Consolidated Comments and Reponses for NASCTN's Draft Test Plan – Impact of LTE Signals on GPS Project

NASCTN convened a panel of technical experts, from NIST and NTIA, to develop a test plan that would meet the objectives of this project:

- Develop a repeatable, calibrated, and well-documented test methodology to investigate the impact of adjacent-band LTE transmissions on GPS receivers operating in the L1 frequency band
- Collect data on a representative subset of available GPS devices in order to validate the proposed test methodology.

In May of 2016, NASCTN distributed a draft test plan and feedback form to a cross-section of GPS manufacturers, Federal agencies and spectrum regulators to obtain technical feedback on the proposed methodology.

Over a two-month period, NASCTN received 159 comments from the following spectrum regulators, Federal agencies, GPS manufacturers and members of the general public:

- Federal Communication Committee (FCC)
- National Telecommunications & Information Administration (NTIA)
- U.S Department of Transportation (DOT)
- National Aeronautics and Space Administration (NASA)
- U.S. Air Force Space Command (AFSPC)
- U.S. Air Force Spectrum Management Office (AFSMO)
- Deere & Company*
- Garmin Ltd.
- Honorable John Stenbit, Dr. Brad Parkinson, Dr. John Betz
- Mr. Larry Chesto

The NASCTN test team reviewed the comments and developed a revised test plan in July of 2016 that addressed the technical issues raised in the comments. The adjudicated comments are not attributed to any specific organization or individual.

**The comments submitted by Deere & Company were non-technical in nature and were not included in the comment adjudication. However, Deere & Company also filed these comments with the FCC.*

Comment Number	Level	Reference within Draft Test Plan	Comment	Commenter's Recommendation	NASCTN Comment Resolution
1	General – C	Cover Page	The test team responsible for preparing this plan and presumably running the test does not include key sufficient PNT expertise. Being involved with GPS interference testing for 25 years, only one of the names is recognized as being associated with the GPS community. An online search of the team's biographies did not readily indicate experience with testing of GPS interference effects. PNT systems differ from communication systems in numerous ways. The original concept for standing up a "National" testing organization recognized the concept of bringing in relevant experts from across the federal government, not just NIST—particularly for PNT.	Formally add technical experts from across the federal PNT community to the test team for purposes developing and executing this test. Will commit to providing technical experts as it has for previous LTE impact tests. Recommend seeking experts from other agencies as well—particularly Air Force and FAA.	The NASCTN process for obtaining feedback on the proposed test plan resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA).
2	General – I	General Comment	C/No changes are the mechanism through which the other KPIs are affected, and the C/No degradation due to LTE can be measured precisely with most receivers.	Emphasis must be given to the C/No data as the most relevant and accurate measurements.	Although the NASCTN test plan includes a number of measurands in the study, including C/No, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators.
3	General – I	General Comment	The plan does not indicate how the internal post--- processing software of the GPS devices will be handled. Many commercial GPS devices have software that will enable internal data corrections to be performed to the signal prior to the final location and display on a map. Functions such as, "snap to road" must be accounted for and either turned off or bypassed in the device. If not, the resulting output and positioning information may alter the actual results of the DUT.	Provide a section on how NASCTN plans to handle the post---processing software within the DUT.	This information will be included in the final report in compliance with the CRADA between NIST and Ligado Networks.
4	General – I	General Comment	The Test Plan demonstrates how to measure the effects of a single LTE base---station on GPS receivers, but does not consider the potential of multiple LTE base---station effects on a GPS receiver.	Consider performing tests to demonstrate the "aggregate" effects from multiple base---stations to a single GPS receiver.	This would be a follow-on investigation. The amount of power at the DUT during these test could represent power from an aggregate test of devices.

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5	General – I	General Comment	One of the most significant requirements of a GPS receiver is the ability to acquire and re---acquire satellite signals. This capability is correlated with C/No. Did not see any tests on how this will be performed in the Test Plan.	Consider adding tests to determine loss---of---lock, initial acquisition, and re---acquisition of satellite signals.	Initial acquisition, loss of lock, and re-acquisition tests added to test plan.
6	General – I	Page 4, 2nd para, lines 3---5	"…but does not incorporate insight from any preliminary anechoic chamber tests that would naturally solidify the test plan."	There are numerous previous "LTE impacts on GPS" tests done in anechoic chambers that produced more than a thousand pages of data on a nearly identical system and in one of the same anechoic chambers you are proposing to use. While I can certainly understand why you might not want to replicate those previous tests precisely, you certainly can and should "incorporate insight" from these previous government anechoic chamber tests. Lessons learned from those tests, as well as the reports from independent audit reports by Idaho National Labs and MIT/LL of the test methodology, can help ensure NASCTN's test "…bridges US resources to get to the right national answer."	The NASCTN test methodology will be well documented, so others will be able to make comparison with previous measurement campaigns.
7	General – I	Section 4 (and 9)	In Section 9, the test plan includes an action "Data analysis and report," implying that a report will be issued. Is that a separate deliverable from the "test methodology and measurement data" referenced here? If so, it should be included here. If a "report" is planned, it may be useful to provide a draft outline for such a report (in **a**n appendix) since such a draft would provide more insight into the information to be documented.	Clearly indicate whether a test report will be issued (deliverable) and, if so, include draft outline for test report.	Final test report will be developed and release in accordance with the CRADA between NIST and Ligado networks. An outline of the test report will not be included in this test plan.
8	General – I	Section 4	A clear statement on the availability of the data would be useful and will note whether the release period is due to internal review of data or due to dictates by the study sponsor. As an observation, this draft test plan appears to function primarily as a test plan, but, also, in some ways to a project plan in its identification of deliverables, etc..	Insert a clear statement on the plan (e.g., timeline, restrictions, etc.) for releasing test report/data. (Or, consider releasing a clearly defined and concise Project Plan to accompany the test plan.)	The handling of proprietary information and distribution of the NASCTN report, measurement data, and data analysis is governed by the CRADA signed by NIST and Ligado Networks. The NASCTN report will include all of the information that is publically releasable.

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9	General – I	Section 8	A back---up plan may be useful to ensure the availability of the data that could be lost due to device, process, or other failure in the collection and transport of the data. A basic overview of such a process would be useful in the test plan (or project plan).	Consider defining and executing a data backup plan (e.g., on---site replication, transport, etc.).	The raw data collected from DUTs is backed-up on a daily basis.
10	I	Section 1, 2nd para. Page 5	The statement that the FCC granted a waiver for operation of a terrestrial network in 2011 is incorrect. The partial waiver was to remove a restriction for an Ancillary Terrestrial component to the licensee's Mobile Satellite Service and was only granted on the condition of proving non---interference to GPS	Change 1st sentence to read *"In January 0f 2011, the United States Federal Communications Commission granted a partial waiver of the integrated service rule for an Ancillary Terrestrial Network, subject to conditions which have not yet been met.*	Text modified to add clarity.
11	I	Section 1, 2nd para, line 4 Page 5	The qualifier about interfering with GPS receiver was not in the FCC Order. Presidential Decision Directive requires federal agencies to also provide interference spectrum for planned and future GPS applications.	Delete the word "existing" from "…would not interfere with existing GPS receivers."	Will make editorial change in final report. Existing receivers are used in this test.

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12	C	Section 1, last para Page 5	Concur with this statement, but the list of receivers provided elsewhere in the Test Plan is in no way a representative subset of available devices. The 2nd NPEF test (2011), focused on just the General Navigation category and tested more than 100 different types of receivers with a wide and significant range of results.	The sentence is OK as is, provided the list of test receivers expands significantly, with input from the federal agencies and industry. If not, this sentence should be deleted as the current plan does not test representative receivers.	The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. NASCTN included a number of GPS receivers in each of these categories in order to adequately validate the proposed test methodology. A major goal of the NASCTN project is to provide a reproducible test project that other organizations can use to perform similar tests on other GPS devices included in this study. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.

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13	I	DUT list, Section 5.2.1 Page 7	Only 1---2 precision receivers to be tested. May want to include receivers using codeless/semi---codeless techniques. May need to transmit both GPS L1P and L2P for this.	Consider expanding DUT list to increase test value. Consider simultaneous testing.	The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. NASCTN included a number of GPS receivers in each of these categories in order to adequately validate the proposed test methodology. A major goal of the NASCTN project is to provide a reproducible test project that other organizations can use to perform similar tests on other GPS devices included in this study. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.

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14	C	Table 1 Page 8	The list of receivers is intended to be representative of the General Navigation category, but has 4 of 7 receivers in the "Hiking" function which is a very narrow subset of general navigation and location. Previously, LightSquared tried to argue that hiking receivers were such a niche use they shouldn't be tested at all. While we don't agree with that, they certainly aren't representative of the entire category. Furthermore, all 4 of these are also from the same manufacturer. 1st responder devices in particular had a wide range of interference response in previous government LTE interference tests. Testing only 1 model can't possibly be "representative".	Significantly expand the number and types of receivers to be tested. Consider adding additional 1st responder receivers, Coast Guard devices for marine navigation, receivers supporting Positive Train Control and intelligent transportation applications, as well as those in surveying, agriculture, construction and other areas. There are an incredibly diverse set of GPS applications and previous tests have shown they do not respond the same in an interference environment.	The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. NASCTN included a number of GPS receivers in each of these categories in order to adequately validate the proposed test methodology. A major goal of the NASCTN project is to provide a reproducible test project that other organizations can use to perform similar tests on other GPS devices included in this study. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.
15	I	Describe GPS simulator configuration, Section 5.2.2 Page 10	What signals are transmitted, what global gain setting, errors that are enabled, etc.	Include some description in plan and details in test report.	Details on GPS setup added to the test plan.

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16	I	Table 5. GPS test levels Page 10	Minimum spec power (3GPP standard) is a good test configuration baseline, as is the limited exposure. May also consider nominal power levels (time varying) scenario to avoid argument that ---130dBm or weaker is a stressing case, thus limiting value of test. I would prioritize the ---130dBm case though if time limitations are factor. Consider also constant weaker signal scenarios, non---static scenarios. Make sure receivers are configured to track weak signals for limited exposure test (some have minimum signal masks).	Please consider.	The test includes testing at both a nominal level of -128.5 dBm per SV and a range of power levels for a limited condition.
17	I	Section 5.2.4, 1st para. Page 11	"..the architecture of the proposed LTE system is not known to authors of the test plan." This seems odd as the entity requesting the test should have some idea of what their architecture is and the choices made in architecture selection affect the interference environment.	Recommend delaying finalizing this Test Plan, until the proposed LTE architecture is better understood, so we are not testing a "generic" LTE that may significantly vary from the final system.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
18	I	Section 5.2.4, last para. Page 11	Must also consider the density of the transmission sources. "LTE impacts on GPS" does not mean interference from only one transmission source. There are 40,000+ transmission sources and our concern is on the interference from the network, not a single tower. The proposed density of the network in 2011 had towers every .4---.7 km. With interference effects predicted at greater than 20 km, that means the victim receiver expects to receive interference from multiple stations simultaneously. Density of the LTE stations can't really be ignored if the criteria is supposed to be "based on end---user experience"	Add density of the LTE base stations as part of the LTE Signaling Scenario factors.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
19	I	5.2.4, Figure 1 Page 12	Although figures are useful, the specific values (functions) should be included on the graphic to remove any questions as to the specific values.	Provide the specific values for the mask in the figure (or add a table).	Specific values will be added in the final report.
20	I	Section 5.3.2, 1st para Page 14	Refers to baseline change. Cannot have a baseline with only one (1) antenna	This usage of "baseline" might mean the location solution with no LTE interference? If so, use different words as "baseline" means the vector between a pair of antennas to this audience.	Text modified to add clarity.

