 MHz channel. The results from static and dynamic tests show that none of the devices experienced harmful interference from LightSquared's lower 10 MHz channel. Even in the worst-case Dense Urban environment, with a 6 dB drop in C/N_0 , the receiver performance continued to be almost indistinguishable from the case in which there is no potentially interfering signal.

Timing. The TWG tested 13 timing devices for potential interference from operation on the lower 10 MHz channel. Only one device tested, of a high-precision type, experienced what might be considered harmful interference in the presence of a lower channel signal at a level that LightSquared estimates would occur in no more than ten percent of its coverage area. All of the other devices, including those typically used in Commercial Mobile Radio Service networks, continued to perform well at levels as high as -20 dBm. The uniquely problematic device appears to be marketed for fixed applications, so those few users in one of the relatively few problematic areas might need to move or replace the device with a more resilient timing device.

Precision and Network. The TWG tested 44 high-precision and network devices for potential interference from operation on the lower 10 MHz channel. The tests results for precision and network devices showed an unfortunate level of interference even from lower channel operations. The interference that was

experienced appears to be largely and perhaps entirely the result of the receiver manufacturers' efforts to minimize cost and maintain flexibility with respect to the range of frequencies of an L-band MSS augmentation signal (used to improve the accuracy of the GPS position fixes). The receivers have a single common front end for both the GPS signal and an augmentation signal transmitted by a Mobile Satellite Service (MSS) satellite anywhere within the entire 1525-1559 MHz MSS band. A variety of mitigation options appear to be available for manufacturers to improve the susceptibility of the devices to LightSquared's signals. These options, and the measures proposed by LightSquared to enable coexistence of LightSquared's terrestrial operations in the lower 10 MHz with high precision and network GPS devices, are discussed below in Section V.E.

Aviation. Aviation represents a unique case because the TWG work is not based on tests of a representative sample of devices to determine where overload would typically occur. Instead, it is based primarily on analyzing whether compatibility would exist for a receiver that just meets the FAA's minimum performance standard, plus an additional 6 dB safety margin and a further 6 dB margin for a cold start acquisition while in flight. Nonetheless, actual testing that was done shows that all four of the receivers tested performed at least 25 dB better than the FAA minimum standard. The conclusion of the TWG report and the report done by RTCA for the FAA is that minimally-compliant receivers will continue to track the required number of GPS satellites in the face of the potential interference from a fully-deployed LightSquared network in the lower channel.

The RTCA report recommends some additional analysis to confirm certain assumptions and consider how much if any additional margin is required for cold start acquisition. LightSquared is optimistic that this further analysis can be concluded in the next few weeks and will support the consistency of LightSquared lower channel operation with FAA performance standards.

Space-based. The TWG tested two space-based receivers for potential interference from operation on the lower 10 MHz channel, one of a type in use today and the other intended for a future mission. The tests show what appears to be an almost unmeasurable level of interference to the receivers in space today. Additional mitigation, however, would be required for the receiver to be used for future missions, in the form of increased selectivity through front end filtering at the receiver.

E. Addressing Precision and Network GPS Devices

Legacy GPS precision measurement receivers and GPS network receivers present a special case because many of them they deliberately “listen in” to the L-Band frequencies in order to improve the accuracy of the GPS signals and receive MSS augmentation signals via commercial agreements with MSS providers. Nevertheless, even these legacy receivers can coexist with LightSquared’s terrestrial operations in the lower 10 MHz channel.

Initially, it should be noted that, though they are employed for a variety of important uses, these legacy precision and network GPS receivers represent a

small fraction of the overall installed base of GPS receivers.⁴² Moreover, a substantial percentage of precision GPS receivers are used in applications such as precision farming and precision mining that are highly unlikely to be near a LightSquared base station – and certainly not in the next several years given the expected rollout of LightSquared’s network over time. LightSquared’s terrestrial deployment plans necessarily focus initially on population centers and only gradually begin to cover less densely populated areas where most precision agriculture and precision mining are practiced. Indeed, LightSquared’s terrestrial deployment plans project coverage of almost 270 million Americans or 86 percent of the U.S. population by the end of 2014, but this population would be located in densely populated areas that cover only 12 percent of the U.S. land mass.

1. Future Precision Receivers

With respect to future precision devices, there appear to be a number of mitigation options available to manufacturers of precision GPS receivers.

LightSquared has made it clear to manufacturers of precision receivers that it will assist them to the extent possible in adopting appropriate mitigation measures. The potential mitigation measures include the following: (i) locating

⁴² Among commercial devices, it is estimated that the number of precision and network GPS devices is approximately 200,000, which represents approximately 0.05 percent of the total installed base of commercial GPS receivers. Some of these devices are designed to receive signals, including augmentation signals, in the MSS L-band frequencies. The mitigation measures discussed below apply to both precision and network GPS receivers, with the added factor that because network GPS devices are at fixed locations, frequency coordination with legacy devices is even more straightforward.

the center frequency of the augmentation signal close to the lower edge of the GPS band, which would permit retention of a common pre-selector architecture, but would require narrowing the pre-selector substantially so as to reject the ATC signal; (ii) keeping the augmentation signal in the MSS L-band but using a dedicated pre-selector for the augmentation signal – in this case, the augmentation signal pre-selector would not be shared with the GPS L1 pre-selector; (iii) using a LightSquared provided multimode (satellite-terrestrial) module, which would automatically switch to the LightSquared ATC link for augmentation before any overload of the satellite signal occurs; or (iv) using a cellular or PCS band modem for the augmentation link.

With respect to (iii), LightSquared is prepared to work with precision receiver manufacturers to incorporate dual-mode receivers, which have already been developed, into their devices. LightSquared could provide an ATC communications link/augmentation signal, which would provide a much higher data rate and potentially even greater accuracy from the augmentation signal.

In order to facilitate appropriate mitigation for future precision GPS receivers, LightSquared commits to work with GPS manufacturers in order to ensure that their receivers reject LightSquared's terrestrial signals and continue to receive MSS augmentation signals. Specifically:

- LightSquared will work with Inmarsat to ensure that precision GPS receivers receive MSS augmentation signals in a “safe” portion of the L-

Band, isolated from LightSquared's planned terrestrial operations, thereby removing the uncertainty that precision receiver manufacturers currently have regarding the frequency used to receive their MSS augmentation signals.

