UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Communications and Information
Washington, D.C. 20230

FEB 14 2012

The Honorable Julius Genachowski
Chairman
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Dear Chairman Genachowski:

On behalf of the National Telecommunications and Information Administration (NTIA), I want to update you on our findings regarding the impacts of the proposed LightSquared deployment of terrestrial operations on Global Positioning System (GPS) services. Since I last wrote you in July 2011, federal agencies have performed a substantial amount of testing and analysis. Based on NTIA's independent evaluation of the testing and analysis performed over the last several months, we conclude that LightSquared's proposed mobile broadband network will impact GPS services and that there is no practical way to mitigate the potential interference at this time. Furthermore, while GPS equipment developers may be able to mitigate these issues via new technology in the future, the time and money required for federal, commercial, and private sector users to replace technology in the field and the marketplace, on aircraft, and in integrated national security systems cannot support the scheduled deployment of terrestrial services proposed by LightSquared.

Background

On January 26, 2011, the Federal Communications Commission (FCC) granted LightSquared a conditional waiver of the Ancillary Terrestrial Component (ATC) "integrated service" rule.[1] The waiver order required LightSquared to help organize and participate in a working group with the GPS community to study the potential for overload interference to GPS devices and to identify any measures necessary to prevent interference to GPS.[2] The waiver order also prohibited LightSquared from commencing commercial service until the working group process was complete and harmful interference concerns were resolved.[3]

On July 6, 2011, NTIA transmitted to the FCC a report of the National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum (NPEF) on testing conducted in the first half of 2011.[4] The test results demonstrated that LightSquared's then-planned deployment of terrestrial operations posed a significant potential for harmful interference to GPS services. The July 6 transmittal further noted that LightSquared had proposed a modification to

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[1] *LightSquared Subsidiary LLC; Request for Modification of its Authority for an Ancillary Terrestrial Component*, SAT-MOD-2010118-00239; Call Sign: S2358, Order and Authorization (Waiver Order), 26 F.C.C. Rcd. 566 (2011).
[2] Waiver Order at para. 41.
[3] Waiver Order at paras. 40, 43.
[4] Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Department of Commerce, to Julius Genachowski, Chairman, Federal Communications Commission (July 6, 2011).

its planned deployment, which would require additional testing in order to better determine the impact on GPS services.[5] Accordingly, NTIA recommended that the FCC "continue to withhold authorization for LightSquared to commence commercial operations until all the available test data can be analyzed and all valid concerns have been resolved."[6]

Thereafter, on September 9, 2011, NTIA requested the Executive Steering Group of the Interagency National Executive Committee for Spaced-Based Positioning, Navigation, and Timing (EXCOM) to work with LightSquared "to develop…a joint testing plan to validate data on the performance of cellular and personal/general navigation…GPS receivers in light of LightSquared's modified proposal to confine its operations to the lower 10 MHz signal…of the Mobile-Satellite Service frequency band."[7] In addition, NTIA noted that LightSquared was in separate discussions with the Federal Aviation Administration (FAA) regarding impacts to certified aviation GPS receivers and recommended "the FAA continue to work this issue directly with LightSquared."[8]

Over the past several months, the NPEF, on behalf of EXCOM, tested general/personal navigation GPS receivers. NTIA oversaw the testing of cellular GPS receivers to validate the measurements performed by the Technical Working Group (TWG). The FAA and LightSquared continued to analyze the potential impact to certified aviation GPS receivers. The EXCOM has now reported the results of the testing of general/personal navigation GPS receivers, the validation testing of the cellular GPS receivers has been completed, and the FAA has completed its analysis of certified aviation GPS receivers.[9]

By letter of January 13, 2012, EXCOM Co-Chairs Ashton Carter and John Porcari reported the conclusion of the EXCOM agencies as follows:

> It is the unanimous conclusion of the test findings by the National Spaced-Based PNT EXCOM Agencies that both LightSquared's original and modified plans for its proposed mobile network would cause harmful interference to many GPS receivers. Additionally, an analysis by the Federal Aviation Administration (FAA) has concluded that the LightSquared proposals are not compatible with several GPS-dependent aircraft safety-of-flight systems. Based upon this testing and analysis, there appear to be no practical solutions or mitigations that would

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[5] LightSquared's original network included 10 MHz base station signals in the upper and lower segments of the 1525-1559 MHz mobile satellite service band. LightSquared has since proposed to limit their operation to the lower 10 MHz and a "stand still" in the upper 10 MHz for an unspecified period of time in an attempt to avoid many of the interference issues with GPS receivers. At this time the duration of such a "stand still" period has not been determined.

[6] *Id.* at 1.

[7] Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Department of Commerce, to William Lynn, Deputy Secretary, U.S. Department of Defense and John Porcari, Deputy Secretary, U.S. Department of Transportation (Sept. 9, 2011).

[8] *Id.* at 2.

[9] National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum, *Follow-on Assessment of LightSquared Ancillary Terrestrial Component Effects on GPS Receivers* (Jan. 6, 2012) ("NPEF Report"); November 2011 Cellular Device Test Report (with Addendum) ("Cellular Report"); U.S. Department of Transportation, Federal Aviation Administration, *Status Report: Assessment of Compatibility of Planned LightSquared Ancillary Terrestrial Component Transmissions in the 1526-1536 MHz Band with Certified Aviation GPS Receivers* (Jan. 25, 2012) ("Transportation Report").

permit the LightSquared broadband service, as proposed, to operate in the next few months or years without significantly interfering with GPS. As a result, no additional testing is warranted at this time.[10]

Our summary and evaluation of the testing and analysis for each of the three categories of GPS receivers tested is as follows:

Cellular GPS Receivers

NTIA, with LightSquared, developed a plan to validate the TWG measurements of GPS receivers used in cellular devices.[11] Two independent test laboratories performed the validation measurements of four devices previously tested by the TWG, along with three new devices.[12] To measure the base station power level that caused GPS receiver degradation, the measurements followed industry-specified test procedures and performance metrics for cellular devices.[13] The power levels measured in the validation testing were consistent with those measured earlier by the TWG.[14]

NTIA used the measured power levels, an equivalent isotropically radiated power (EIRP) level of 62 dBm, a representative base station antenna pattern, and base station deployment parameters (antenna height and down-tilt angle) to calculate distance separations necessary to preclude potential interference to GPS receivers used in cellular devices.[15] Based on our analysis, we conclude that the lower 10 MHz base station signal does not significantly impact GPS receivers used in cellular devices.[16]

Personal/General Navigation GPS Receivers

The NPEF, on behalf of the EXCOM, worked with LightSquared to develop a plan for the validation measurements of personal/general navigation GPS receivers.[17] The NPEF measured 92 personal/general navigation GPS receivers as compared to the earlier TWG tests of

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[10] Letter from Ashton B. Carter, EXCOM Co-Chair, Deputy Secretary of Defense and John D. Porcari, EXCOM Co-Chair, Deputy Secretary of Transportation, to Lawrence E. Strickling, Assistant Secretary for Communications and Information (Jan. 13, 2012) ("EXCOM Letter").

[11] The test plan and the cellular devices tested were coordinated with the National Coordination Office for Space-Based Positioning, Navigation, and Timing. Greg Turetzky of SiRF Technology/CSR Group served as an independent observer for the testing of cellular devices.

[12] The independent test laboratories for the cellular device testing were InterTek and ETS-Lindgren.

[13] The industry standards used in the testing of cellular devices were 3GPP TS 34.171: Terminal Conformance Specification, Assisted Global Positioning System (A-GPS), Frequency Division Duplex (FDD) Release 6 and 3GPP2 TIA 916, Recommended Minimum Performance Specification for TIA/EIA/IS-801-1 Spread Spectrum Mobile Stations, Telecommunications Industry Association, April 2002.