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21	E	5.3.3 first para, last sentence Page 15	"…, and a length should be chosen that *maximizes* these variations."	Maximizes should be minimizes	Text is correct. See reference.
22	I	Section 5.3.3 Page 15	Shows Time interval counter	Be sure to use a post---processed carrier solution for the receiver clock offset to achieve state of the art, which is <100 ps accuracy in biased time transfer. Reference GRACE and DSAC missions.	The post-processing of the time interval counter results will measure the impacts to the accuracy as specified by the manufacturer of the device.
23	I	Fig 3. Page 16	Will probably need GPS amplifier, don't think GSS8000 will provide high enough signal level to radiate 3m	Add an appropriate amplifier that will provide adequate signal levels for the test to be performed.	Amplifier added to figure.
24	I	Section 5.4 Page 20	Data acquisition dwell times	Recommend look at results from ABC testing to see the variety of C/No "overshoots" and settling times observed.	The NASCTN test methodology will be well documented, so others will be able to make comparison with previous measurement campaigns. Although the NASCTN test plan includes a number of measurands in the study, including C/No, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators.
25	E	5.4, Figure ? Page 21		Insert figure number and caption.	Added figure number and caption.
26	E	5.4, Figure ? Page 22		Insert figure number and caption.	Added figure number and caption.
27	I	5.4, Figure ? Page 22 (other sections as well)	It is not clear what the "step" power levels will be in this and other processes identified in the test plan. Given the protection limits used in traditional sharing recommendations, this value will need to be < 1 dB (per ref unit).	Identify the expected "step" power levels for the different test processes.	The stepped power levels are chosen based on the regions of significant device response. This range is initially estimated by a preliminary sweep of power levels; additional levels are tested as needed. This results in a lower uncertainty in the data for measured power levels.

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28	I	5.5	Although both suggested methods in Section 5.5 are useful, varying the level of the out of band emissions (e.g., Section 5.5.1) is necessary for understanding the tolerance of the devices and, from a different perspective, the system---wide impact that factors the distance from the base station. Ideally, however, both the absolute OOBE power level and the LTE transmitter power should be varied independently to capture both the distance effects and the relative transmit power.	At a minimum, use the swept range method (e.g., Section 5.5.1) to vary the level of the out of band emissions.	Added text for clarity.
29	I	5.5.1 Emulate swept range vs 5.5.2 Study LTE In---Band Coexistence Margins Page 23	Marginal preference for swept range. However also consider fully separate testing of OOBE and in---band LTE source (toggle them on and off) at swept power to be able to distinguish the effects. Mechanism for interference is very different between the in---band and out of band signals.	For consideration.	Added text for clarity.
30	C	Section 5 (and 6)	Because the recorded values of key parameters are self--- reported by each DUT, a procedure should be included to calibrate each device's reporting of key values as a function of both the change in RNSS system input power and a change in the external noise (in---band and/or OOBE, AWGN) power in the absence of the LTE signal. The calibration will provide insights to the relation to the "absolute" (or perceived) DUT noise temperature, any quantization of the reported values, and any variation due to input levels in the self---reported values.	Include procedures to calibrate each DUT's reporting of the key values such as C/N0, as needed, as a function of both the change in RNSS system input power and a change in the external noise power.	As pointed out in the introduction, GPS devices are inherently not metrology devices and thus the concept of "calibrating the device" is misleading. The calibration process in the testing process applies to setting the RF conditions created at the plane of the DUT location, including the GPS signal power, the LTE power, and the LTE out-of-band emission mask. The baseline condition, with no LTE power or OOBE present is measured over a sufficient time period to establish a statistically valid baseline.

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31	C	Section 6.2 Page 24	A critical measure of a GPS receiver is the ability to acquire satellites—often in challenging environments such as urban canyons—and the time it takes to acquire. The NIST proposed methodology assumes the victim receiver is already locked on and measures when it loses lock. The more challenging real--- world situation is to acquire in an LTE environment where the interfering signals are already present.	Add to list of response variables: GPS acquisition (binary), time to acquire (seconds)	Initial acquisition, loss of lock, and re-acquisition tests added to test plan.
31	C	Section 6.2 Page 24	The most important variable to control, or at least to know, is the noise temperature of the DUT (with no RFI) in the test setup compared to what is expected in operation. Otherwise, a high noise level during testing would obscure effects from the LTE interference.	Add calibrations of the DUT noise floor under test conditions minus the LTE signal. Will need to inject noise at a known level. For example, well--- calibrated OOBE interference could be used for this.	The expected noise temperature in an operational setting is not an established standard value for all devices or all use cases. The measurement process includes a baseline case that does not include an LTE or the proposed OOBE mask – i.e., no interference. By testing in a well-controlled environment, the results data show the DUT response due to the added radio activity.
32	I	Section 6.2 Page 24	No tests of acquisition are included	If you rely on KPI instead of C/No degradation, you should test the receiver function most sensitive to RFI, which is a cold---start acquisition scenario.	Although the NASCTN test plan includes a number of measurands in the study, including C/No, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators. Tests of acquisition in the with LTE activity have been added to the test plan.
33	I	Section 6.2 Page 24	Greater specificity and information about the planned variables would be useful. For example, as noted in the draft, values such as C/No are based on the devices' internal reporting, so such "sources" for the data should be documented. As written, the test plan is a bit vague in defining the response measures and the associated (meta) data defining each. In addition, identifying the initial data format concept for the reported data will assist readers of the test plan in understanding the actual output of the testing.	Include a detailed table for all planned response measures that includes key information such as source of value (e.g., external reporting, internal test point, external test device measurement, observation, status signal, etc.), operating mode of the DUT, and other factors. Consider defining (table in appendix?) the planned output format (data schema) for the core (raw) data.	This information will be included in the final report in compliance with the CRADA between NIST and Ligado Networks.

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34	I	6.3 (and other sections) Page 25	While recognize that the proposed baseline testing provides insights into core effects, other situations and test scenarios should be considered and defined as part of this round or future testing. Such scenarios include: --- DUT in motion --- DUT initial signal acquisition --- Different GPS constellation configurations --- Test configurations to emulate a network of LTE systems (Note: Although the closest, single base station may be the most likely situation (and impact) for terrestrial GPS systems, the LTE network deployment may have an effect on airborne and space GPS users.) --- TBD: other scenarios will be based on the types of receivers not included in this round	Although probably outside the scope of this baseline testing, consider other test scenarios such as DUTs in motion, impact on DUT's initial signal acquisition, other types of receivers and their operational scenarios, etc..	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
35	I	Appendix A Pages 28 --- 29	How is Appendix A to be used. This seems only relevant for OOBE signal effects. LTE "in--- band" UL/DL effects depend on rx out of band filtering and linearity. Will SIR be used separately for OOBE and in--- band?	Please provide clarification.	Additional clarifying test has been added.
36	I	Appendix A Page 29	Specifies receiver noise floor will be characterized. How will this be done. System noise temp is important for 1dB C/No loss criteria.	This is critical to translating test results to real--- world conditions, particularly if unreported high test noise floors are used to obscure the effects of RFI on the C/No.	The baseline case provides information on device response to the ambient noise in the test setup.
37	I	Appendix A Definition of Prs Page 29	Receiver is designed to acquire and track at a given C/No, NOT a given received signal power.		The satellite power is independent from the GPS device performance and is the signal the device desires to capture and demodulate.
38	I	Appendix A Last equation Page 29	SIR is not important by itself. We need to know the Interference to noise ratio to predict the effects on C/No, and we must know the Signal to (noise + interference) ratio which shows up along with all the additional errors in KPIs.	Rethink this issue. You may be considering the receiver system noise during tests vs during actual operations, but this needs to be made explicit.	C/No along with other measurands are being collected. SIR is information that can help in the DUT analysis.
39	E	Appendix B Page 31	Consists of only a table.	Add detail.	Title and caption provide information on table contents.
40	E	Table 9 Page 32	Spectrum Analyzer not at GPS output. Noise floor depends on analyzer bandwidth setting, etc.		Calibrations sections will be updated in final report.
41	E	Appendix C.2 Page 33	Paragraph 2 does not describe the test configuration figure 12. Break is at LTE generator output in figure, at amp output in paragraph. If active device is in network analyzer test, must set NA test power to not compress amp.	Need to fix.	Calibrations sections will be updated in final report.

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42	E	Table 11 row 2 Page 35	“GPS” should be “LTE”	Need to fix.	Calibrations sections will be updated in final report.
43	E	Table 12 (Page 36), Table 13 (Page 37), Table 14 (Page 39)	OOBE is mixed up with “in--- band” in several places. Cross references are inaccurate. Clarify that measurements are made at minimum attenuation setting of step attenuators, which I believe is intent.	Need to fix.	Calibrations sections will be updated in final report.
m	I	Appendix C.4 Page 40	GSS8000 may not produce high enough signal level to make these measurements or to radiate. May need GPS amp. May be able to use “MON” port for measurements, or rely on simulator spec. Do need to characterize simulator source noise accurately.	Please consider.	GPS amplifier is included and characterized in the testing.
45	E	D.1 Page 42	There appears to be a misplaced word (linear vs. circular) in the initial sentence.	Revise to remove ambiguity.	The text has been corrected to reflect the circular polarization.
46	E	Table 18 , last row, last para. Page 43	“LTE” should be “GPS”	Need to fix.	Calibrations sections will be updated in final report.
47	I	Appendix D.3 Page 44	Network analyzer will likely provide more accurate path loss measurement.	Please consider.	A network analyzer is utilized for the path loss measurement.
48	I	Appendix E.1 Page 46	We calculate the worst case for 3rd order IM products will come from the band edges, namely ---1627.5+1536 + 1637.5 = 1546.0 MHz	Recommend you select the worst---case frequencies from the LTE signal to calculate the locations of the IM products.	Will consider in the up and downlink combination.
1	C	N/A	Based on experience with the GPS Adjacent Band testing, there are a number of elements that should be more fully described in the test plan or in a test procedures document to include: (1) defined set of test events, (2) minimum data elements to be recorded and associated processing, (3) completed equipment list, and (4) venue for testing.	Recommends updated document(s) be circulated for review when these additional elements for testing are known.	The updated NASCTN test plan is posted on its website (https://www.nist.gov/ctl/national-advanced-spectrum-and-communications-test-network-nasctn).

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2	C	N/A	The NASCTN process stresses the need for openness and transparency. Benefited tremendously in its GPS Adjacent Band effort by holding public workshops and using a *Federal Register* Notice to solicit comments on its draft test plan.	Recommends use of a *Federal Register* Notice process so that all interested parties who would like the opportunity to review and comment have the opportunity to do so. Also, it creates a public docket for comments, increasing openness and transparency. Also recommend holding public workshops as part of the Outreach and Community Feedback process.	The NASCTN process for obtaining feedback on the proposed test plan resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA). NASCTN is reviewing notification process to improve awareness among the stakeholder community.
3	C	N/A	The test plan states "The output of this project will be a test methodology and measurement data from a set of GPS devices subject to nearby LTE activity".	Recommends further consideration be given to describing how the data from this effort will be handled, including who will have access to the test results and the measurement data.	The handling of proprietary information and distribution of the NASCTN report, measurement data, and data analysis is governed by the CRADA signed by NIST and Ligado Networks. The NASCTN report will include all of the information that is publically releasable.
4	C	N/A	Signal acquisition is usually the most fragile GPS receiver function in the presence of interference. If any alternative metric (aside from the accepted 1 dB) for harmful interference is recommended, it must be demonstrated that GPS devices will continue to be able to acquire in the presence of interference. Also, operation in the presence of other real-world stressed conditions besides lower power levels (e.g., dynamics, vibration) should be considered. These points were discussed extensively at the workshops in conjunction with its GPS Adjacent Band effort and additional testing to include signal acquisition.	There is broad interagency support for evaluation of signal acquisition testing and testing under stressed conditions in general. We would welcome having discussions with NIST regarding inclusion of these test conditions.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
5	I	Title	The Title of the test plan states it is "LTE Impacts on GPS *Test and Metrology Plan*".	In terms of scope, this study is only looking at the impact of one particular proposed set of LTE frequencies – those proposed by Ligado – and only a subset of civilian GPS devices (high precision, timing, GLN). Recommend limitations of the scope of the study be reflected in the title of the test plan, as well as elsewhere in the document.	The scope section of the test plan provides this material.