- LightSquared will commit contractually to its augmentation customers to keep precision GPS receivers at the same MSS augmentation signal frequency for a sustained period, and will work with Inmarsat to put in place a similar arrangement, including a potential loan of satellite spectrum to Inmarsat if needed to enable it to provide MSS augmentation signals in a "safe" portion of the L-band.⁴³
- LightSquared will, at its own expense, work with filter manufacturers and GPS device manufacturers to develop new filters that can adequately ensure protection of new precision receivers from planned LightSquared operations in the lower 10 MHz.
- LightSquared will make its base station equipment and appropriate technical and engineering staff available to work with manufacturers of precision GPS devices to ensure that these steps are sufficient to ensure

⁴³ LightSquared estimates that approximately half of the precision GPS receivers in the field use MSS augmentation signals; these are predominantly used in agricultural applications. The two primary resellers of MSS augmentation signals are OmniStar, now owned by Trimble, who purchases its augmentation signals from LightSquared, and Starfire, owned by Deere, who purchases its augmentation signals from Inmarsat. LightSquared has already agreed to move OmniStar to an augmentation signal at 1557 MHz, and will contractually commit to keeping them at the same frequency for a ten year period to give it greater certainty. LightSquared will work with Inmarsat to identify a similar solution for Starfire.

coexistence of precision GPS receivers with LightSquared's network operations.

2. Legacy Receivers

LightSquared can coexist with legacy precision measurement receivers by using appropriate frequency coordination measures. As an initial matter, as noted above, a substantial percentage of legacy precision receivers are used for applications such as agriculture and mining and tend to operate in rural and other remote areas. Given LightSquared build-out plans discussed above, in which initial deployment will focus on densely-populated urban and suburban areas, these receivers will be unaffected by LightSquared's deployment for many years. Of the remaining legacy precision receivers that are likely to operate near LightSquared base stations, many of these receivers are used for applications such as surveying, construction, and snowplowing that tend to be time-limited in nature. These characteristics make frequency coordination an especially appropriate solution for addressing interference concerns.

Accordingly, legacy GPS receivers can be addressed by a good faith frequency coordination obligation that the FCC should impose upon both LightSquared and precision GPS users, with the Commission acting as a backstop in cases where an agreement cannot be reached.

LightSquared further commits to maintaining an automated database accessible via the Internet that includes information regarding LightSquared base station locations (including precise latitude and longitude information) and

operation, together with a coordination hotline with operators available 24/7. LightSquared will also make available to GPS receiver manufacturers and users a timetable for rollout of its network by each geographic area.

VI. CONCLUSION

LightSquared's proposed solution is costly in money and disruption to its operations. It also creates uncertainty regarding the timing and composition of its full complement of frequencies. However, even though LightSquared is already committed to investing tens of billions of dollars going forward on its network, it is willing to bear this additional expense and disruption in order to move forward immediately with its network.

It is reasonable to ask a GPS industry that receives a subsidy estimated at \$18 billion from use of a government GPS satellite infrastructure and free access to government frequencies – as well as unauthorized free access to LightSquared frequencies – to accept a modest degree of responsibility to use the radio spectrum resource efficiently and not quarantine adjacent frequency bands that are desperately needed for expanded broadband services.

If the LightSquared opportunity is lost, consumers would lose, rural America would lose, entrepreneurs and innovators would lose, and even the GPS industry would lose because it would continue uncorrected on a path of vulnerability to the development of nearby spectrum. The only beneficiary

would be the wireless carrier oligopoly that would not have to face the challenge of a disruptive and motivated competitor.

Respectfully submitted,

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Dated: June 30, 2011

**TECHNICAL APPENDIX TO
RECOMMENDATION OF
LIGHTSQUARED
SUBSIDIARY LLC**

Technical Appendix

This Technical Appendix summarizes the process and results of the TWG (“Technical Working Group”) tests for LightSquared operation on the lower 10 MHz channel. The process of testing the lower 10 MHz channel began after the TWG initiated its efforts to test LightSquared’s originally-planned deployment, in order to supplement that effort and consider potential transmitter-side mitigation.

To test the lower 10 MHz channel, the TWG developed test plans, selected representative devices in seven major civilian receiver categories, and tested over 130 devices, using eight laboratories and a nearly two-week field trial. In the process, the TWG collected an enormous amount of data. As explained herein, that data demonstrates that well over 99 percent of receivers in use today in the United States, including 100 percent of GPS-enabled mobile phones and general location and navigation devices, can be expected to experience no meaningful interference from LightSquared operations in the lower 10 MHz channel.

For the most part, there was consensus within the TWG regarding the data collection process and the validity of the data. Any disagreement is largely limited to the interpretation of the data in terms of operational impact and the potential for mitigation through improved receiver design. With respect to the interpretation of the data, there are two principal areas in which LightSquared has disagreed with some of the TWG participants regarding the analysis of the test results: (i) what constitutes the appropriate threshold for “harmful interference” and (ii) the probability that the signal from a LightSquared base station will exceed that threshold, which depends on the propagation model used. As discussed further below, interpretations of the data by GPS device manufacturers typically rely on definitions of harmful interference and

projections of potential LightSquared signal levels that are demonstrably unsupportable and overly conservative.

The population of GPS receivers in the United States. LightSquared estimates that there are roughly 400 million GPS receivers in use today in the United States.¹ The overwhelming majority of these are used in mobile phones (approximately 300 million) and personal navigation devices (approximately 100 million, but declining as the use of smart phones increases). There are fewer than one million devices total in the remaining categories studied by the TWG: Timing (as many as 500,000 total), Precision and Network (200,000 total), and Aviation (75,000-200,000 total). The Space-based category is limited to a few receivers currently in flight or planned for deployment.

Lower channel results. The following summarizes the process for testing and the results of the TWG tests for LightSquared operations on the lower 10 MHz channel.

Mobile phones. The TWG tested 41 mobile phones in three laboratories and 29 mobile phones in a field trial in Las Vegas, all for potential interference from operation on the lower 10 MHz channel. The test plans for both the laboratory tests and the field trial were agreed to by consensus of the Cellular Sub-Team, which included representatives of LightSquared (Team Lead), Alcatel-Lucent, AT&T, CSR, Globalstar, Judge Software, Motorola Mobility, New Mexico E-911, Qualcomm, Samsung, Sprint Nextel, Spirent, T-Mobile, Trimble, U-Blox, USCellular, and Verizon Wireless [see TWG Final Report, Appendix C.1]. The sub-team conducted approximately 40 days of testing at the following labs: PCTEST in Columbia, Maryland; ETS Lindgren in Austin, Texas; and Intertek in Lexington, Kentucky, from May 16-27, 2011.

