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Filed Electronically

Dr. Sheryl Genco
NASCTN Project Manager
325 Broadway
Boulder, Colo. 80305-3337

Re: LTE Impacts on GPS - Test and Metrology Plan

Dear Dr. Genco:

Deere & Company ("Deere") hereby submits this letter in response to the National Advanced Spectrum and Communications Test Networks' ("NASCTN's") request for feedback to its draft test proposal entitled *LTE Impacts on GPS Test and Metrology Plan* ("Test Plan") which "focuses on the potential impacts of proposed Long Term Evolution ("LTE") activities adjacent to the L1 GPS band," and developing "test methods and data … intended to provide sound and transparent technical information that can support the technical dialogue between affected parties."[1] Deere directs its remarks to the appropriate role and design of the proposed NASCTN test and the appropriate metric for assessing data derived from NASCTN's test and any other test of adjacent band service compatibility with GPS and other Global Navigation Satellite Service ("GNSS") signals.

1. Deere's Interest

As a prominent United States-based global manufacturer of state-of-the-art high-precision GPS receivers and GPS-derived technology, including many advanced agricultural applications critical to feeding our planet and responsibly managing its resources in the 21st Century and beyond, Deere views with intense interest test efforts examining the impact of new radiofrequency services in spectrum adjacent to bands occupied by GPS and other GNSS signals. Interference to GPS and other GNSS signals from new services operating in adjacent spectrum jeopardizes existing widespread and important agricultural and other GPS uses putting at risk significant U.S. commercial sectors, public safety, and consumer interests. For this reason, for years, Deere has participated in the ongoing examination of the impact that new adjacent band services may have on GPS and GNSS, including deliberations by the Federal Communications Commission ("FCC"), Department of Transportation ("DOT") and other domestic and international organizations. Deere carefully evaluates the impact of new and revised terrestrial radiofrequency services on GPS and GNSS, and in recent years has contributed significant

[1] Young, William *et al.*, *Draft: LTE Impacts on GPS Test and Metrology Plan*, NATIONAL ADVANCED SPECTRUM AND COMMUNICATIONS TEST NETWORK, at 5 (May 2016) [hereinafter *Draft NASCTN Plan*].

physical and human resources toward test efforts undertaking such evaluations.[2] Deere has encouraged a greater understanding of high-precision and other navigation services and consistently pressed decision makers and stakeholders not to adopt flawed and/or incomplete analyses of the very challenging technical issues raised by various adjacent band proposals notwithstanding the urgings of motivated financial stakeholders in potential new spectrum uses.

2. The Proposed NASCTN Test Falls Short of a Comprehensive, Open Examination and Risks Confusion and Misinterpretation

In reviewing NASCTN's informal draft test proposal, Deere cautions that we stand on the cusp of concluding the DOT's Volpe Center's Adjacent Band Compatibility Assessment Plan ("ABC Study"), a robust, thorough and transparent process which has involved widespread support and participation from many GPS manufacturers across all classes of GPS receivers to examine appropriate uses of spectrum in bands neighboring GPS and GNSS signals.[3] The ABC Study is a thoughtful, transparent, and comprehensive initiative examining the spectrum environment adjacent to the 1559-1610 GNSS allocation that supports the L1 GPS signal and other widely used and critically important GNSS signals.[4] Deere questions the benefits of running a similar but much narrower test effort in parallel focused only on one specific wave form and emission characteristic, as proposed by NASCTN. Moreover, the Test Plan's methodology, NASCTN's unexamined purposes in launching a "competing" process at this time, and apparently narrow outreach to a limited group of GPS interests, raises serious concerns about the credibility and utility of the data yielded from the instant test effort and any subsequent report or recommendations derived from such data. Such data, and any analysis derived therefrom, risks injecting confusion and inefficiencies in the technical consideration of adjacent band services with little countervailing benefit.

At present, Deere is an active participant in the ongoing ABC Study. Deere views the ABC Study as the current standard bearer for test initiatives evaluating the compatibility of radiofrequency services adjacent to GPS and GNSS for various reasons, including the following:

- Outreach to interested parties concerning the ABC Study was broad and DOT created an inclusive environment for other federal agencies, GPS manufacturers for every class of receiver, voluntary standard setting bodies, as well as cellular interests and proponents of

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[2] Notably, Deere led the high-precision sub-group of the FCC's mandated Technical Working Group test initiative that evaluated the impact of LightSquared Inc.'s (now Ligado Networks) original terrestrial network proposal on GPS. *See Ex Parte* Letter from LightSquared Subsidiary LLC to Marlene H. Dortch, Secretary, FCC (Nov. 18, 2010); Working Group Final Report, Section 3.4, SAT-MOD-20101118-00239 at 180 (re High Precision, Timing, and Networks) (filed June 30, 2011).