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6	E	Section 1 Pg. 5 3rd Paragraph	Insert “conditional” before “waiver”	Same as comment	Modified text.
7	E	Section 1 Pg. 5 3rd Paragraph	Change “measurement effort” to “study”	Same as comment	This is a measurement effort.
8	I	Section 1 Pg. 5 3rd Paragraph	This paragraph would benefit from discussion of the Technical Working Group (TWG) test results.	Recommends including a description of the TWG results, including the widespread interference impact witnessed during this testing.	The NASCTN test methodology and results will be well documented, so others will be able to make comparison with previous measurement campaigns.
9	I	Section 1 Pg. 5 3rd Paragraph	This paragraph would benefit from discussion of the National Space-Based PNT Engineering Forum (NPEF) testing that took place in 2011.	Recommend including background material to summarize the tremendous amount of additional work that was conducted on LightSquared compatibility with GPS by the Federal government subsequent to the FCC-mandated TWG. See, e.g., http://www.gps.gov/spectrum/lightsquared/. Background should also include mention of the DOT ABC study/testing and what differences there are between the proposed test and the ABC test. Willing to have follow-up discussions as necessary to provide additional information about these tests.	The NASCTN test methodology and results will be well documented, so others will be able to make comparison with previous measurement campaigns.

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10	C	Section 1 Pg. 5 4th Paragraph	This section states that the "GPS industry" prefers the 1-dB CNR degradation metric. While we understand there has been much discussion over the metric to apply for an interference protection criterion, feedback and discussion at the DOT GPS Adjacent Band workshops supported use of the 1-dB criteria by the majority of participants, both from government and industry. We note that the Space-Based PNT Advisory Board also has recommended use of this criteria at their recent meeting and in a letter to the EXCOM co-chairs. Furthermore, this metric is embedded in ITU-R Recommendations on protecting RNSS, including M.1903. Further, NTIA directed the NPEF to use this metric in Federal Government testing of LightSquared conducted in 2011, and the EXCOM endorsed the 1-dB metric in their January 2012 conclusions regarding the compatibility of LightSquared's proposed network with GPS. See, e.g.,https://www.ntia.doc.gov/files/ntia/publications/lightsquared_letter_to_chairman_genachowski_-_feb_14_2012.pdf	From our perspective, protection of GPS/GNSS from interference is critical for safety-of-life applications. The 1 dB CNR degradation metric provides the interference protection criteria. Trying to define harmful interference based on "end-user experience" is challenging given the diversity of receivers and applications and is problematic in ensuring those applications are protected from interference.	Although the NASCTN test plan includes a number of measurands in the study, including C/No, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators.
11	C	Section 2 Pg. 5 1st Paragraph	The stated objective is "to establish a test methodology to investigate the impact of LTE transmission on GPS receivers". This objective statement is far too broad to communicate accurately what distinguishes this test plan from the many test plans for earlier LightSquared-GPS tests.	Recommend the objective section should make it clear that this test plan focuses only on impact of one proposed LTE network on GPS – specifically the one proposed by Ligado. The specific frequencies and power levels to be tested should be mentioned here.	The scope section provides details on the overall NASCTN test. The NASCTN final report will include a discussion of the limitations of the tests performed as well as a summary of the underlying assumptions.

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12	C	Section 2 Pg. 5 3rd Paragraph	The test plan states that "a representative subset of available devices will be tested…". However, later on in the test plan it is clear that only a small number of receivers representing a small number of civilian application categories will be tested.	Received feedback through several public workshops on the importance of testing receivers representing a wide number of GPS/GNSS applications. Categories of receivers included in the DOT testing were: aviation (non-certified), general location and navigation, cellular, timing, high-precision and networks, and space-based receivers. Recommend that NIST include receivers from each of these categories in the NASCTN testing. Otherwise this limitation in scope should also be addressed in the objectives section.	The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. NASCTN included a number of GPS receivers in each of these categories in order to adequately validate the proposed test methodology. A major goal of the NASCTN project is to provide a reproducible test project that other organizations can use to perform similar tests on other GPS devices included in this study. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.
13	C	Section 3 Pg. 6 1st Paragraph	This section states in the 1st sentence that the objective of the test is to establish the impact of LTE signals on GPS devices".	In terms of scope, this study is only looking at the impact of one particular proposed set of LTE frequencies – those proposed by Ligado – and only a subset of civilian GPS devices (high precision, timing, GLN). Recommend limitations of the scope of the study be reflected in the title of the test plan, as well as elsewhere in the document.	The scope section modified to add additional content and clarity. The NASCTN final report will include a discussion of the limitations of the tests performed as well as a summary of the underlying assumptions.

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14	I	Section 3 Pg. 6 3rd Paragraph	It is not the OOBE that makes the handset emissions of concern – it is the potential for very close proximities of the handsets to the GPS receivers, for which both coupling of the fundamental and OOBE can cause deleterious effects.	Recommend modifying text to highlight this point.	Depending on the input filtering of the DUT, the OOBE may emit energy in the operating bandwidth of the DUT.
15	C	Section 3 Pg. 6 4th Paragraph	A significant limitation in the scope of the test plan is only considering GPS and not multi-GNSS. Feedback received from GPS receiver manufacturers during the DOT GPS Adjacent Band workshops is that most civil/commercial receivers now incorporate multi-GNSS signals.	In order to be representative of current user equipment and for the testing to be rigorous, the scope should include GNSS signals from other constellations. Understand that FCC rules require licensing of non-Federal receive-only equipment operating with foreign satellite systems, including receive-only earth stations operating with non-U.S. licensed radionavigation-satellite service (RNSS) satellites. However, in reality, widespread GNSS equipment has been deployed over the past decade or more. Also, this licensing rule does not apply to federal user equipment such as those GNSS receivers being used in significant volumes for high-precision applications by NASA, USGS, NOAA, etc.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
16	C	Section 3 Pg. 6 4th Paragraph	It is stated that LTE “will” be present in the bands listed.	“Will” should be replaced with “has been proposed” since currently the FCC has not decided that the licensee can proceed with operating the proposed network.	Text has been updated accordingly.
17	C	Section 3 Pg. 6 6th Paragraph	The draft test plan indicates that “Aviation, space-based, cellular, and DoD devices of all categories are not included”.	Received feedback through several public workshops on the importance of testing receivers representing a wide number of GPS/GNSS applications. Categories of receivers included in the DOT testing were: aviation (non-certified), general location and navigation, cellular, timing, high-precision and networks, and space-based receivers. Recommend NIST include receivers from each of these categories in the NASCTN testing. Otherwise this limitation in scope should also be addressed in the objectives section.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.

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18	I	Section 3 Pg. 6 6th Paragraph	Why would modification to test procedures be required for these other categories of receivers?	Received feedback through several public workshops on the importance of testing receivers representing a wide number of GPS/GNSS applications. Categories of receivers included in the DOT testing were: aviation (non-certified), general location and navigation, cellular, timing, high-precision and networks, and space-based receivers. Recommend NIST include receivers from each of these categories in the NASCTN testing. Otherwise this limitation in scope should also be addressed in the objectives section.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
19	C	Section 4 Pg. 7	The test plan states "The output of this project will be a test methodology and measurement data from a set of GPS devices subject to nearby LTE activity".	Recommends further consideration be given to describing how the data will be handled, including who will have access to the test results and the measurement data.	The project is governed by a CRADA that was negotiated between NIST and Ligado Networks. The NASCTN final report will include all information that is publically releasable.
20	I	Section 5.1 and 5.2.2 Pg. 7 and Pg. 10	Not including atmospheric impairments will lead to larger than necessary position errors by the GPS receivers under test.	All GPS devices apply corrections for ionospheric and tropospheric delays. Setting these errors to zero in the simulated signals will lead to larger errors than necessary. For ionospheric errors, GPS devices apply corrections in several different ways: (1) single-frequency standalone receivers use the broadcast Klobuchar coefficients in the navigation data, (2) dual-frequency receivers apply corrections based upon the difference in delay seen on L1/L2 pseudoranges, (3) differential receivers apply corrections from WAAS or another differential system. For the troposphere, every device applies corrections using models, etc. If you set the simulator to not apply ionospheric delays, there is a problem that the ionospheric parameters in the emulated GPS navigation data cannot be set to produce a 0 m correction. If the simulator does not emulate tropospheric errors, you cannot make most GPS devices NOT apply their corrections so you'll end up with pseudorange errors of up to 25 m (for SVs emulated at low elevation angles for an emulated user location near 0 m MSL)	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.

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21	I	Section 5.2.1 Pg. 7	It is stated that the “first round of testing will focus on the top two or three devices” in each category but no definition is provided for “top” or any evidence that the devices selected meet that definition.	Please provide a definition for “top” devices and evidence that the devices selected for test are “top” by that definition. Address inconsistencies with later statements in the test plan that devices would be selected based around practicalities (e.g., what was available and could produce the desired data). Clarify different rounds of testing to be conducted.	The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. NASCTN included a number of GPS receivers in each of these categories in order to adequately validate the proposed test methodology. A major goal of the NASCTN project is to provide a reproducible test project that other organizations can use to perform similar tests on other GPS devices included in this study. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.

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22	C	Table 1 Pg. 8	It appears that many of the devices to be tested are older devices which are not representative of modern designs. If a large number of devices were being tested to include newer receivers, especially those processing multi-GNSS signals, this would not be a concern. However, to only focus on these devices is a limitation of the test effort.	The MW810 was introduced in 2007. The eTrex H was introduced in 2007 and is discontinued by the manufacturer. The Montana 650t is discontinued. It doesn't appear that any of the GLN devices are GLONASS-capable, which is the norm for new designs. Even if the testing will not address LTE impacts on GLONASS signal reception, it is important to test modern receivers because the font-end is typically shared amongst all GNSS signals tracked. GPS/GLONASS receivers using a wider front-end make GPS signal reception more sensitive to LTE interference in the 1626.5 – 1660.5 MHz band. Recommends expanding the diversity of devices to be tested, to reflect actual and future devices market conditions.	Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.