[14] A total of 47 cellular devices were measured in the TWG and validation testing.

[15] NTIA calculated the propagation losses in the cellular GPS receiver analysis using the free space model for separation distances of less than 1,000 meters and the NTIA Irregular Terrain Model for separation distances greater than 1,000 meters.

[16] It is NTIA's understanding that, in order to avoid self interference, GPS receivers used in cellular phones, typically employ a narrower bandwidth compared with other categories of receivers.

[17] At the request of the NPEF, staff members from the Idaho National Laboratory served as independent observers for the testing of personal/general navigation GPS receivers. The NPEF also permitted LightSquared representatives and GPS receiver manufacturers to participate in the tests.

29 receivers.[18] Because there are no industry-specified performance metrics for personal/general navigation GPS receivers, NTIA directed the NPEF to use a 1 dB reduction in the carrier-to-noise density to measure the base station power level that caused GPS receiver degradation.[19] This is the protection criteria used by NTIA and the international community in managing the potential interference to terrestrial GPS receivers.[20] NTIA believes the power levels measured by the NPEF are consistent with those measured by the TWG.[21]

The NPEF concluded that 69 out of 92 of the devices tested were impacted by the lower 10 MHz base station signal at an EIRP of 62 dBm, a representative base station antenna pattern, an antenna height of 15 meters, and an antenna down-tilt angle of six degrees.[22] Of this total, we discounted receivers believed to be outmoded or improperly categorized as personal/general navigation receivers. For example, we are not basing our conclusions on data collected from GPS receivers used for general aviation.[23] Similarly, we are not relying on data from high-precision and timing GPS receivers because all parties have acknowledged that the proposed LightSquared network will have significant impacts on these receivers that need to be analyzed separately.

Using the maximum EIRP and deployment parameters for LightSquared's network, NTIA concludes that the lower 10 MHz base station signal would impact currently deployed personal/general navigation GPS receivers.[24] However, without detailed product/sales information that is only available from the manufacturers, NTIA cannot determine the likely impact of the lower 10 MHz base station signal on specific personal/general navigation GPS receivers being used today.[25]

NTIA performed its own analysis of the NPEF test data to determine if there might be alternative EIRP, antenna height, and antenna down-tilt angle configurations of LightSquared's network that would not cause interference to personal/general navigation GPS receivers. We determined that LightSquared could adjust its operating parameters to reduce the impacts on these GPS receivers on the ground to an acceptable level. However, LightSquared concluded that adopting these requirements for limiting the EIRP as a function of antenna height and down-

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[18] The NPEF testing also included high-precision, timing, and general aviation GPS receivers.

[19] NTIA September 2011 Letter at 3.

[20] The interference protection criteria for terrestrial GPS receivers specified by the United States in international spectrum sharing standards is based on limiting the increase in system noise due to interference to 1 dB, which is consistent with a 1 dB degradation in the carrier-to-noise density. *See* Recommendation ITU-R M.1903, *Characteristics and Protection Criteria for Receiving Earth Stations in the RNSS (Space-to-Earth) and Receivers in the ARNS Operating in the Band 1559-1610 MHz* (January 2012). This recommendation contains interference protection criteria for various types of terrestrial GPS and other RNSS receivers.

[21] The NPEF and TWG measurements for personal/general navigation GPS receivers can be used to analyze the impact of modifications to the base station EIRP or deployment parameters.

[22] NTIA calculated the propagation losses in the personal/general navigation GPS receiver analysis using the free space model for separation distances of less than 1,000 meters and the NTIA Irregular Terrain Model for separation distances greater than 1,000 meters.

[23] The general aviation GPS receivers were analyzed for a situation where the aircraft is on the ground.

[24] Based on NTIA's analysis, depending on the base station EIRP, deployment parameters, and measured interference level of the GPS receiver, the distance around a base station where personal/general navigation receivers can be impacted ranges from less than 100 meters to several kilometers.