[3] *GPS Adjacent-Band Compatibility Assessment Plan*, U.S. DEPARTMENT OF TRANSPORTATION (Dec. 2012), *available at* http://ntl.bts.gov/lib/52000/52500/52560/GPS_Adjacent_Band_Compatibility_Assessment_Final_Dec_2012.pdf; *See also* GPS Adjacent-Band Compatibility Assessment, U.S. DEPARTMENT OF TRANSPORTATION, *available at* http://www.gps.gov/spectrum/ABC/

[4] Test Plan to Develop Interference Tolerance Masks for GNSS Receivers in the L1 Radiofrequency Band (1559-1610 MHz), U.S. DEPARTMENT OF TRANSPORTATION (Mar. 2016), *available at* http://ntl.bts.gov/lib/57000/57000/57046/DOT_GPS_Adjacent_Band_Test_Plan_Final_03012016.pdf [hereinafter *ABC Test Plan*].

terrestrial broadband.[5] Given this level of outreach many of these parties attended ABC Study technical workshops (in person or by webcast) and the testing that recently concluded at the United States Army's Electromagnetic Vulnerability Assessment Facility ("EMVAF") anechoic chamber ultimately involved over 70 GPS/GNSS receivers and two dozen engineers representing diverse federal and commercial interests.

- The DOT process was transparent throughout the development of the ABC Study test plan and during testing itself. Federal Register notices announced workshops and sought public comment on the test plan.[6] Workshop agendas, presentations, and tests were open to participants and observers, and moderators at events welcomed input, including constructive criticism.

- The publicly stated goal of the ABC Study was to determine appropriate power limits for terrestrial services in adjacent bands to the 1559-1610 MHz GNSS allocation that would not diminish existing or future GPS and GNSS service, or inhibit advances in GPS/GNSS technology.[7] Given this goal, the ABC Study was intentionally transmission technology agnostic, and evaluated both narrowband and wideband signals at varying center frequencies and power levels.[8] Accordingly, the ABC Study, its data, and recommendations derived from the study will continue to have utility regardless of what future proposals, if any, come forward for adjacent bands.

With the testing component of the ABC Study having concluded in late April, the DOT, with input from other federal agencies and commercial interests participating in the test effort, has begun the process of evaluating data. It is Deere's expectation that the DOT will publish recommendations derived from ABC Study test data in the near future.

In light of the DOT process, the NASCTN plan, however well-intentioned, falls short of a test process that would add anything of value to the extensive test record already under

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[5] The Department of Transportation noted that the final published test plan "reflects input the Department obtained from broad public outreach over the past year that included four meetings with stakeholders on September 18 and December 4, 2014, and March 12 and October 2, 2015, public issuance of a draft test plan on September 9, 2015, and comments received regarding the test plan." Notice and Request for Voluntary Participation, GPS Adjacent Band Compatibility Testing, U.S. DEPARTMENT OF TRANSPORTATION, 81 F.R. 12565 (Mar. 9, 2016).

[6] *See* Notice of Meeting, Global Positioning System Adjacent Band Compatibility Assessment Workshop, U.S. DEPARTMENT OF TRANSPORTATION, 79 F.R. 47171 (Aug. 12, 2014); Notice of Meeting, Global Positioning System Adjacent Band Compatibility Assessment Workshop II, U.S. DEPARTMENT OF TRANSPORTATION, 79 F.R. 68345 (Nov. 14, 2014); Notice of Meeting, Global Positioning System Adjacent Band Compatibility Assessment Workshop III, U.S. DEPARTMENT OF TRANSPORTATION, 80 F.R. 8125 (Mar. 12, 2015); Notice of Meeting, Global Positioning System Adjacent Band Compatibility Assessment Workshop IV, U.S. DEPARTMENT OF TRANSPORTATION, 80 F.R. 57915 (Sep. 25, 2015); Notice and Request for Voluntary Participation, GPS Adjacent Band Compatibility Testing, U.S. DEPARTMENT OF TRANSPORTATION, 81 F.R. 12564 (Mar. 9, 2016).