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23	C	Table 5 Pg. 10	It is not stated where these power levels are referenced to. In TS 37.571-1, these power levels are referenced to the output port of a passive antenna within a cellular device. Also, the selection of appropriately reduced power levels for "stress" testing is critical to the completion of the stated test objectives.	If -130 dBm is intended to be used as the received power level for the "nominal" referenced to the output port of a 0 dBic antenna, then the power levels should be adjusted for each GPS device tested. For instance, high precision GPS receivers typically use antennas with gain patterns that vary from +5 dBic at boresight to -5 dBic at 5 degree elevation angle. This is quite different from GPS devices in cellular phones, whose antenna gain patterns are closer to 0 dBic (or less) for most directions (because the cell phone can be held with any orientation). Consideration of the user antenna gain pattern is particularly important for the "limited exposure testing". If a high precision antenna is tested in the chamber with the GNSS signal generator antenna at boresight, it will provide ~+5 dBic gain for all satellites, whereas in the real-world, this receiver would see gains as low as -5 dBic towards desired satellites. *The establishment of baseline C/N0's in the "limited exposure" testing will critically influence the outcome of this proposed testing. The authors should give considerable thought towards ensuring a suitably stressing environment. A 1-dB degradation to the receiver noise floor has EXACTLY the same impact as if all GPS satellites decreased transmitted power to 80% of their current values. We firmly believe that it would have a significant impact on user equipment performance.* *This would not be the case for receivers outside in the clear. However, It would be the case driving down a street that is tree-line, or for a banking aircraft etc. --- almost all GPS users frequently experience periods when one or more tracked satellites are seen at C/N0's that are within 1-dB of their break-lock point. This is where the difference in performance would be seen – those satellites would not be tracked with 1 dB lower C/N0. If the test does not create such scenarios, this very important finding will be missed.*	Plan has been updated with details on satellite constellations and power levels, both nominal and limited. In the absence of well-defined industry standards for limited exposure testing conditions, the limited conditions in this test are set to provide data over a range of satellite power levels. Motion is an additional factor not included in these measurements.

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24	C	Section 5.2.3 Pg. 11	Feedback received during the workshops strongly recommended inclusion of augmentation signals in the MSS band.	Recommend augmentation signals in the MSS band be included in the test effort.	The intent of the testing is to focus on the LTE impacts on GPS. When possible, the DUT will be tested initially without augmentation signals to ensure that the impacts can be mapped to the GPS component of the receiver. Augmentation signals such as Wide Area Augmentation Signals (WAAS), Real Time Kinematic (RTK) solutions (e.g., signals from a secondary receiver), have been enabled. The signal constellation will include two WAAS satellites. RTK units will be tested.
25	I	Section 5.2.4 Pg. 11	Unclear why a 96 dB attenuation selected for the downlink? This would lead to -34 dBm being received from a 62 dBm base station. Much higher power levels were seen during earlier LightSquared testing when 3 towers were lit up in Las Vegas. In those tests, received powers of up to -14 dBm were seen 2 m off the ground. More than predicted using free-space, but rather consistent with the two-ray propagation model. Users > 2 m off the ground (e.g., UAS) can see far higher power levels.	Please provide a rationale for choosing a propagation loss consistent with free space at 1 km for this particular test.	This loss factor is utilized in the combined up and downlink test, not the downlink only case.
26	I	Section 5.3.2 Pg. 14	The Draft Test Plan states “It is important to recognize that these tests are focusing on the change in the baseline due to the LTE activity, not on precise locations”. Are the receivers going to be reset to run under the same conditions with LTE activity as the baseline?	Recommend providing clarification in this section.	Test plan modified to add clarity.
27	I	Section 5.3.4 Pg. 19	Encouraged to see recognition in the draft test plan that the separation distance between a GPS receiver and LTE handset can be less than 1 m and even 0.5m.	Recommend conducting testing using a short (0.5m) separation distance.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.

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28	I	Section 5.4 Pg. 20	It isn't clear what is intended by "Power level increments are determined by an initial investigation of the DUT behavior and the eventual maximum power level sought". Aren't all of the devices tested under the same conditions?	Recommend providing clarification in the test plan on the power levels to be tested, including increments of increasing the power level.	The stepped power levels are chosen based on the regions of significant device response. This range is initially estimated by a preliminary sweep of power levels; additional levels are tested as needed. This results in a lower uncertainty in the data for measured power levels.
29	C	Section 5.5.2 Pg. 23	3 meters is stated as an example separation distance for between an LTE transmitter and GPS device under test. As stated elsewhere in this plan, LTE handsets can be much closer than this. What is the rationale for this distance?	Recommend applying a shorter separation distance (less than a meter) as discussed in Section 5.3.4.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional tests are needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
30	I	Section 6.3.1 Pg. 25	Measured data is listed elsewhere in the report to include C/N0, pseudoranges, time, etc. However, in this section it is noted that the "data" will be processed until there is less than a 1% change. This process makes sense for data elements such as C/N0 for a fixed interference level, but such a steady-state would never be seen for other data elements (e.g., pseudorange, or receiver time output).	Recommend this section be written so it is clear in describing that the data processing would only be applied to certain specific receiver output data. These receiver output data should be identified.	Test plan modified to add clarity.
31	C	Section 7 Pg. 26	The NASCTN process stresses the need for openness and transparency. GPS Adjacent Band benefited tremendously by holding public workshops and using a *Federal Register* Notice to solicit comments on its draft test plan. Also coordinated many interagency discussions through the NCO.	Recommend use of a *Federal Register* Notice process so that all interested parties who would like the opportunity to review and comment have the opportunity to do so. This approach creates a public docket for comments, increasing openness and transparency. Also recommend NIST hold public workshops as part of the Outreach and Community Feedback process and provide information to the NCO to ensure widespread distribution within the interagency for review.	The NASCTN process for obtaining feedback on the proposed test plan resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA). NASCTN is reviewing notification process to improve awareness among the stakeholder community.

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32	I	App A Pg. 28	Equation 1 appears to be incorrect.	The -10 log10(Br/Bi) terms do not appear to make sense. If a 10 MHz LTE signal is received by a 2 MHz GPS C/A-code receiver, one would expect the received power (if it were defined to be that power seen within the GPS device under test) to be attenuated by 7 dB rather than enhanced. But -10*log10(2/10) = +7 dB. Also, please note that this equation is not particularly useful for adjacent band interference. If the 10 MHz LTE is not cofrequency with a 2 MHz C/A-code device, then a correction for Br/Bi does not seem appropriate at all. For adjacent-band interference we are concerned primarily with the fundamental component of the interference signal compressing the front-end of the GPS device under test. For this reason, this equation and the entire appendix come across as spurious.	Additional clarifying text have been added to the test plan.
33	I	App D Pg. 42	It is noted that the LTE antenna is linearly polarized whereas the transmit antenna is linear. It is speculated that “circular” was meant in the latter instance. Note also that Ligado had at one time planned to use +/-45 deg cross-pol antennas (see the Jan 2012 FAA LightSsquared report at www.gps.gov)	Recommend fixing the 1st sentence. Also, the EIRP in 3GPP GPS Power Level appears to be missing a unit (e.g., an ‘m’ or ‘W’ after dB)	Test plan modified to address comment.
1	-	Para 5.3.5 on OOBE	The first thing to is to address Unwanted Emissions as OOBE does not include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products especially when narrowband signals are used by multiple users. A narrow band spike at the GPS frequency is not desired.	-	A prototype of the proposed system is not currently operational, so we cannot collect information on unwanted emissions. The unwanted emissions are assumed to be below the OOBE levels considered here, but that would need to be verified on a prototype system.

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2	-	-	The 2nd thing is to perform a live spectrum analysis of Ligado signals and use this information for setting up your simulation. See definitions below and always refer to unwanted emissions in the 1559-1610 MHz. Unwanted Emissions in this band are very important.	-	We generally agree that a live spectrum analysis of Ligado signals would be beneficial for informing the test plan. However, no system is currently deployed or functionally operational, and thus spectrum captures are not possible. Therefore, we cannot capture the unintentional emissions. The next best surrogate is to utilize an industry LTE waveform generator in combination with noise generators to create the OOBE.
3	-	-	The 3rd thing to consider in your simulation is propagation, near and far field.	-	The LTE signal will be amplified to compensate for the separation distance between the transmitting antenna and the DUT. The amount of gain is calculated relative to a free space far-field propagation path, thus assumes an r^2 path loss. Near field path loss factors are a great deal more complex than far-field path loss, including a loss of assumption on antenna gain patterns, which are based on far-field behavior, and the interaction between the DUT and the transmitting antenna. The near-field configuration is outside of the technical merits of this test setup.
4	-	-	The 4th thing to consider is the difference between antenna gain towards interference and the gain towards the GPS satellites (you may have this covered by GPS satellites of various power levels.)	Remember that GPS is officially a 24 satellite system and one does not see all satellites (12) most of the time, so testing with 4 to 6 satellites only should be considered.	In section 5.2.2, the test plan describes both a nominal and Limited Exposure condition. The Limited Exposure considers only 8 satellites in view, with 6 power levels at least 5 dB below the nominal 128.5 dBm.

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1	Informative	Section 1, paragraph 4	Some additional background information w.r.t. the use of 1 dB change in carrier-to-noise density ratio (C/N_0): This metric was introduced as the critical test criterion initially in the TWG test efforts performed by the GPS industry and then used in the NPEF follow-on testing performed over the 2011-2012 timeframe. Prior to the introduction of this metric as the sole test measurand, the standard criteria for GPS interference testing was an impact to position accuracy (typically pseudorange, but many receivers don't report this measurand), loss-of-lock w.r.t. a single satellite (aka "break-lock"), and reacquisition time (time required to reacquire a lost satellite once the interference signal is removed). Each of these three metrics can be directly correlated to an impact on one or more of the four basic GPS performance parameters of accuracy, availability, integrity, and reliability. There is considerable debate over whether a 1 dB C/N_0 degradation criterion should be used in lieu of these traditional metrics, and if so, whether the metric should apply to receivers that extend their passbands beyond the RNSS allocation, particularly since no direct correlation has been made between this test metric and a degradation to any of the four aforementioned core GPS receiver performance expectations.	None – Background Information Only	-
2	Important	Section 1 and briefing slides of 6/10/16.	Break-lock is a traditional GPS susceptibility measurand that is important to include because it's typically available across all GPS receivers.	Include satellite break lock in the list of measurands to be collected.	Loss of lock is included in test but data is device dependent.

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3	Suggestion	Section 3, paragraph 5.	The GPS receiver categorization proposed is consistent with what has been done in past efforts, but the results from the TWG and NPEF testing seem to indicate that a categorization based on receiver RF architecture may be more appropriate than categorizing based on application. For example, categorizing according to narrowband and wideband (SPS) GPS receivers may be more appropriate given that the trend in all of the previous test efforts seems to indicate that the primary impediment to achieving EMC are those GPS receivers that utilize wide pass bands so as to either capture the entire transmitted GPS signal (including the residual sidelobes), or to more readily accommodate the reception of GPS augmentation signals, multiple GPS signals (e.g., L2C and/or L5) and/or satellite signals associated with other GNSS constellations.	Consider re-categorization or subcategorization according to GPS receiver RF front-end architecture.	The scope section now points out that a categorization by the basic receiver architecture, i.e., narrowband versus wideband, may be a better predictor of device performance in the presences of out-of-band emissions.
4	Important	Section 3, paragraph 9.	Agree that the DUT (i.e., GPS receiver) is generally not a metrology-grade piece of equipment and that it can contribute significantly to the overall measurement uncertainty budget, particularly when C/N_0 is considered as a primary metric. For example, there is no standard model/algorithm used in GPS receivers for estimating the C/N_0. Rather, there are at least five different algorithms that are utilized by GPS receivers for this estimation. Information obtained from the open literature suggests that there can be considerable variation between these algorithms which will impact on the uncertainty budget when using a GPS receiver to estimate the C/N_0 level. Further, relevant to the point of comment #1, a 1-dB variation in the carrier level (and thus also in the C/N_0) is a common and recurring occurrence in normal GPS operation, absent any increase in noise. The GPS Interface Specification stipulates that the received signal level will vary by at least 2 dB in normal operation and thus will also impact on the uncertainty budget when using a GPS receiver to estimate the C/N_0 level.	Include a component in the measurement uncertainty budget to account for the variation among carrier and noise estimation algorithms utilized by the different GPS DUTs and to account for the natural variation of the GPS downlink signals.	A study of the uncertainty due to different carrier and noise estimation algorithms would be useful. Due to time limitations, it is not clear that a thorough analysis can be completed during this effort.