¹ Accurate numbers are difficult to obtain, but the estimates included here represent a best guess based on the results of research using proprietary and public sources.

The lab tests were based on conformance tests defined in 3GPP and 3GPP2 standards² and comprise pass/fail criteria relative to key performance indicators (KPI) such as 2-D position error and response time (time-to-first fix, or TTFF). These tests required some adaptation to accommodate the presence of adjacent band interference, which is not included in the standardized tests. The types of tests included both “deep sensitivity tests” where the GPS signal levels were set to very low levels (below -147 dBm), as would be the case when the GPS signals were facing considerable blockage, and nominal accuracy tests where the GPS signals would be representative of open sky outdoor conditions (-130 dBm). [see TWG Final Report, Appendix C.1 for Laboratory Test Plans and Section 3.2.9.6, Figure 3.2.20 for applicability of different tests to different operating environment]. Passing the test involved meeting a specified condition relative to the KPIs, such as a 2-D position error of 100 meters and a response time of 20 seconds 95% of the time, in a specified number of trials with a specified confidence factor. [see 3GPP TS 34.171, Table 5.2.1.2]. Not all tests had the same KPI requirements. These KPI requirements roughly correspond to the E911 requirements, such that passing the test provides high confidence that the E911 requirement would be met in the scenario that is most applicable to that test. [FCC 47 CFR Part 20.18] The E911 requirement for the 2-D position error is less than 50 meters 67% of time and less than 150 meters, 95% of the time. [ibid]

For the field trial, the KPI data of 2-D position error and response time were collected without categorizing them into pass/fail criteria. [TWG Final Report, Appendix C.3] Tests were performed both in fixed locations that were selected because they had the highest power level on the ground in the vicinity of the base station tower and in a moving vehicle that repeatedly drove a route in the vicinity of the tower. The former are referred to as Static tests and the latter as

² Details relating to the 3GPP standard are available at <http://www.3gpp.org/>. Details relating to the 3GPP2 standard are available at <http://www.3gpp2.org/>.

Dynamic tests. KPI data were collected in adjacent 15-minute epochs when the transmitter was on and when it was off. This allowed the differential impact of the LightSquared signals to be observed without excessive change in satellite constellation geometry, which could have an independent effect on the position accuracy.

The results of the laboratory tests demonstrate that, for the lower ATC channels of 10 MHz, all of the cellular devices tested passed the test corresponding to outdoor operation (Tests 2.4.1.4 and 2.4.2.4 in the Cellular Laboratory Test Plan) in the presence of a LightSquared signal at -30 dBm [TWG Final Report, Table 3.2.4]. Only two devices failed the above test at a level above -15 dBm. [ibid] For the deep sensitivity test (Tests 2.4.1.2 and 2.4.2.2 in the Cellular Laboratory Test Plan), where the GPS signal level was below -147 dB, the results were that one failed at levels above -45 dBm³ and two failed at levels above -30 dBm. As the deep sensitivity test corresponds to indoor operation, where approximately 10 dB of building loss may be accounted for, these “failure” levels may be increased by 10 dB to determine the equivalent outdoor LightSquared power level, i.e. -35 dBm and -20 dBm, respectively, in the above cases.

In the field testing in Las Vegas, with the lower 5 MHz channel in use, no systematic impact⁴ of the presence of the LightSquared signal could be discerned in the position errors noted at any site (dense urban, urban, suburban, and rural). [TWG Final Report, Section 3.2.13] The Las Vegas data shows that even when devices were subjected to power levels as high as -25 dBm, there was no perceptible effect on the position error that could be attributed to the LightSquared signal. [ibid. In rural site #53, according to data collected by Trimble, 1157 incidences of measured powers above -20 dBm were reported (this is equivalent to -25 dBm at the device antenna port assuming a -5dB adjustment for device antenna coupling loss, assumed

³ The one outlier which failed at levels above -45 dBm for the deep sensitivity test was a prototype of an obsolete model that has not been sold for 2 years.

⁴ Position errors of similar magnitude were recorded both with and without the presence of the LightSquared signal.

by the Cellular Sub-Team). However, in the Dynamic tests with the lower 5 MHz ATC channel at the same location, no systematic impact of LightSquared signal was discernible – Section 6.2.1.ii]. Moreover, all of this analysis is without regard to the cellular triangulation function that provides an independent basis for position location when GPS is unavailable and in most mobile phones takes over automatically if a quality metric of the GPS positioning report is deemed too low. So, even in the truly extraordinary case in which a mobile phone is one of the few that is susceptible to interference in a tiny percentage of the LightSquared coverage area and the device experiences interference at a level significant enough to affect its accuracy by more than 50 meters, the cellular assist capability will be triggered and restore required accuracy.

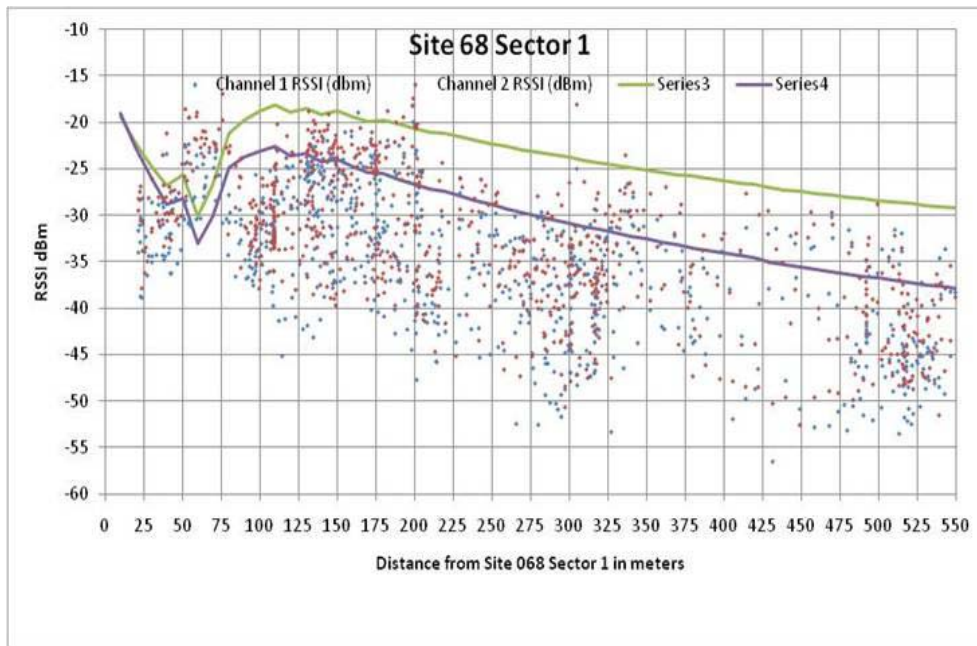
Key to any interference assessment is the probability that the LightSquared signal will be at any particular level over any given percentage of the service area. The data collected by the TWG process during the Las Vegas tests, as well as independent studies by LightSquared, demonstrate that, when considered over its entire network comprising the full range of tower heights, the LightSquared lower channel signal will be at levels of -20 dBm in no more than roughly 0.1 percent of its service area, -25 dBm in no more than 0.5 percent of its service area, and -30 dBm in no more than 1.0 percent of its service area. This is based on the Korowajczuk model simulations for Washington DC [TWG Final Report, Section 3.3.9.1.1] and additional independent simulation work performed by LightSquared.