[25] For example, several of the personal/general navigation receivers that the NPEF measured are listed as discontinued on the manufacturer's website. Discontinued GPS receivers may comprise a significant percentage of GPS receivers currently in use, particularly by the federal agencies.

tilt angle would render its network unable to deliver the necessary level of service absent a multi-billion dollar investment in additional base stations, which was financially impractical as well as an action that itself would add to the impacts on GPS receivers.

Accordingly, NTIA concludes that there is no practical way at this time to mitigate the interference that LightSquared's proposed network would cause to personal/general navigation GPS receivers.[26]

Aviation GPS Receivers

During the last several months, the FAA has worked with LightSquared to analyze data related to LightSquared impacts to certified aviation receivers. This work focused on the protection of FAA-certified aviation receivers operating in accordance with international aviation standards at various altitudes and used during different phases of flight.[27] Certified GPS aviation receivers support three main functions: navigation, surveillance (e.g., automatic dependent surveillance-broadcast or ADS-B), and terrain awareness and warning systems (TAWS). The FAA and LightSquared agreed to use the existing, internationally harmonized standard in the analysis assessing the potential impact to certified aviation GPS receivers.[28]

The analysis examined the impact on certified aviation receivers used in high-altitude scenarios from multiple base stations. The analysis also considered the impact for low-altitude scenarios from multiple and single base station interactions.[29] Based on the analysis, GPS receivers used for low-altitude aviation operations such as terrain awareness navigation and surveillance would not be compatible with a LightSquared base station operating at its maximum proposed EIRP taking into account transmitter and GPS receiver antenna patterns. Interference would occur when the GPS receiver is in the vicinity of a base station, or at lower altitudes in the presence of multiple base stations. The FAA concluded that the compatibility situation improves as the aircraft altitude increases so that at higher altitudes the interference is expected to be acceptable.

Although the FAA and LightSquared worked cooperatively to evaluate compatibility between the lower 10 MHz base station signal and GPS aviation receivers, they could not reach agreement on certain technical issues. In an attempt to address these compatibility issues, LightSquared proposed several mitigation measures. The FAA concluded that these proposals would result in the FAA's accepting operational impacts, or replacing the avionics of all GPS equipped aircraft operating in compliance with approved and internationally harmonized aviation standards.[30] Specifically, absent replacement receivers, LightSquared's proposals would require constant, individualized monitoring and adjustment to over 40,000 sites nationwide to ensure

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[26] The NPEF measurements also indicated that some personal/general navigation receivers were susceptible to LightSquared handset signals in the 1627.5-1656.7 MHz band. NTIA believes additional analysis is necessary to assess the impact of handsets on personal/general navigation receivers.

[27] This analysis does not address non-certified GPS receivers used for general aviation.

[28] The standards for aviation GPS receivers are defined in TSO-C145, TSO-C146, TSO-C161, and TSO-C196. These standards invoke industry standards developed through RTCA: RTCA/DO-229, RTCA/DO-253, and RTCA/DO-316.

[29] The low-altitude scenarios are those associated with approach and landing operations to any airport or heliport.

[30] This would include developing new receiver standards and replacing existing avionics with GPS equipment certified to those new standards.

consistency with air safety requirements. That FAA concluded, and we agree, that this is not a practical solution, particularly where safety of life is involved. Accordingly, NTIA does not believe that base stations can operate in the lower 10 MHz, as proposed, in the next few years, without impacting to some degree safety-critical GPS functionality.

High-Precision and Precision Timing Applications

In addition to the testing and analysis work described above, there have been developments with respect to high-precision and timing applications. All parties participating in the TWG agreed last summer that base station signals in the lower 10 MHz will cause unacceptable interference to GPS receivers used for high-precision and precision timing applications. During the past several months, LightSquared met with NTIA staff members to discuss progress toward development of filter solutions that mitigate the interference from the lower 10 MHz base station signal which LightSquared believes can be implemented without degrading the performance of high-precision and precision timing receivers. In my September 2011 letter to the Departments of Defense and Transportation, I stated that the federal agencies at some point would need to develop and execute a plan to test and analyze LightSquared's proposed interference mitigation solution. However, since LightSquared and the federal agencies have been unable to resolve the interference issues associated with personal/general navigation and aviation GPS receivers, there is no reason for federal agencies to undertake the expense and resource commitment to test high-precision and precision timing GPS receivers at this time.