[7] Van Dyke, Karen, *Overview of GPS Adjacent Band Compatibility Assessment Plan*, U.S. DEPARTMENT OF TRANSPORTATION, presented at the International Committee on GNSS (ICG)-9 (Nov. 2014), *available at* http://www.gps.gov/multimedia/presentations/2014/11/ICG/vandyke.pdf

[8] *ABC Test Plan*, Section VII, at 4.

development in the DOT process and risks confusion and misinterpretation as an assessment intended to prove a predetermined conclusion. While Deere appreciates any interest in examining the impact of adjacent terrestrial signals on GPS and GNSS service, based on the preliminary scope of the Test Plan, NASCTN's proposed test effort does not reflect the technically comprehensive, transparent, and broadly inclusive test program developed by the DOT which Deere has and will continue to support.

First, the Test Plan focuses solely on an LTE wave form occupying the specific frequencies presently proposed for Ligado's terrestrial network.[9] The ABC Study, however, has already completed anechoic chamber testing evaluating wideband signals centered at various frequencies including those at or very near those proposed by Ligado. Accordingly, the Test Plan put forward by NASCTN does little to advance the effort to protect GPS and GNSS service while permitting expanded terrestrial services in adjacent spectrum. Instead, NASCTN is merely covering old ground, most likely with a smaller and less diverse group of GPS/GNSS receivers under test. Second, although NASCTN identifies transparency as a priority, Deere is unaware of NASCTN posting its proposed test plan or request for comment to any public forum. Moreover, it remains unclear to Deere how test data generated from NASCTN testing will be handled and disseminated, and whether and to what extent third parties might gain access to such data. Finally, Deere is unaware of how many GPS manufacturers and other interested parties NASCTN has contacted concerning the Test Plan. The universe of manufacturers, associations and standard setting bodies interested in evaluating compatibility between GPS and GNSS service and terrestrial spectrum uses is large, diverse and growing, extending far beyond the three manufacturers most heavily involved in the evaluation of the predecessor to Ligado's network. The growth and diversity in interested parties can be seen in filings made in the FCC's record concerning Ligado's present network proposal.[10] NASCTN cannot credibly argue that it has made an earnest effort to be inclusive without reaching out to these parties.

3. Data Developed in this and Other Testing Should be Evaluated Against the 1 dB Interference Threshold

With respect to any initiative evaluating the impact of adjacent signals on GPS and GNSS, Deere herein reaffirms its unwavering support for applying a one (1) dB decrease in Carrier-to-Noise Power Density ("C/N_0") as the appropriate metric for determining whether a GPS receiver under test has experienced harmful interference.

Despite assertions to the contrary, overwhelming consensus support exists within the GPS and GNSS communities for the 1 dB C/N_0 standard, which offers the only universal and quantifiable metric for measuring harmful interference to GPS and GNSS service. International regulatory bodies, United States federal agencies and affiliates, industry associations, standard setting bodies and GPS/GNSS manufacturers all committed their support to the 1 dB C/N_0

[9] *Id.* at 6.

[10] *See, e.g., Ex Parte* Letter from the Alliance for Telecommunications Industry Solutions to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 12-340 (filed Oct. 13, 2015); *Ex Parte* Letter from NovAtel Inc. to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 16-442, 12-340 (filed May 19, 2016); Comments of The Boeing Company, IB Docket Nos. 11-109, 12-340 (filed May 23, 2016); Comments of The National Public Safety Telecommunications Council, IB Docket Nos. 11-109, 12-340 (filed May 23, 2016).

standard during the evaluation of the predecessor to Ligado's original terrestrial network proposal. For example, the NTIA clarified that "both the International Telecommunications Union ("ITU") and the NTIA use a 1-dB signal-to-noise degradation as a maximum tolerable GPS interference criterion."[11] During its test program to evaluate interference into GPS and GNSS services, the National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum ("NPEF") applied the 1 dB C/N_0 standard, explaining that a "1 dB degradation point (approximately 25% loss in effective signal power) is not necessarily a tolerable level of degradation from LightSquared emissions but is useful to highlight the onset of severity associated with these emissions."[12] Deere was itself among numerous commercial entities that concurrently supported the 1 dB C/N_0 standard, explaining that "empirical test data… establishes an undeniable correlation between a 1 dB rise in the noise floor and a real-world degradation of GPS receiver performance."[13]