A CDF analysis of this level presented in the Cellular Sub-Team section of the TWG Report [TWG Final Report, Fig. 3.2.26, LightSquared data, Site #68/Sector 1], adjusted by -5 dB to account for user device antenna coupling loss, showed the probability of a -20 dBm signal to be 1.2 percent for an atypical base station antenna height of 16.8 meters.⁵ The average antenna

⁵ [TWG Final Report, Appendix C3] The power of -20 dBm reported in the above graph was referenced to a 0 dBi dual, linear, orthogonally polarized antenna. The Cellular Sub-Team agreed that a cellular GPS receiver would

height in LightSquared’s deployment plan will be 30-50 meters above ground level. For a tower height of 71.6 meters in Las Vegas (Site 217), no power was measured above -35 dBm in data collected by LightSquared or above -30 dBm in data collected by Trimble. [TWG Final Report, Figure 3.2.30]

The field trials show that in open terrain, free space propagation can sometimes hold but, more frequently, the received power will have a median level that is less than that predicted by the WILOS model.⁶ The following is an example provided from the TWG Report for a suburban area. [TWG Final Report, Section 3.2.9.8].



The above diagram shows received LightSquared signal power (RSSI values) measured at ground level, at various distances from the transmit site, with a vertical monopole antenna mounted on a van [details are provided in TWG Final Report, Appendix C3]. Each point is a

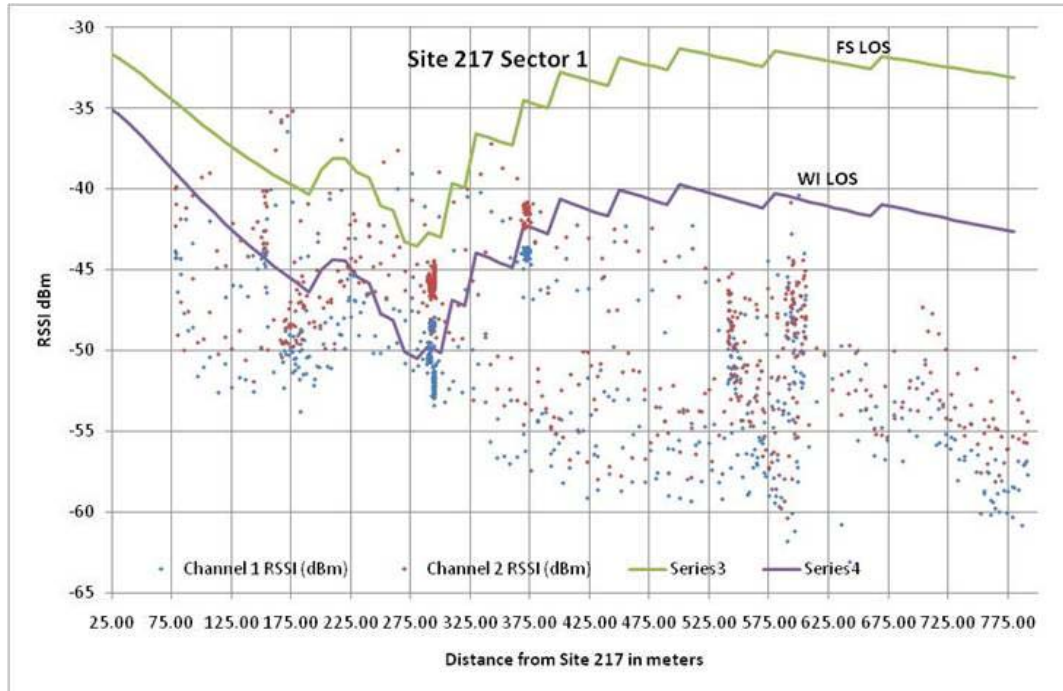
receive a power corresponding to -25 dBm corresponding to -20 dBm reported in the field owing to 5 dB antenna coupling loss.

⁶ It is difficult to tell if an instantaneous, high value of power collected by a moving vehicle is due to Rayleigh fading multipath, which can lead to power levels that are 10 dB higher than the local mean. Such Rayleigh peaks occur for very small areas of only a few inches that are unlikely to cause an operational impact to most use cases except fixed timing units.

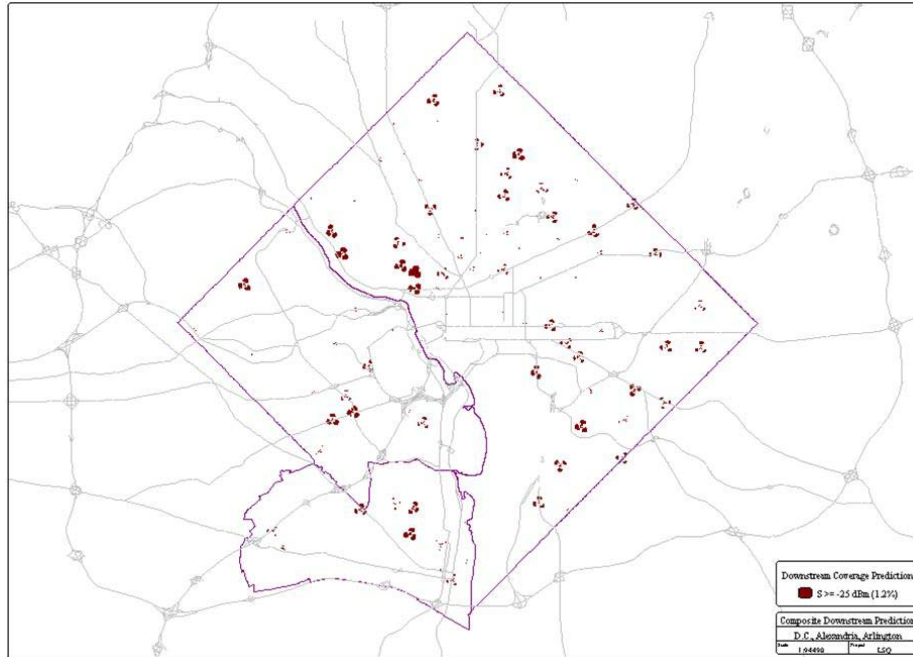
power measurement averaged over 20 milliseconds. The dots of different color indicate the power for different carriers (upper 5 MHz and lower 5 MHz). The two continuous lines indicate the predicted power levels for LOS (Line Of Sight) and WILOS (Walfisch Ikegami Line Of Sight) models, taking into account the elevation pattern of the antenna used.