Space-Based Receivers

In my September 2011 letter, I also highlighted a potential interference problem with current and future space-based GPS receivers operated by the National Aeronautics and Space Administration. The measurements and analysis performed by the TWG showed that current space-based GPS receivers are not impacted by the lower 10 MHz signal. However, the next generation of space-based GPS receivers will have wider front-end filter bandwidths and will be impacted by a signal in the lower 10 MHz.

GPS Receiver Standards

The EXCOM decided during its January 13 meeting that federal agencies will move forward this year to develop and establish new GPS spectrum interference standards that will help inform future proposals for non-space commercial uses in the bands adjacent to the GPS signals and ensure that any such proposals are implemented without affecting existing and evolving uses of space-based PNT services vital to economic, public safety, scientific, and national security needs.[31] This task will require striking the right balance between interference caused by transmitters and performance of GPS receivers. There are currently no federal, FCC, or industry developed GPS receiver standards except for those international standards discussed above for certified aviation devices.[32] Our analysis of the test measurements suggests that GPS

[31] EXCOM Letter.

[32] Receiver standards can include limitations on the GPS receiver radio frequency bandwidth and/or specifications defining the radio frequency interference environment GPS receivers must tolerate (e.g., interference rejection levels).

receivers used in cellular devices and personal/general navigation GPS receivers can be designed to be compatible with the lower 10 MHz base station signal and deployed over time without disrupting user requirements. The work performed under the EXCOM will serve as the basis to protect such GPS receivers used by civilian and military federal agencies from outside interference, as well as the basis for standards for the development and procurement of GPS receivers to support their various mission requirements.

FAA standards, codified in international agreements, define the radio frequency interference environment used in the certification of GPS aviation receivers.[33] Changing domestic and international aviation standards for compatible operation with signals in the lower 10 MHz may be possible, but will take many years, and retro-fitting or replacing the GPS receivers to be compliant with the new standards once they are adopted will take many more years. NTIA will request through the Department of Transportation that the FAA initiate an effort to examine what changes could be made to the existing standard to eventually make certified GPS aviation receivers compatible with a signal in the lower 10 MHz.

NTIA will work with federal agencies to review receiver requirements for federal systems, but that will not produce a solution for the majority of devices in the marketplace. Moreover, NTIA recognizes the importance that receiver standards could play as part of a forward-looking model for spectrum management even beyond the immediate issue of GPS. Accordingly, in parallel with our efforts with the federal agencies, NTIA urges the FCC, working with all stakeholders, to explore appropriate actions to mitigate against the impact GPS and other receivers may have to prevent the full utilization of spectrum to meet the nation's broadband needs. We look forward to working with you on this important issue.

[33] The effective date for the existing aviation standard is 2002.

Conclusion

The federal agencies and LightSquared have invested significant time and resources to identify and analyze proposed solutions to address the impact of LightSquared's planned network implementations. Based on the testing and analyses conducted to date, as well as numerous discussions with LightSquared, it is clear that LightSquared's proposed implementation plans, including operations in the lower 10 MHz would impact both general/personal navigation and certified aviation GPS receivers. We conclude at this time that there are no mitigation strategies that both solve the interference issues and provide LightSquared with an adequate commercial network deployment.

If you have any questions about our analysis, please do not hesitate to contact me or Karl Nebbia, NTIA Associate Administrator of the Office of Spectrum Management.

Sincerely,

Lawrence E. Strickling

Enclosures: EXCOM Letter
Cellular Report
NPEF Report
FAA Report