Strong support continues to be expressed for the 1 dB C/N_0 standard as the threshold for harmful interference affecting GPS and GNSS services. In recent comments filed regarding Ligado's present terrestrial network proposal, a chorus of support from a diverse group of interests reaffirmed commitment to the 1 dB C/N_0 standard. Among others, AGCO Corporation, Airlines for America, Garmin International, Inc., Leica Geosystems, Inc., NovAtel Inc., Phoenix Aerial Systems, Inc., the Resilient Navigation and Timing Foundation, Trimble Navigation Limited, and Veripos (US) Inc. filed comments supporting the 1 dB C/N_0 standard and reaffirming that a direct correlation exists between a 1 dB degradation and real world interference.[14] Deere enthusiastically and unequivocally agrees that the 1 dB C/N_0 standard remains the only relevant metric for measuring harmful interference into GPS and GNSS service. Changes in Carrier-to-Noise Power Density remain the only direct measurement of interference to a device under test that is objective, quantifiable and empirical.

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[11] September 18, 2013 Letter from John D. Porcari, Deputy Secretary, U.S. Department of Transportation, to Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Department of Commerce. *See* Letter from Karl Nebbia, Associate Administrator for the Office of Spectrum Management, FCC, to Julius Knapp, Chief of the Office of Engineering and Technology, FCC, IB Docket Nos. 11-109, 12-340 (filed Jul. 1, 2014).

[12] *Assessment of LightSquared Terrestrial Broadband System Effects on GPS Receivers and GPS-dependent Applications*, NATIONAL SPACE-BASED POSITIONING, NAVIGATION, AND TIMING SYSTEMS ENGINEERING FORUM (Jun. 14, 2011), *available at* http://www.gps.gov/spectrum/lightsquared/docs/2011-06-NPEF-lightsquared-report.pdf

[13] Reply Comments of Deere & Company at 8, IB Docket No. 11-109, SAT-MOD-2010118-00239 (filed Aug. 15, 2011).

[14] *See, e.g.*, Comments of AGCO Corporation, IB Docket Nos. 11-109, 12-340 (filed Jun. 6, 2016); Comments of Airlines for America, IB Docket Nos. 11-109, 12-340 (filed May 23, 2016); Comments of Garmin International, Inc., IB Docket Nos. 11-109, 12-340 (filed May 23, 2016); Comments of Leica Geosystems, Inc., IB Docket Nos. 11-109, 12-340 (filed May 26, 2016); *Ex Parte* Letter from NovAtel Inc. to Marlene H. Dortch, Secretary, FCC, IB Docket Nos. 11-109, 16-442, 12-340 (filed May 19, 2016); Comments of Phoenix Aerial Systems, Inc., IB Docket Nos 11-109, 12-340 (filed May 26, 2016); Comments of the Resilient Navigation and Timing Foundation, IB Docket No. 11-109 (filed May 23, 2016); Comments of Trimble Navigation Limited, IB Docket Nos. 11-109, 12-340 (filed May 23, 2016); Comments of Veripos (US) Inc., IB Docket Nos. 11-109, 12-340 (filed Jun. 2, 2016).

Finally, Deere emphasizes that test initiatives attempting to evaluate the compatibility of proposed terrestrial services with GPS and GNSS based on end user outputs or metrics are inherently subjective and lack reliability in this context. With these flaws, such initiatives are unlikely to withstand rigorous scientific scrutiny. Specifically, given the incredible variations in GPS/GNSS receiver design and use models, no test program can credibly assert to successfully harmonize and evaluate end user outputs or metrics. For example, a degradation of device accuracy (a key end user output/metric for any navigation receiver) of even a few centimeters might render certain high-precision receivers inoperable, whereas certain general location and navigation devices may be able to tolerate a markedly greater loss of accuracy without affecting the end user. Moreover, within a broader class of device (e.g., high-precision) there may be varied expectations for accuracy depending on the end user and specific application. Therefore, to undertake a meaningful test using accuracy as one end user metric for determining harmful interference, a test program may need to develop hundreds (or thousands) of test scenarios, which would be impractical (or more likely impossible) even with virtually limitless resources and time. Of course accuracy is only one critical end user output for a GPS/GNSS receiver. Integrity, continuity and availability are also critical end user outputs that would need to be evaluated for each device under test, and each of these outputs involves similar degrees of variation between device classes, sub-classes and in some instances individual devices.

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To the extent NASCTN has questions regarding Deere's comments, please feel free to contact the undersigned.

Respectfully submitted,

/s/

Mark Lewellen
Manager of Spectrum Advocacy
John Deere