The scatter plot shows that there are occasional high values that exceed the WILOS or even the Free Space models. Some of these high values are probably the peaks of Rayleigh fading multipath and others may be local mean hotspots created by a very clear line of sight to the base station antenna. Unless the user is completely stationary, the adjacent band interference will present itself as a Rayleigh fading signal and the mean value will be no more than that predicted by the WILOS model and, often, will be much lower. Because the TWG testing was limited to constant power LightSquared signals, it presents an unrealistically conservative picture; in a practical, mobile use case, the highest power levels in the above graph will not be presented constantly to the GPS receiver.

It should be further noted that most of these measurements were performed in open areas relative to the base station antenna and for a relatively low antenna height (16.8 m). In urban and dense urban areas, where significant blockage will exist relative to the propagation of the base station signal, lower power levels will be much more typical. The following example, also from the TWG Report, is for a 71.8 m base station antenna in a dense urban setting. [ibid]

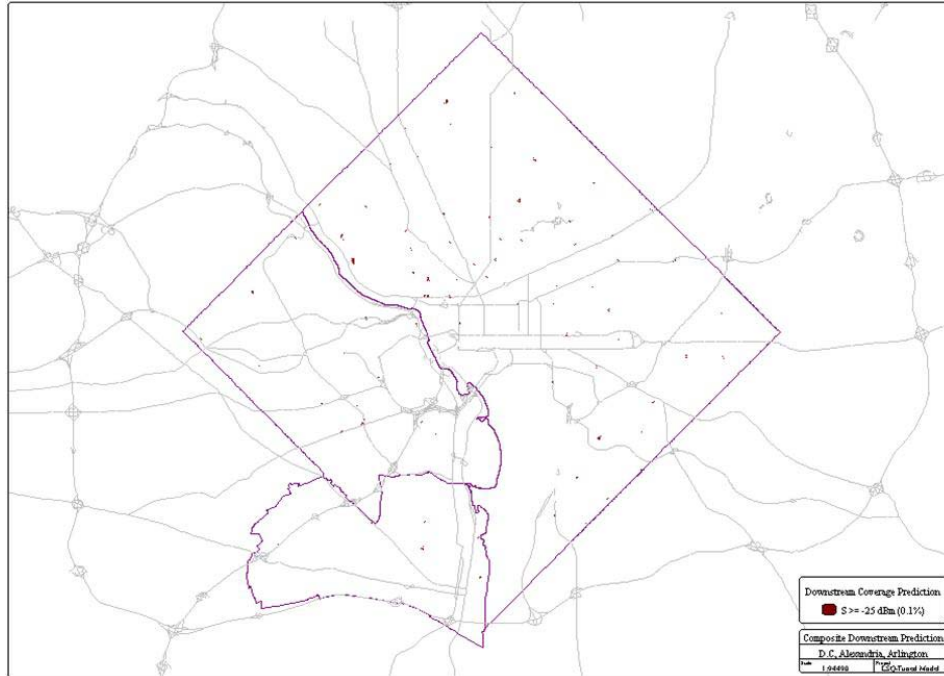


The Las Vegas results are consistent with independent analysis done by LightSquared using standard propagation modeling tools. In the Washington, DC market, the WILOS model shows that signal strength in excess of -25 dBm would occur in roughly 1.2% of the coverage area. This model assumes a diffraction/multipath induced loss greater than free space propagation but no blockage.



WI-LOS Model

In order to most accurately predict signal propagation in a real world environment, it is appropriate to use more sophisticated models, such as the Korowajczuk model, which account for the actual morphology (i.e, blockages) of a given market. The analysis presented here used the Korowajczuk model tuned for L-band propagation in the Washington, DC area and the actual transmitter sites planned for the LightSquared deployment. It shows that signal strength in excess of -25 dBm will occur in about 0.1% of the coverage area of the Washington, DC market and signal strength in excess of -30 dBm will occur in no more than 0.4% of the area.



Korowajczuk (Celplan) Model

General Location and Navigation. The TWG tested a total of 29 general location and navigation devices including 6 public safety devices for potential interference from operation on the lower 10 MHz channel for the static interference scenarios. The test plan was agreed to by consensus of the sub-team, which included representatives of Garmin (Team Lead), Trimble, OnStar, Kenwood/JVC, Motorola Solutions, BI, Hemisphere GPS, Judge Software, WCCCA, the National Park Service, Furuno USA, Aerospace/USAF, Summit County, CO, State of Virginia, U-Blox, CSR, Globalstar, TomTom, e-ride. The sub-team conducted approximately 16 days of testing at two Alcatel Lucent labs in Illinois and New Jersey. Alcatel Lucent also collected dynamic testing information for a range of dense urban, urban, suburban, and rural morphologies. The GPS devices were then exposed in the lab to the pre-recorded GPS signals collected from driving these morphologies, played back by simulation equipment inside of an anechoic chamber. This process simulated the effects of LightSquared signals on devices as if they were travelling through these types of areas.