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5	Important	Section 5.2.1, Table 4.	While it is recognized that including GPS development boards within the suite of test receivers provides additional test flexibility, extreme care should be exercised when assessing the interference susceptibility of such developmental/prototype applications, particularly if such boards are not shielded, since it may be difficult to ascertain the interference ingress.	Steps should be taken to ensure that any interference identified to development boards be attributable to ingress via the receive antenna port and not through other means attributable to a lack of a shielded enclosure.	Development boards are no longer included in the list of DUTs. They will only be utilized for test setup diagnostics.
6	Important	Section 5.2.2, Table 5.	The power level settings for the emulated GPS satellites appears to be too low. For the nominal case, the proposal to set all satellites to a level of -130 dBm is not representative of a normal "real world" configuration. The current GPS Interface Specification states that the L1 navigation signal strength at end-of-life (EOL), worst-case, will be -158.5 dBW (-128.5 dBm) for all SV Blocks. In normal operation the satellite signal strengths are 3-5 dB hotter than the EOL levels. This situation is compounded in the "Limited Exposure" case in that the received GPS power levels are proposed to be set to levels that are at, or below (by as much as 5.5 dB), the worst-case EOL levels. Also question the limitation to 6 satellites in the GPS constellation emulation. With the expansion of the GPS constellation from 24 to 30 satellites, in normal operation there are typically at least 10-12 GPS satellites in view of a user's location and most modern receivers are capable of processing at least 12 satellites simultaneously.	Include a mix of GPS satellite power levels to include at least one at EOL spec level of -128.5 dBm with the remaining SV levels set to represent a distribution over 'real world' levels. This will enable a comparison of some measurands/metrics over best-case, nominal, and worst-case constellation configurations. Emulate more than six satellites in the simulation (10-12 being more realistic). The lack of satellite availability or received signal degradation due to signal blockage should be considered on a case-by-case basis in the follow-on operational scenario-based link budget analyses.	The "limited" case provides a range of reduces power levels to simulate additional signal loss in the propagation path.
7	Important	Sections 5.3.2 and 5.3.3, Figures 2 and 3.	The block diagrams representing the LTE emulation component of the applicable test set-up depicts a "Custom OOBE Filter" in the transmission chain. The characteristics of this filter will be critical in understanding the final test results.	Provide technical specifications and operational characteristics for the custom filter used in the test program.	OOBE filter design will be documented in the NASCTN Test Report.
8	Important	Section 5.3.3, paragraph 6.	It is stated that the LTE signal power will be incremented until the receiver loses lock. Is the loss of lock relative to a single GPS SV being tracked, to one of the SV's being used in the solution, or to all SV's in view? Typically, the first satellite that the receiver loses lock with is the one with the lowest received power level, which is the point of comment #6 (i.e., if the satellite received power is set to levels lower than EOL levels, then the associated results can reflect a bias.	Clarify.	Loss of lock is dependent on device generated reports.

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9	Editorial	Pages 21 and 22.	There are no captions associated with the two figures on these pages, to include the figure numbers that are called out in the relevant text.	Include captions with figure numbers.	The captions have been corrected.
10	Important	Appendix A, A.3 – Equation 1.	The 'L_{filt}' term in the equation represents the attenuation of the transmitted fundamental signal due to the RF filtering employed by both the source transmitter and the victim receiver" (i.e., receiver selectivity). This term is also known as the "Off-Frequency Rejection" (OFR) component of the Frequency-Dependent Rejection (FDR) term.	Change to clarify that receiver selectivity is also a relevant component of this interference link budget parameter.	Additional clarifying text have been added to the test plan.
11	Suggestion	Appendix A, A.3 – Equation 1.	The term "10log10 (Br/Bi)", which is also known as the On-Tune Rejection (OTR) component of the FDR, is superfluous when considering adjacent-channel interactions with a noise-like emission source. In these cases, it's typically assumed that $B_i = B_r$ and thus this term reduces to zero in the worst-case.	For the adjacent-channel (band) interactions under consideration, this term can be left out of the equation (perhaps with some explanation).	Additional clarifying text have been added to the test plan.
1	-	NASCTN Draft, page 4	(We) agree that any tests, if conducted, should involve a "transparent, well-calibrated test method." Transparency also requires making publicly available input from any other federal agencies prior to, throughout, and after the testing process. In addition, data derived from any testing – including "raw," pre-analysis data as well as processed, post-test data and information – must similarly be publicly available to ensure that the rights of all parties are protected.	In the interest of such transparency, any process should make publicly available all comments sent to NIST concerning the test plan and the testing, including all correspondence with the test's sponsor that have led to this stage. Any sponsorship arrangements should also be a matter of public record. In addition, data derived from any testing – including "raw," pre-analysis data as well as processed, post-test data and information – must similarly be publicly available to ensure that the rights of all parties are protected	NASCTN will post the comments, NASCTN's response, and a copy of the revised test plan on its website. The handling of proprietary information and distribution of the NASCTN report and measurement data is governed by the CRADA signed by NIST and Ligado Networks.

Comment Number	Level	Reference within Draft Test Plan	Comment	Commenter's Recommendation	NASCTN Comment Resolution
2	-	NASCTN Draft, page 4. NASCTN Draft, Section 6.1, page 24.	The test plan also notes as a goal "sound and statistically valid data retrieval and processing." The test plan also acknowledges "a risk of selection bias in the test results" as well as the likelihood that conclusions based on such data "will not be rigorously generalizable to the population of all devices." (We) have concerns that, given that only seven devices will be tested from the "outdoor" segment of the General Location-Navigation ("GLN") device market, such "bias" will be likely to occur; seven devices are in no way statistically representative of the tens of millions of GLN devices in the outdoor, marine, aviation, automotive, and fitness segments. The devices proposed for testing also do not represent the latest makes and models that incorporate multi-GNSS technology.		The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. NASCTN included a number of GPS receivers in each of these categories in order to adequately validate the proposed test methodology. A major goal of the NASCTN project is to provide a reproducible test project that other organizations can use to perform similar tests on other GPS devices included in this study. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.
3	-	NASCTN Draft, page 4. NASCTN Draft, Section 4, page 7	The test plan also advocates a "clear path from measurement set-up to data collection to processed results." At the same time, it notes that "pass/fail criteria will not be discussed nor will conclusions be drawn by the testing team on the data collected."	Despite this second statement, (we) urge public release of all NASCTN material related to these tests to ensure a "clear path" is followed.	The NASCTN final report will not only include the results of the tests, but will also provide the detailed test process used in the NASCTN measurements so that other organizations will have an opportunity to reproduce the tests or extend them to other GPS receivers.

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4	-	NASCTN Draft, Section 5.2.3, page 11.	In addition, the test plan notes that augmentation signals will be tested on an “as needed” basis or “time permitting.” (We) are concerned that test results will be questionable if expected signals – such as WAAS or RTK for high precision devices – are not present. If devices and systems are not tested in the configurations and with the signals needed to function in their intended modes, the “clear path” may be obstructed.		The intent of the testing is to focus on the LTE impacts on GPS. When possible, the DUT will be tested initially without augmentation signals to ensure that the impacts can be mapped to the GPS component of the receiver. Augmentation signals such as Wide Area Augmentation Signals (WAAS), Real Time Kinematic (RTK) solutions (e.g., signals from a secondary receiver), have been enabled. The signal constellation will include two WAAS satellites. RTK units will be tested.

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5	-	NASCTN Draft, page 4. NASCTN Draft, page 5.	Public release of all data is needed to ensure NASCTN's goal to "inform discussions between different interests on proper measurement requirements" is upheld. The test plan also notes that the GPS industry prefers use of an interference metric based on a 1 dB decrease in the carrier-to-noise density ratio (C/N0), whereas potential users of spectrum adjacent to GPS prefer a definition of interference premised on end-user experience. Absent use of the 1 dB metric, We have concerns about the conclusiveness (and certainly the universal applicability) of assessment of interference based on just one or two aspects such as position accuracy and/or timing. The possibility and implications of interference must be considered not only for accuracy, but for integrity, continuity, and availability. Further, in measuring timing accuracy, in addition to position accuracy, NASCTN's proposed test plan fails to consider velocity, another key output of most GPS devices. If those conducting tests aim to measure key performance indicators other than the fundamental metric of a 1 dB degradation in C/N0, they must measure all outputs that are significant to users of GNSS systems. (We) participated in the early planning of the DOT "Adjacent Band Compatibility" Study and support that proceeding's use of the appropriate metric (1 dB metric), its vetting through public and government input, its transparency and government sponsorship, and its broader and more meaningful sample of devices. Most importantly to (us), in terms of advancing the prompt expansion of broadband service, the DOT testing has already been completed and analysis is underway.		The handling of proprietary information and distribution of the NASCTN report and measurement data is governed by the CRADA signed by NIST and Ligado Networks. The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about interference levels or defining interference protection criteria. Although the NASCTN test plan does include a number of measurands in the study, including the C/N_0 measurand, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators.

Comment Number	Level	Reference within Draft Test Plan	Comment	Commenter's Recommendation	NASCTN Comment Resolution
1	Critical	No Reference Given	Changing the measure of interference from the internationally recognized standard, even if done based on sound testing, will require DOD to rewrite the Joint Capability Integration and Development System (JCIDS) Requirements documents for its ongoing acquisition of Military GPS User Equipment. This will add significantly to acquisition timelines and will certainly add significant cost for components of critical weapon systems in each of the Services (Army vehicles, Navy ships and Air Force jets). Depending on the standard chosen, it is also likely to require retrofitting of ~2 million already fielded military receivers designed to work within the current interference standard - presuming retrofitting can even be done as a technical matter. Obviously none of the UAVs ("drones") will function without reliable GPS.	The House and Senate Armed Services Committees and the Defense Appropriations subcommittees of each Chamber must be involved in proposals to change interference standards, as they are significant stakeholders in DOD resourcing decisions. The scope of this program is not insignificant; the MGUE program alone was funded at $142+M in 2016, and is programmed for $1,061,867,000 over the FYDP (2018-2022). (AFSPC/JA Addition)	The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about interference levels or defining interference protection criteria.
2	Important	Preface, Page 4, Paragraph 3	The third para states the comparison of results between this test and previous testing (presumed to be government) are out of scope for this effort. To be academically complete this test plan, as a deliverable, should address differences in anechoic chamber testing methodology with previous testing	As a deliverable, include an addendum that addresses the differences between this test plan's anechoic chamber testing and other testing (e.g. 2011 NPEF test plan and DoT ABC Assessment test plan)	The NASCTN test methodology will be well documented, so that others will be able to make comparison with previous measurement campaigns.
3	Critical	Preface, Page 4, Last Paragraph	In the interest of transparency, the test plan needs to identify who NASCTN solicited comments from and how comments received are adjudicated	As a deliverable, include an addendum of groups or entities NASCTN solicited comments from, who responded and how their comments were adjudicated	The NASCTN process for obtaining feedback on the proposed test plan has resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA). NASCTN will post the comments, NASCTN's response, and a copy of the revised test plan on its website.
4	Important	Preface, Page 4, Last Paragraph	The NASCTN process for soliciting comments needs to include standard government and public mechanisms for ensuring all affected stakeholders are afforded the opportunity to participate. This ensures NASCTN's process is open, transparent, inclusive and documented in the proper, associated forums	NASCTN should use the IRAC to solicit comment from federal agencies and the Federal Registry for public comment.	The NASCTN process for obtaining feedback on the proposed test plan has resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA).