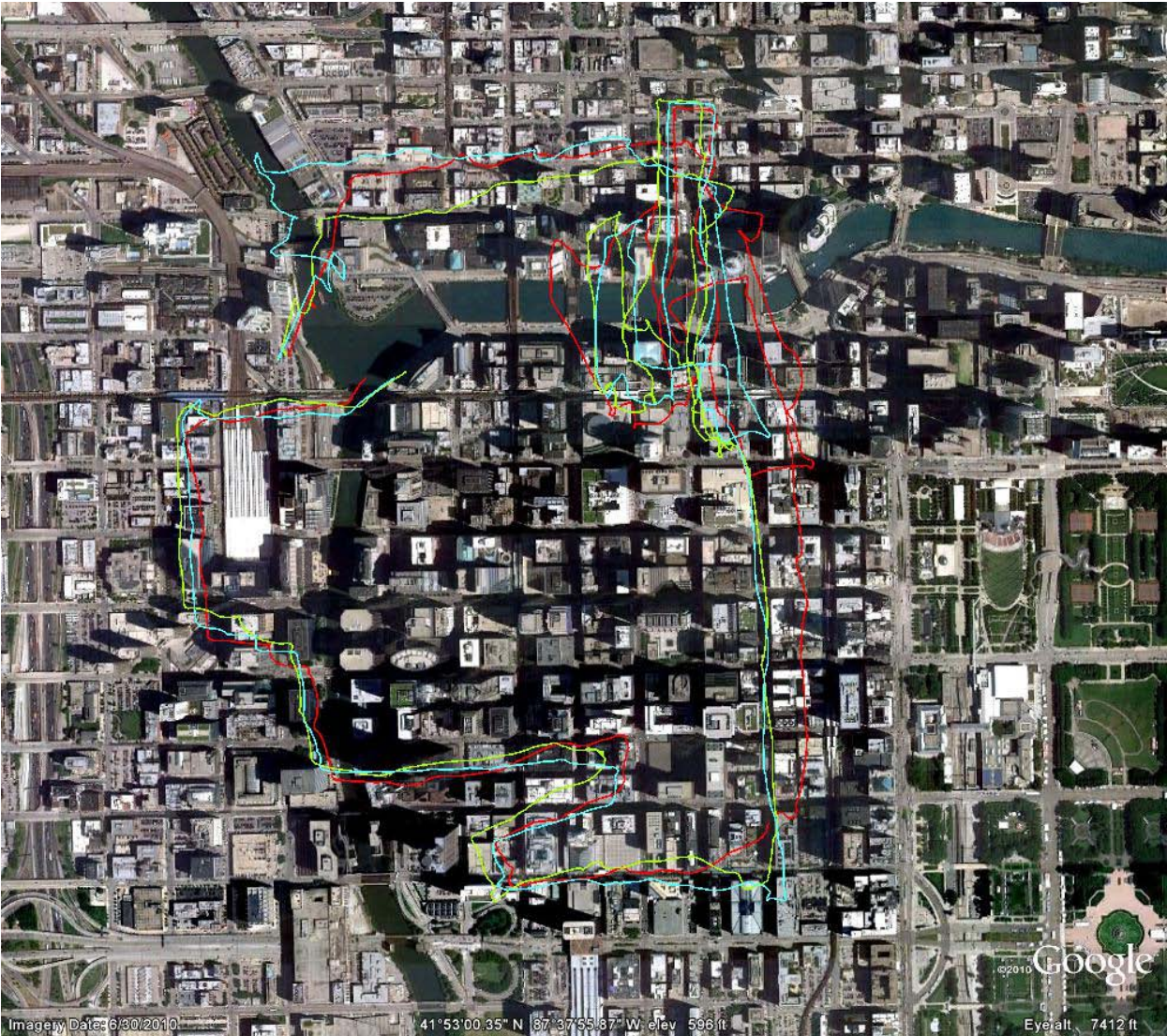
The results of the lab and field tests are summarized in the Alcatel Lucent report GPCL-2011-0080-LS R3.0 “LightSquared L-Band GPS Receiver Equipment Impact Evaluation Testing” (June 17, 2011), included as Appendix G2 of the TWG Report.

While some sub-team members were present during the Las Vegas field tests, it is not known if they performed testing on any General Location/Navigation devices as no field test results were presented to the TWG by members of this sub-team.

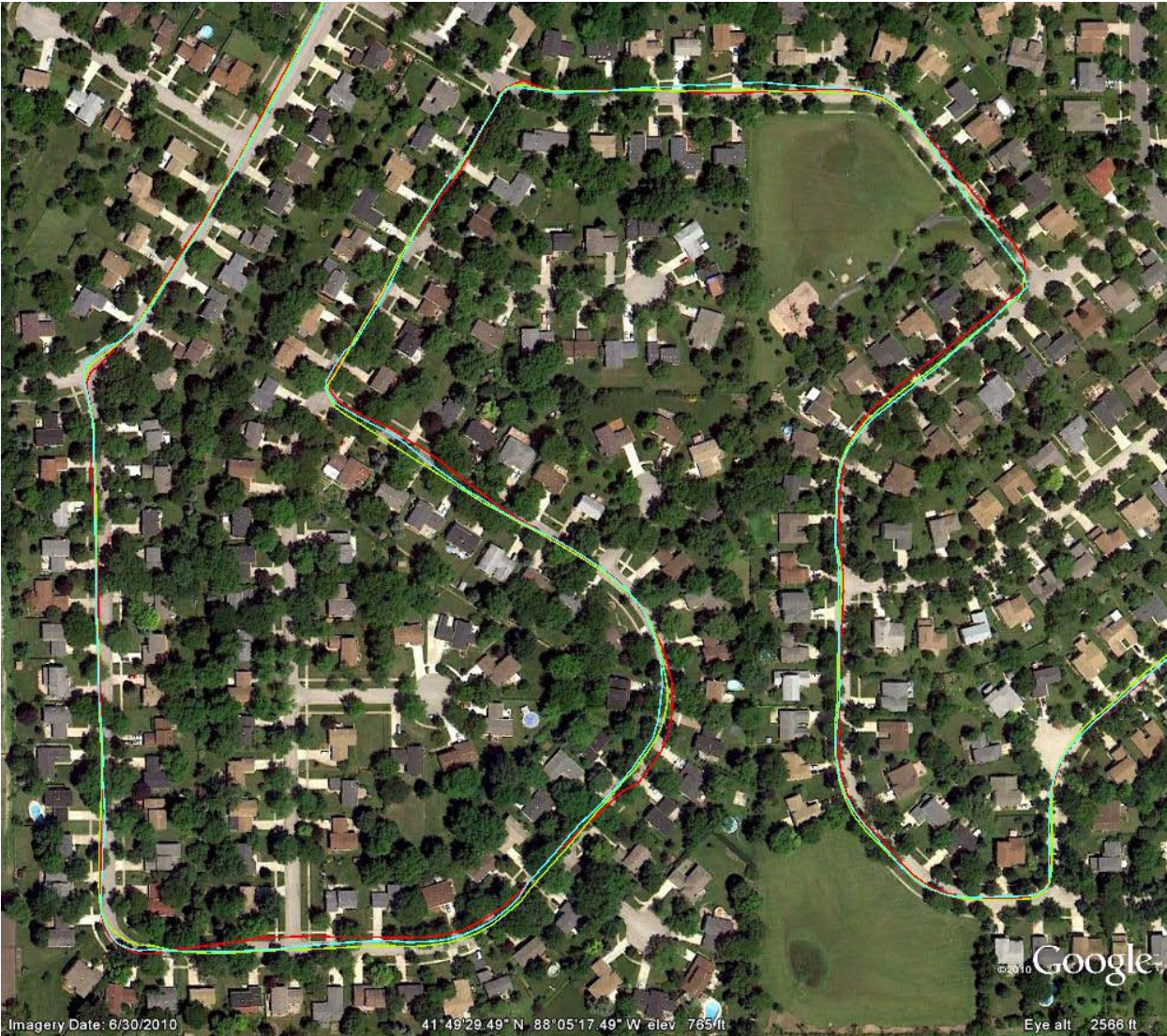
The results of the lab tests show that all of the devices experienced no more than a 6 dB reduction in the received carrier power to noise spectral density ratio (C/N_0) in the presence of LightSquared lower channel power levels of as much as -25 dBm. [See TWG Final Report, Table 3.3.6]. The dynamic tests conducted by Alcatel Lucent demonstrate that even with a decrease of 6 dB C/N_0 , the impact on receiver performance was essentially imperceptible to the user. [See TWG Final Report, figures 3.3.20-3.2.29].