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5		Background, Page 5	The background does not address how NASCTN was engaged by the commercial sector to develop a test plan, the source/amount of funding, and the substance of the agreement as it relates to scope and content of the test plan. This detail is important for the reader to fully understand and appreciate the context of how the test plan is being influenced by this agreement.	Include a paragraph under Background that explains the engagement from the commercial sector that is driving this effort and the substance of any agreement with NACSTN that is influencing assumptions, methodology, constraints and participation in this effort. For transparency, the agreement with the commercial entity should be appended to the test plan and resulting report.	The project is governed by a CRADA that was negotiated between NIST and Ligado Networks. The NASCTN final report will include all information that is publically available.
6	Important	1 Background, page 5, 3rd para	Para states that a consensus was not reached on what constitutes GPS receiver interference but does not qualify what constitutes a consensus. Para only identifies the GPS industry as having a preference for the 1 dB IPC	Qualify what is believed to be constitute a consensus. Government testing, facilitated by the PNT EXCOM, along with GNSS related ITU recommendations formulated the government's assessment of what constitutes permissible GPS receiver interference (ref NTIA Report 05-432, para 5.3)	As evident by comments on the test plan, not all stakeholders fully accept that a 1 dB change in C/No is the best measure for determining interference.
7	Critical	2, Objective, Page 5	The test objective is only clear on testing a range of LTE power levels on GPS receivers. Later in the document it is clarified that testing will only be performed in a steady state condition. There is no discussion on how GPS receiver acquisition and reacquisition is or is not being considered.	Clarify in the test objectives what modes of operation, both LTE and GPS, are being tested. Explain what modes are not being tested and why.	Time to first fix and GPS receiver reacquisition has been added to the test plan, where appropriate.
8	Important	3 Scope, page 6, 6th para	The para identifies what categories of GPS receivers will not be tested but does not address any future requirement or plan to do so	Specify if, then when, untested GPS receiver categories will be addressed	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional testing is needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.

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9	Important	3 Scope, page 6, 8th para	Later in the test plan it is also stated GPS receivers will be tested in a GPS acquired, steady state. If this para is to capture the constraints associated with the tested GPS receivers then this needs to be treated with the same level of detail afforded LTE	Para needs to fully explain the limitations and constraints being assumed within this particular test plan. Para should explain rational for only addressing a GPS acquired steady state GPS receiver performance. Para should explain rational for not exploring a means to measure 1 dB IPC metrics along with performance metrics at higher interference levels.	Time to first fix testing has been added to the test plan, i.e., data will be collected on the time it takes the GPS receiver to establish satellite lock in the presence of LTE signals. C/No will be collected for all tested LTE power levels, assuming the device reports C/No. An important goal of this effort is to provide an open set of data that can assist all stakeholders in their discussions on the proposed LTE system impacts on GPS receiver performance.
10	Important	Table 1, page 8	An Apple iPad Air 2 (WiFi only) is included in the pool of general navigation and location devices. This device does not include a GPS chip; it is dependent upon an external device like a Bluetooth capable GPS receiver (e.g. Bad Elf)	Remove and replace with a GPS capable tablet	The list of GPS devices considered in this study has been modified, including the removal of the Apple iPad Air 2.
11	Critical	Section 7, page 26	The test plan states comments will be solicited from "the engineering community within federal and non-federal groups and entities."	The test plan should list specifically which organizations and at what level were coordinated with. And, if those organizations submitted comments to the test plan, a comment resolution matrix dispositioning each and every comment should be sent out to all who commented on the test plan. This is essential to maintain "a transparent, well-calibrated test method" as stated on page 4 of the test plan.	The NASCTN process for obtaining feedback on the proposed test plan has resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA). NASCTN will post the comments, NASCTN's response, and a copy of the revised test plan on its website (https://www.nist.gov/ctl/national-advanced-spectrum-and-communications-test-network-nasctn).
12	Critical	Section 8, page 26	The test plan does not address disposition of raw test data. The test plan states the measurements "will be physically removed by NASCTN personnel at the end of the measurement period."	To maintain the transparency sought by NASCTN, the raw test data should be made available to stakeholders as identified by the PNT EXCOM. The CRADA between NASCTN and Ligado should also be updated to reflect this. If so desired, organizations receiving raw test data could be required to sign Non-Disclosure Agreements (NDAs) to protect proprietary Ligado data.	The handling of proprietary information and distribution of the NASCTN report and measurement data is governed by the CRADA signed by NIST and Ligado Networks. Release of data will be controlled by relevant statutes and the terms of the CRADA.

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13	Critical	Section 9, page 26	The project tasks as listed do not reflect disposition of individual comments to commentating entities.	Update the Project Task list to include formal disposition of comments and rationale for adjudication.	The NASCTN process includes the collection, adjudication and posting of the comments along with the distribution of a revised test plan.
1	Important	Section 1 Background in the second paragraph end of first sentence.	It is not clear that only GPS receivers operating in the tracking mode are being considered (e.g., no acquisition or TTFF).	Change first sentence as follows: In support of these functions, this NASCTN effort focuses on potential impacts of proposed Long Term Evolution (LTE) activities adjacent to the L1 GPS ~~band~~ receivers operating in tracking mode.	Time to first fix is now included and the sentence has been edited to reflect this change.
2	Editorial	Section 1 Background last paragraph	"This implies that a 1 dB increase to the noise floor, as measured by any receiver in a shielded or direct-wired environment, is considered interference."	Suggest the following to replace the sentence: "That most GPS receivers operating over a wide range of GPS signal levels and receiver types and designs will not suffer performance degradation (due to interference), if the interference signal level at the input to the GPS receiver is at least 6 dB below receiver noise. "	It is not obvious that the two statements are equivalent. No change can be made to the test plan without further discussion.
3	Important	Section 2 Objective in the first sentence	It is not clear that only GPS receivers operating in the tracking mode are being considered (e.g., no acquisition or TTFF).	Change the first sentence as follows: The objective of this project to establish a test methodology to investigate the impact of LTE transmission on GPS receivers operating in tracking mode.	Text has been updated to reflect inclusion of TTFF.
4	Critical	Table 5	The GPS L1 C/A signal power level of -130 dBm is not correct.	In Table 5 change -130 dBm to -128.5 dBm. Should all of the GPS signal power levels be set to the same level?	Table updated.
5	Important	Table 1 and Table 2	Should increase the number of high precision receivers tested	Reduce the number of general navigation receivers by two and add two high precision receivers	Devices list has been changed to reflect the inclusion of additional high precision receivers.
6	Important	Section 5.3.2	Filter response of custom OOBE filter in Figure 2 is missing	Include the measured response of the custom OOBE filter	The NASCTN test report will include the measurement of filter response.
7	Important	Section 5.5.1 and 5.5.2	Sections 5.5.1 and 5.5.2 describe two approached for varying the power levels for the in-band and OOBE signal levels for the LTE downlink and uplink test signals. Both approaches address different issues related to GPS interference.	Retain both approaches to varying the power levels for the LTE test signals.	Due to time constraints, the approach with fixed OOBE and varying LTE power is given priority.

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8	Critical	Section 6.2	A key performance parameter is the loss of lock between the GPS receiver and a GPS satellite. This condition occurs when an interfering signal reduces the carrier-to-noise density ratio to such an extent that the GPS receiver can no longer adequately determine pseudorange.	Add GPS receiver break-lock power level to the list of Key Performance Indicators. The break-lock condition is as reported by the GPS receiver.	Added but is DUT specific depending on data provided.
9	Important	Section A.3 first paragraph, second sentence	The deployment model is important to assessing the aggregate power levels.	Add a footnote to the second sentence: The aggregate interference will be determined by the deployment model which establishes antenna couplings and minimum separation distances.	A footnote has been added to the text to the effect of the comment.
10	Important	Section A.3 Equation 2	There is a parameter in the link budget for the desired signal for polarization mismatch loss. For the desired link would there a loss for polarization mismatch?	Delete the parameter for loss due to polarization mismatches from Equation 2.	The desired signal may have a polarization mismatch if the polarization on the receiver is not identical to the transmitted polarization. For example, an elliptically polarized receive antenna will have some polarization loss when the desired signal is linearly polarized. (The propagation loss does not incorporate this loss in this case.)
11	Editorial	Table 10	Table 10---What is the meaning of an AWGN propagation condition?	Please explain or add reference.	This condition has been removed. The additional signals, L1C pilot, Pseudo Y, and M-code, that will be present have been added.
12	Editorial	No description of the data format for the measurement results	Will the measurement data be presented for each satellite in the test?	Add a new section describing the format of the output data	The data available is dependent on the DUT and will be provided in the final report.

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13	Editorial	Appendix D. D.1 p.42	The text below is misworded:- …spectral masks are specified for linear polarization, but the transmit antenna is designed for linear polarization…If the transmit antenna radiates true RHCP…	Suggest revising text as shown below: …spectral masks are specified for linear polarization, but the transmit antenna is designed for circular polarization…If the transmit antenna radiates true RHCP… {Ref. Table 7 antenna (RCHP for anechoic chamber) ETS-Lindgren 3102}	The text has been corrected to reflect the circular polarization.
1	Critical	No Reference Given	The comment feedback ROE mentions to consider the test plan scope before commenting however the scope of the testing effort should be coordinated with the federal stakeholders and PNT EXCOM. Since the PNT EXCOM is already performing licensee agnostic testing through the DOT ABC effort to produce appropriate regulatory level decision making results NASCTN should support the conclusion of this testing before attempting to start a separate effort.	Re-evaluate scope or consider delaying or canceling testing until after completion of the DOT ABC effort. At a minimum, explain how the NASCTN testing relates to the ABC testing, why it is necessary in light of the ABC effort, and how it adds to and is not duplicative of the ABC testing.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional testing is needed beyond this project, organizations are encouraged to submit project proposals to NASCTN. The final test process and measurement results of the DOT ABC test campaign have not been made public, so it is inappropriate for NASCTN to comment on this on-going effort.
2	Critical	No Reference Given	The NASCTN test plan misleads the reader/audience into thinking that NASCTN is conducting its own independent test effort to evaluate GPS compatibility when in reality it is hosting R&A/Ligado's re-accomplishment of their testing with a government observer. At best, since Ligado intends to file their test results as a public notice with the commission, this entire effort is redundant and unnecessary. At worst, this activity will be misconstrued to imply the US Government endorses the testing and conclusions made by a biased private company over the Executive Committee established to coordinate the use of PNT across the US government.	Re-evaluate purpose of testing or at a minimum be more open about the process and minimal value of the results	The NASCTN test plan was developed by an independent team of researchers from NIST and ITS, not by Roberson & Associates or Ligado Networks. Also, all measurements and data analysis associated with this project will be performed by NIST and ITS personnel.

Comment Number	Level	Reference within Draft Test Plan	Comment	Commenter's Recommendation	NASCTN Comment Resolution
3	Critical	No Reference Given	This testing would produce a laundry list of criteria that can be used instead of the 1 dB criteria for evaluating service level GPS compatibility. These other protection criteria are not supported by the domestic or international regulatory framework or the various government agencies and PNT community that support the PNT EXCOM. In addition, none of the proposed criteria represent adequate and objective protection criteria to evaluate service level compatibility. A bigger picture study would need to take place on what constitutes an appropriate GPS protection criteria and the assumptions necessary to evaluate them before collection is accomplished.	Flawed testing yields flawed data. Re-evaluate purpose of testing. If the question is "what is an appropriate metric to measure GPS compatibility?" consider undertaking a study that evaluates the merits of any other proposed metrics and their applicability to all aspects and users of GPS as well as what assumptions should be applied when evaluating them. This background framework is necessary to ensure data collection efforts produce valid and usable data to the GPS and spectrum management communities. Experts from the PNT community should be involved in this effort from the onset.	Although the NASCTN test plan does include a number of measurands in the study, including the C/N_0 measurand, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators.
4	Important	No Reference Given	The focus of the test plan is restricted only to GPS and ignores other GNSS system effects from the proposed Ligado operations. Failure to address other GNSS systems seems to run counter to both existing PNT Policy (NPSD-39) and National Space Policy.	Re-evaluate scope, add other GNSS signals. The US National Space Policy indicates "the US shall engage with foreign GNSS providers to encourage compatibility and interoperability." Creating and institutionalizing a new interference standard by effectively repurposing spectrum for uses incompatible with current internationally accepted interference standards violates this policy. Before accepting a new interference standard, it is necessary to engage with foreign GNSS providers – even presuming the proposed test plan were not flawed.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional testing is needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.