The following examples from the dynamic tests are for Dense Urban and Suburban morphologies, showing the results for three cases: no potentially interfering signal (aquamarine), a 3 dB decrease in C/N_0 (blue), and a 6 dB decrease in C/N_0 (red). The results show that even in the worst case Dense Urban environment, with a 6 dB drop in C/N_0 , the receiver performance continues to be almost indistinguishable from the case in which there is no potentially interfering signal. [See also TWG Final Report, figures 3.3.20-3.2.23]. The Suburban results show a much better performance for all cases, including virtually no perceptible degradation for the 6 dB C/N_0 case. [See also TWG Final Report, figures 3.3.24-3.3.29].

Dense Urban Dynamic Test Results



Suburban Dynamic Test Results



Timing. The TWG tested 13 timing devices for potential interference from operation on the lower 10 MHz channel. The test plan was agreed to by consensus of the sub-team, which included representatives of NovAtel (Team Lead), Alcatel-Lucent, American Electric Power, Arlington County, VA, AT&T, Ericsson, FEI-Zyfer, Furuno USA, JS Engineering, Los Angeles County, Motorola Solutions, NIST, Sprint Nextel, State of Virginia, Symmetricom, Trimble, True Position, USGIC, Wabtec Railway Electronics, Washington County Consolidated Communications Agency (Oregon). [See TWG Final Report, High Precision and Timing Sub-section 8.1]. The sub-team conducted five days of testing at Naval Air Warfare Center Aircraft Division (NAVAIR) chamber in Maryland from May 10-14, 2011. In addition Trimble and Deere collected data during the Las Vegas field tests. The results of the lab and field tests are available in Sections 10 and 11 of the sub-team report.

Of the 13 timing devices tested, only one device, of a high-precision type, experienced what might be considered harmful interference in the presence of a lower channel signal at a level of as low as -40 dBm, which, according to LightSquared's estimates, could occur in as much as 8 percent of its coverage area. [Based on Korowajczuk (Celplan) Model for Washington DC presented above]. All of the other devices, including those typically used in Commercial Mobile Radio Service networks, continued to perform well at levels as high as -20 dBm. [See TWG Final Report, High Precision and Timing Sub-section Figure 37].

Precision and Network. The TWG tested 44 high-precision and network devices for potential interference from operation on the lower 10 MHz channel. The test plan was agreed to by consensus of the sub-team, which included representatives of Navcom (Team Lead), American Electric Power, Florida CORS Network, Globalstar, Hemisphere GPS, Inmarsat, Leica Geosystems, LightSquared, NASA, NCO/PNT, Novatel, Rangeline Surveying, Septentrio,

Topcon Positions Sys., Trimble, UNAVCO, Univ. of Maine, USGIC and Wabtec Railway Electronics. [See TWG Final Report, High Precision and Timing Sub-section 8.1]. The precision and network devices were tested together with the timing devices at the Naval Air Warfare Center in Maryland.

The tests results for precision and network devices showed an unfortunate level of interference even from lower channel operations. Receivers tested experienced a 1 dB reduction in C/N_0 at power levels of as low as -75 dBm. [See TWG Final Report, High Precision and Timing Sub-Section figure 36]. The interference that was experienced appears to be largely and perhaps entirely the result of the receiver manufacturers' efforts to minimize cost and maintain flexibility with respect to the range of frequencies of an L-band MSS augmentation signal (used to improve the accuracy of the GPS position fixes). They designed receivers with a single front end that receives both the GPS signal and an augmentation signal transmitted by a Mobile Satellite Service (MSS) satellite anywhere within the entire 1525-1559 MHz MSS band.

A variety of mitigation options appear to be available if manufacturers are interested in decreasing the susceptibility of the devices to LightSquared's signals. These include use of either: (i) locating the center frequency of the augmentation signal close to the lower edge of the GPS band (i.e. near 1559 MHz), preserving the common preselector architecture but narrowing the preselector substantially so as to reject the ATC signal; (ii) keeping the augmentation signal at an arbitrary location in the MSS L-band but using a dedicated pre-selector for the augmentation signal – in this case, the augmentation signal preselector would not be shared with the GPS L1 pre-selector; (iii) a LightSquared provided multimode (satellite-terrestrial) module, which would automatically switch to the LightSquared ATC link before any overload occurs; or (iv) a cellular or PCS band modem (e.g. GPRS or EVDO) for the augmentation link, substituting

the latter when it was sensed to have been overloaded – in this case, the current MSS L-band augmentation signal would be preserved.⁷ Options (iii) and (iv) would allow a higher throughput wireless data link to be established in urban areas than is possible with the current MSS-based 600 bps link. One manufacturer has admitted that this higher throughput link would permit it to develop new machine-to-machine communication applications.