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5	Critical	No Reference Given	Since Ligado representatives designed and are funding the test, and will conduct it, with NASCTN observers simply ratifying the test plan was executed, the NASCTN testing will produce results similar in nature to what the private Ligado testing produced, which sets up a situation of FCC and NTIA having two similar results based on receiver performance effects (NASCTN and Ligado's independent testing) with the third "outlier" then being the AF and Federal agency supported DoT ABC test and analysis effort that, like the previous NPEF test, uses the 1 dB IPC. The proposed NASCTN testing can be used to undermine the DoT's ABC effort and the criteria that underpins the previous National Space-Based PNT Systems Engineering Forum (NPEF) testing from 2011 and the January 2012 EXCOM letter that was based on the NPEF testing.	NASCTN should consider delaying this testing and review existing published NPEF test results to become familiar with current valid testing on GPS compatibility. Further, given the suspended lawsuit LightSquared filed against the US in the Court of Federal Claims on 11 July 2014, which has only been dismissed without prejudice, it is likely that Ligado will sue the US for additional costs and lost profit, claiming reliance on the NASCTN testing, should it not get the approval it seeks from the FCC based on the results – or, if it does get approval and then have it revoked due to actual interference experienced in national critical infrastructure by Ligado operations.	The NASCTN test plan was developed by an independent team of researchers from NIST and ITS, not by Roberson & Associates or Ligado Networks. Also, all measurements and data analysis associated with this project will be performed by NIST and ITS personnel.
6	Critical	No Reference Given	The NASCTN testing itself appears contrary to the PNT EXCOM letter from January 2012 that indicated no further testing was warranted at that time to evaluate the Lightsquared proposal. The key parameters for the Lightsquared base stations that drove the EXCOM conclusion in January 2012 are the same as the NPEF tested in 2011. The 2011 NPEF testing and January 2012 EXCOM conclusion remain valid since the proposed adjacent band use by Ligado has not really changed from what was tested in 2011. The difference is that the NASCTN test ignores the international standard for interference used by the ITU, and formerly accepted by the FCC, and proposes instead a measure which is untested, has no basis in science, and is designed to accommodate a single emitter (Ligado).	Postpone this effort and support the DOT ABC test effort. If the goal is to explore potential interference standards which might serve as a legitimate alternative to the current internationally accepted standard, the objective should so state - and the effort must engage the larger GNSS community, both domestically and internationally, regarding that goal. Per OMB Circular A-119, implementing 15 USC 272(b), as well as Executive Order 12866 Section 1(b)(8) Federal Agencies shall use technical standards developed or adopted by voluntary consensus bodies unless they are inapplicable or impractical. Further, 19 USC 2532(3) require Agencies to use existing international standards in compliance with US obligations assumed with the World Trade Organization Agreement on Technical Barriers to Trade Agreement unless they create "fundamental technical problems", in which case the US Trade Representative must be consulted, OMB A-119, 5(h). If no suitable standard exists, and the agency decides to develop its own, it must report this to OMB, for further reporting to Congress, OMB A-119 Section 10. (AFSPC/JA Addition)	The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about inference levels or defining interference protection criteria.

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7	Critical	Page 5, Paragraph 3	On numbered Page 5, third paragraph, it is clear the Plan authors lack a basic understanding of the use of interference protection criteria (IPC), which is used to prevent interference levels from reaching "harmful" levels and, consistent with U.S. Space Policy, sustain the RF environment for GPS. The Plan mischaracterizes the conclusions of the FCC-mandated Technical Working Group (TWG), which with the exception of LightSquared and its partners and supporters (e.g., Sprint, which had an agreement with LightSquared at the time), all supported use of the 1 dB IPC. Further, the Plan, in the same paragraph, notes that: "This implies that a 1 dB increase to the noise floor, as measured by any receiver in a shielded or direct-wired environment, is considered interference." This is exactly the case…the 1 dB IPC is used to examine interference effects from one system into another using the domestic and internationally recognized criteria for making such assessments. It is unclear what this statement is trying to say other than that the authors seem to lack an understanding of interference and spectrum management. Instead, the Plan will collect "measurands" of receiver performance that are consistent with Ligado's independent test purposes or provide options to use criteria other than the well-established 1 dB IPC to protect GPS.	Engage PNT spectrum experts and spectrum professionals to gain a better understanding of interference protection criteria and reevaluate and revise the test plan criteria to ensure that the testing does not use inappropriate criteria or undermine other USG test efforts and National Space Policy.	The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about inference levels or defining interference protection criteria.
8	Important	Page 5, Paragraph 3	The Plan, on Page 5, third paragraph, also asserts that many modern receivers cannot provide measured C/No information. This is not the case, or is misleading, because we know the NPEF testing in 2011 did measure C/No degradations from GPS receivers.	Remove Sentence "To complicate matters, many modern GPS receivers do not readily provide Key Performance Indicators such as C/N0"	The language has been clarified to point out that how the C/No value is estimated on the devices is not well-defined. In addition, there is no agreed upon standard calibration process for C/No.

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9	Critical	Page 5	There is no mention of the two rounds of NPEF testing from 2011…only the TWG effort on numbered Page 5, second paragraph. The NPEF test and analysis effort, which had the full support of federal agency GPS stakeholders, tested a significant number of receivers used for different applications and used the standard 1 dB IPC to assess compatibility with GPS receivers. By comparison, the proposed NASCTN testing uses a small set of receivers using criteria ("measurands") that are vague and without explanation of purpose and seem aimed at measuring levels of interference that cause some form of degradation to the receiver, which would be at or above harmful levels.	Update the background material to include these efforts and how their conclusions influenced the development of this test plan. If they were not considered, take the time to review them before attempting a new GPS measurement effort and learn from the methods/results already presented to better frame this and future efforts. If the true goal is to explore new interference criteria, then begin a dialogue with knowledgeable representatives of the PNT user community, including users of PNT timing in critical national infrastructure, and the international GNSS community. (AFSPC/JA Addition)	The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about inference levels or defining interference protection criteria.

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10	Critical	Page 5, Final Paragraph	This sentence mentions that a "representative subset of available devices will be tested…". There is no further explanation throughout the document as to how it was determined this subset is representative of anything or which entities had any input in making a determination that the number of devices and the applications they support are in fact adequate for the testing. Of particular concern to DOD, military receivers are not adequately represented.	Reach out to the PNT EXCOM and community experts to determine the appropriate set of devices for GPS compatibility testing. Review the work the DOT accomplished before developing the ABC test plan and how they created a more representative receiver set. Expand the receiver set to be tested, including in particular precision and timing receivers and those functions that depend on GPS timing. This is no small matter. Well known location uses aside, GPS timing is ubiquitous, and critical to the US financial system (for processing ATM, check, bank-to-bank and Federal Reserve transactions as well as the New York Stock Exchange), the utility grid, and phone and data communications networks. No testing is included in the Ligado/NASCTN plan to assess the interference these critical infrastructure components would suffer, although it is clear from the testing done in 2011 (using internationally accept interference standards), that interference can be expected. Note: DOD is prohibited by 10 USC 2281 from concurring in a test plan which will yield inadequate data regarding the impact on military receivers, since assured PNT is now critical to Joint operations. Flawed test plans which yield flawed data that becomes a basis for spectrum use decisions would directly and adversely impact the military potential of GPS. (AFSPC/JA addition)	The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. NASCTN included a number of GPS receivers in each of these categories in order to adequately validate the proposed test methodology. A major goal of the NASCTN project is to provide a reproducible test project that other organizations can use to perform similar tests on other GPS devices on included in this study. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.

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11	Critical	Page 6, Paragraph 6	The limitations of the NASCTN testing are explained…e.g., not covering space-based receivers, military receivers, aviation, or even cellular receivers. The much more comprehensive NPEF testing, as well as the ABC test and analysis effort, do cover these receivers. It therefore seems the NASCTN testing will be of very limited utility to the overall discussion of impacts to GPS from the proposed Ligado use of the MSS L-band spectrum since most receiver types and applications will have been ignored. Reach out to the PNT EXCOM and community experts to determine the appropriate set of devices for GPS compatibility testing.	Reach out to the PNT EXCOM and community experts to determine the appropriate set of devices for GPS compatibility testing.	The NASCTN test plan includes GPS receivers from the following categories: • General location and navigation • Precision position • Precision timing Other GPS receiver categories, including aviation, space-based and DoD receivers are beyond the scope of the NASCTN project. If additional testing is required beyond this project, organizations are encouraged to submit project proposals to NASCTN. Based on the feedback from Federal agencies and GPS manufacturers, NASCTN has revised its list of GPS receivers.
12	Critical	Page 7, Paragraph 1	It is not clear how the data will be distributed and who owns the end product. If the output data is not subject to public peer review and scrutiny, it can be misused or misrepresented. More information on how the data will be handled and reviewed by agencies and the public is necessary to understand the risks associated with undertaking the NASCTN test effort and to ensure transparency in the test process.	Re-evaluate purpose of testing and be more open about the process, including using a Public Notice process to ensure all stakeholders and the public in general have an opportunity to comment on issues affecting a system, such as GPS, that has such enormous value to the broader National interest. Handling of proprietary data is also not articulated. It will be impossible to plan a representative test if receiver manufacturers do not cooperate – and without assured protection of proprietary data they cannot.	The handling of proprietary information and distribution of the NASCTN report and measurement data is governed by the CRADA signed by NIST and Ligado Networks. DUT manufacturers provided technical information and support, as needed, to the execution of the test plan.
13	Critical	Section 5.2.3, Paragraph 1	Not testing the effects of receivers that are designed to receive the MSS signal in the 1525-1559 MHz is a serious omission as some of the fundamental problems involved in the Ligado-GPS issue stem from the requirement to receive the augmentation signal anywhere in the MSS band from 1525-1559 MHz.	Re-evaluate purpose and scope of the testing, to include test cases that stress the effects augmentation signals received in the MSS band.	At least six precision timing and precision location devices will be tested. In general, these devices represent wider-band architectures.