Aviation. With respect to aviation receivers, the TWG relied on testing conducted under the auspices of the RTCA for the Federal Aviation Administration. The RTCA tested eight aviation devices for potential interference from operation on the lower 10 MHz channel. The test plan was agreed to by consensus of the sub-team, which included representatives of MITRE (Team Lead), Airline Pilots Association, the FAA, Garmin, LightSquared, Rockwell Collins, Thales, Trimble, Unite Airlines, USGIC and Zeta Labs. [See TWG Final Report Appendix A.1]. The sub-team conducted testing at Zeta Labs. The results of the lab tests are available in Appendix A.2 of the Final Report.

Aviation represents a unique case because the TWG work is not based on tests of a representative sample of devices to determine where overload would typically occur. Instead, it is based primarily on analyzing whether compatibility would exist for a receiver that just meets the FAA’s minimum performance standard, plus an additional 6 dB “safety margin” and a further 6 dB margin for a cold start acquisition while in flight. [See TWG Final Report, Section 3.1.4]. Nonetheless, actual testing that was done shows that all the few receivers tested performed at least 25 dB better than the FAA minimum standard. [See TWG Final Report, Table 3.1.1]. The conclusion of the TWG report and the report done by RTCA for the FAA is that minimally-compliant receivers will continue to track the required number of GPS satellites in the

⁷ This assumes that in any area where LightSquared has a terrestrial deployment that might cause interference, there is also likely to be a cellular or PCS system nearby that can transmit the augmentation signal.

face of the potential interference from a fully-deployed LightSquared network in the lower channel. [See TWG Final Report section 3.1.11.1]. The RTCA report recommends some additional analysis to confirm certain assumptions and consider how much if any additional margin is required for cold start acquisition. [See RTCA Paper Number 108-11/PMC-899, Assessment of LightSquared Ancillary Terrestrial Component Radio Frequency Interference Impact GNSS L1 Band Airborne Receiver Operation]. LightSquared is optimistic that this further analysis can be concluded in the next few weeks and will support the consistency of LightSquared lower channel operation with FAA performance standards.

Space-based. The TWG tested two space-based receivers for potential interference from operation on the lower 10 MHz channel. The test plan was agreed to by consensus of the sub-team, which included representatives of NASA (Liaison), Aerospace/USAF, LightSquared, Rockwell Collins and Trimble. [See TWG Final Report, Appendix S.1]. The sub-team conducted two days of testing at the NASA's Jet Propulsion Laboratory in Pasadena, CA. The results of the lab tests are available in Appendix S.1 of the sub-team report.

The tests of space-based receivers show what appears to be an almost unmeasurable level of interference to the receivers in space today. LightSquared emissions in the lower 10 MHz channel caused a 1 dB loss in C/N_0 at approximately -13 dBm for the existing receivers. [See TWG Final Report, section 3.5.8]. The peak aggregate interference levels identified by the simulations were -55.1 dBm for the COSMIC-2 satellite in a 800 km/72° inclined orbit, -88.2 dBm for the COSMIC-2 satellite in a 520 km/24° inclined orbit and -78.1 dBm for the LEOSAT in a 400 km/72° inclined orbit. [See TWG Final Report, table 3.5.20 – table 3.5.23].

LightSquared believes that, based on the measured lower channel test results and simulation calculations, restricting LightSquared emissions to the lower 10 MHz channel completely mitigates the current generation IGOR receiver with an excess of 40-dB margin between the peak aggregate power received and the received power level resulting in 1-dB C/N_0 degradation. [See TWG Final Report, Section 3.5.11.1.1]. LightSquared also acknowledges that restricting operations to the lower 10 MHz channel reduces the impact on the next generation TriG receiver, but does not completely mitigate it. Additional mitigation would be required in the form of increased selectivity through front end filtering at the receiver. LightSquared believes that since the TriG receiver is still in development, it could be modified to achieve complete mitigation with minimal impact on NASA science missions. NASA has indicated it is prepared to consider such mitigation following sufficient testing. [See TWG Final Report, Section 3.5.11.2.1].

Contrary views. With respect to the appropriate interference threshold, LightSquared's position is that harmful interference should be determined based on whether the user experiences a loss of performance that is meaningful to the user, recognizing that GPS devices are often subject to some reduction in performance for a variety of reasons. In some cases, some GPS device manufacturers on the TWG argued for much more rigid pass/fail criteria, despite the evidence that their preferred interference threshold metric does not correlate to any perceptible reduction in the quality of the GPS service from the user's perspective.

The most prominent example of this disagreement is with respect to the analysis of the General Location and Navigation devices. GPS device manufacturers argued for the use of a 1 dB decrease in C/N_0 as the criterion for failure, despite the lack of any evidence that the user would be able to perceive a difference between a drop of 1 dB C/N_0 and one of 6 dB C/N_0 , which

LightSquared supports. As discussed above, the dynamic tests conducted by Alcatel Lucent provide compelling evidence that even at a reduction of 6 dB C/N_0 performance remains robust. [See TWG Final Report, Section 3.3.9.2].

The other significant area of some disagreement in analyzing the test data, primarily with GPS device manufacturers in the context of the General Location and Navigation Sub-Team, is with regard to the probability that a user will experience a signal from the LightSquared base station that exceeds its interference threshold. These manufacturers insist on using a free-space propagation model that is based entirely on the assumption that the LightSquared signal is never blocked by any buildings, trees, or other obstacles, and that there is no effect from either diffraction or multipath, although it is acknowledged in the literature that, in terrestrial radio communications, even an optical line of sight between the user and the transmitter does not always lead to free space propagation.⁸ LightSquared, in contrast, supports the use of standard tools that have been developed and refined over the years to predict actual power levels in the field, regardless of whether an optical line of sight exists.⁹ The TWG Las Vegas field trials provide further support for the validity of LightSquared's perspective. As discussed above, the Las Vegas field trials show that, while free space power levels may be encountered in some small hot spots, particularly in areas surrounding unusually low base stations, these have a relatively minor impact on operational performance when considered over the entire network. [See TWG Final Report, Section 3.3.9.2].

⁸ e.g. the WILOS model, which is used in an urban environment when an optical line of sight does exist, predicts higher pathloss than the free space model.

⁹ The only exception to this is with respect to the modeling of potential interference to receivers on aircraft in flight, in which case LightSquared agrees that a free-space model is appropriate.