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14	Critical	Section 5.3.2, Paragraph 1	It is stated that "It is important to recognize that these tests are focusing on the change in the baseline due to the LTE activity, not on the precise locations." It is precisely this measure of degradation, the "user experience" criteria that federal agencies do not support and that is advocated only by Ligado and its supporters. "User experience" is not an interference protection criterion. This is the fatal flaw in the NASCTN testing and why the effort could be used to undermine the DoT ABC test and analysis effort and the previous NPEF testing in 2011 as well as the rationale for the January 2012 PNT EXCOM letter.	Consider undertaking a study that evaluates the merits of any other proposed metrics and their applicability to all aspects and users of GPS as well as what assumptions should be applied when evaluating them. This background framework is necessary to ensure data collection efforts produce valid and usable data to the GPS and spectrum management communities. Experts from the PNT community should be involved in this effort from the onset. It is inappropriate to agree to a test plan designed around a single commercial product. (AFSPC/JA Addition)	The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about inference levels or defining interference protection criteria. Although the NASCTN test plan does include a number of measurands in the study, including the C/N0 measurand, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators.
15	Importa nt	Section 5.5	There is discussion regarding the swept LTE levels with two types, one with the fixed OOBE and the other with changing OOBE. It is unclear why the OOBE should be changing for different LTE transmit power, which seems contradict what was filed by Ligado? Further explanation should be provided for this section.	Provide further explanation on why different OOBE levels would be used.	Additional text has been added to explain the two different scenarios. In both cases, the agreed upon OOBE mask is the same. The first case assumes a fixed physical distance between the GPS device and the LTE emitter, e.g. 3 m. In the second case, the distance between the LTE emitter and the GPS device is assumed to change with the LTE device transmitting at maximum power.
16	Critical	Section 6.3.1, Paragraph 4	It is stated that additional metrics will be investigated, apparently on the fly and with no pre-planning, to determine steady state performance of the receiver. This kind of arbitrary statement and process is both unscientific and unsound and should be thought out and planned for in a much more thorough fashion.	Re-evaluate purpose of testing, take a more scientifically sound and rigorous approach to any test effort. Expedited data collections without a clear framework of assumptions and methodology are not likely to produce useful results.	The available measurands are device dependent, and as devices are added based on feedback, the list of measurands has become better defined. Key measurands are listed in the test plan, and will be collected if extracting from the device is possible.

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17	Critical	Section 7, Page 26	The outreach plan should include publication of the Test Plan in the Federal Register and solicitation of public comments as was the case with the DoT ABC effort. This is the only way to ensure transparency in the process…by using a well-known vehicle to gather input from the public.	Re-evaluate purpose of testing and be more open about the process, including using a Public Notice process to ensure all stakeholders and the public in general have an opportunity to comment on issues affecting a system, such as GPS, that has such enormous value to the broader National interest.	The NASCTN process for obtaining feedback on the proposed test plan has resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA). NASCTN is reviewing notification process to improve awareness among the stakeholder community.
18	Important	No Reference Given	The measurement of interference effects should be explained in context…e.g., that interference impacts/effects on the receiver constitute harmful interference to the receiver and sound spectrum management practice and procedure is aimed at preventing such levels from occurring in the first place.	Engage PNT spectrum experts and spectrum professionals to gain a better understanding of interference protection criteria and reevaluate and revise the test plan criteria to ensure that the testing does not use inappropriate criteria or undermine other USG test efforts and National Space Policy.	The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about inference levels or defining interference protection criteria.
1	-	-	To justify replacing the 1 dB criterion for tolerable interference will require a very extensive justification looking at many worst case GPS/GNSS operational situations. By not using the widely accepted and previously employed 1 dB degradation criterion, NASCTN is taking on a daunting task. Working with the many receivers, receiver operating modes and operating conditions needed to identify and adequately measure other key performance indicators will require an extensive amount of resources and time to be done correctly. Finding cases and conditions where the impact is acceptable is not sufficient; the proposed testing must explore all relevant cases and conditions to demonstrate that the impact is not unacceptable. It appears that they do not have the needed resources and time, and instead are planning to use an overly simplistic test that will not provide the needed information.		Although the NASCTN test plan does include a number of measurands it the study, including the C/N_0 measurand, it does not make any recommendations on the appropriateness of these measurands, which is the purview of the spectrum regulators.

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2	-	-	If NASCTN does not have the resources and time to do this for a large number of receivers and conditions, then it would be better to do this thoroughly for a small number of receivers that previous testing has shown to be particularly sensitive to LTE interference, rather than use an overly simplistic approach on a larger number of receivers. Note especially the change from “GPS receivers” to satnav receivers. The test plan has taken a first step in this respect by including WAAS receivers, but signals from other satnav systems are already being used extensively in the U.S., and other signals will be used as well, consistent with U.S. policy.	Plan should add goal of answering the key question: determining the level of LTE interference that can be accepted by satnav receivers operating satisfactorily under *all* relevant conditions. This fundamental goal should be added to the Preface.	The objective of the NASCTN project is to establish a test methodology to investigate the impact of LTE transmission on GPS receivers. NASCTN will not be making any recommendations about inference levels or defining interference protection criteria.
3	-	-	When we asked during the telecon, we were told that it is not the objective of this effort to find what margin is left for LTE when satnav receivers are operating in stressed conditions. If the tests do not provide this result, then they do not provide the needed information for assessing LTE compatibility with satnav receivers. No one source of interference can take up all the margin, which receivers rely upon to handle a large set of different stresses, including other sources of interference. Many of the following comments involve more detailed technical aspects of this observation and recommendation, pointing out several of the ways that this test plan does not meet the objective it states in the first sentence of its Section 3 “to develop a rigorous testing methodology and collect supporting data to establish the impact of LTE signals on GPS devices.” Instead, the current test plan only establishes the impact on a limited number of GPS devices operating in their most interference-resistant mode under relatively unstressed conditions. As a follow-up, during the Interagency Discussion on 10 June, NIST/NASCTN indicated they would welcome suggestions to help define the envelope of more stressed conditions. This is a welcome change, but there is no way to respond to this new opportunity before the 13 June comment deadline.	Plan should address highly stressed conditions – the “envelope” conditions.	The fact that the test population is limited does not imply that the test is not rigorous. Key attributes of a rigorous test are repeatability, calibration of measurements, and the control of confounding sources of variability. The number of devices required for a statistically meaningful result that completely covers all categories and use cases of devices is beyond the scope of this effort. The definition of a stressed condition is highly subjective. The limited conditions proposed here are derived from reviewing previous tests and solicited feedback. To the best of our knowledge, there is no consensus on stressed condition parameters.

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4	-	-	The test plan currently involves getting a device under test (DUT) into steady state tracking mode, then evaluating the effect of different levels of interference on the tracking performance. Since steady state tracking is usually the most robust, interference-resistant mode of receiver operation, the results of this test do not adequate assess LTE impacts on receiver operation. Instead, for each interference configuration, including the baseline with no interference, tests should evaluate receiver performance in every mode and state of operation, defining and observing the Key Performance Indicators appropriate to that mode and state of operation. This would be an expansion to the flowcharts shown on pages 21 and 22 of the test plan. As examples, cold start acquisition should evaluate the time to first fix, carrier phase differential receivers should evaluate time for ambiguity resolution, and many receivers should be tested for error-free reading of the data message. Handling rising and setting satellites, as well as satellites disappearing and appearing due to blockage, are additional conditions under which the effects of interference must be evaluated.	Plan should include all receiver classes, receiving modes and states, particularly those that are well known to be most sensitive to interference, e.g. acquisition (cold start) and reacquisition.	Loss of lock has been included in the test plan, and time to first fix (TTFF) has been added as well. Other conditions, modes, and setting will be considered by the Test Master as a test modification as appropriate.
5	-	-	The test plan states that receivers will be tested when stationary. Many receiver functions are stressed by the acceleration, jerk, and vibrations associated with receiver motion. Receiver susceptibility to interference should be evaluated under significant dynamics, not only the easy case of no dynamics. As a minimum, vehicle dynamics should be included for devices that might be used in vehicles.	Plan should include moving receivers.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional testing is needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.
6	-	-	The test plan does not include any other sources of interference, despite the fact that satnav receivers often operate under conditions where there is some level of out of band and in band interference. Stressing levels of other interference should be used during the testing in order to assess how much additional interference from LTE can be tolerated. As examples, there is and will be intrasystem interference from other GPS signals and satellites, intersystem interference from current and future satnav systems, interference from FCC Part 15 devices, interference from UWB devices, as well as other spectrum uses in adjacent bands.	Plan should include other sources of interference.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional testing is needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.

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7	-	-	While the specified minimum received power for C/A signals is -158.5 dBW (or -128.5 dBm), received power levels can be much less than that value due to receive antenna gain, blockage due to foliage or construction materials, or tracking of reflected signals when the direct path is blocked. Also, while many GPS satellites are usually visible to a receiver with open view of the sky, visibility can be reduced to four satellites or fewer (in which case altitude hold and/or clock hold may be used) due to blockage from buildings or terrain.	Plan should include various received power levels and numbers of satellites.	The proposed limited exposure does include a reduced number of satellites and reduced power levels.
8	-	-	The test plan indicates it will test one receiver at a time. Yet differential systems require multiple receivers—at least one reference receiver, or base, and one user receiver, or rover. Some modern differential systems (e.g., networked differential systems) may require several reference receivers. The effect of interference must be assessed when all of these receivers are exposed to the interference, and thorough testing should examine different interference conditions for each of the reference receivers and user receivers.	Plan must include multiple receivers simultaneously, at least in some cases.	RTK systems that utilize two receivers will be included.
9	-	-	Proposed test plan seems to address only receivers for GPS C/A signals and WAAS signals. GPS L1C signal receivers should also be evaluated. Further, there are other satnav systems with signals in this band, and they may be used in the U.S. At a minimum, Galileo PRS receivers, or their surrogates, should be tested as well.	Plan should include receivers for more satnav signals, including L1C and from other GNSS. These advanced signals are the basis for many high productivity applications.	The scope of this NASCTN project has been negotiated in the CRADA between NIST and Ligado Networks. If additional testing is needed beyond this project, organizations are encouraged to submit project proposals to NASCTN.

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10	-	-	While Appendix A in the test plan suggests use of signal to LTE interference ratio (SIR) as a metric, this metric will be of little use. At low LTE interference levels, receiver performance is only an affine function of SIR, since thermal noise and other interference have observable effects. At high LTE interference levels, receivers may respond nonlinearly to interference. Thus, the same SIR, with different levels of desired signal levels, can produce very different results in the receiver. Furthermore, there are four power levels of interference (power in the designated uplink and downlink bands, and power in the satnav band from uplink and downlink transmissions), and received satnav signals have different power levels as shown in Table 5 of the test plan. Thus, there is no such single quantity known as SIR.	Plan should focus on absolute received power levels, not signal to interference ratio	The absolute power levels (assuming a 0 dBi antenna) present at the DUT will be known. In addition, these test include a scenario with energy in both an uplink and downlink band simultaneously. To the best of our knowledge, this condition has received minimal consideration in previous testing.
11	-	-	While the test plan does not address it, there are also significant technical issues concerning extrapolation of test chamber results to operational conditions. Variations in path loss, transmit and receive antenna gains, and overlapping transmitter coverage are a few examples of the many issues that need to be addressed in performing an adequate extrapolation.	Plan should address how test data will be extrapolated to operational conditions.	The comment applies to the systems analysis that should accompany any well-engineered proposed deployment. Data from the NASCTN test, amongst others, could be included in that analysis.

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12	-	-	Given that the current plan for testing will not involve all representative and realistic stresses, and that only a limited number of receivers will be tested, and then only in their most robust modes, the results will not provide useful results concerning how much LTE interference can be tolerated by satnav receivers. Buried on page 24 of the test plan is the admission that, "the conclusions that can be drawn from this test will be limited to the specific set of devices under test, and will not be rigorously generalizable to the population of all devices." Currently the limitations of this testing are not clearly stated in the test plan's Preface, Background, or Scope. These limitations should be highlighted and detailed prominently in the Test Plan and Test Report. Otherwise, it will be easy for these limitations to go unrecognized, and consequently for any test results to be misinterpreted as actually informing about the level of LTE compatibility with satnav receivers, when they really only provide limited insights: for a small number of receivers, under relatively benign conditions, when the receivers are operating with ample margin.	At a minimum, the test plan and test report should clearly and prominently *highlight* limitations of the testing, and the resulting restrictions on drawing conclusions from the tests.	The NASCTN final report will include a discussion of the limitations of the tests performed as well as a summary of the underlying assumptions.
13	-	-	If the objectives of this test plan include the recommendation from comment 2: "To develop a technically and operationally valid way to determine the level of LTE interference that can be tolerated by satnav receivers operating satisfactorily under all relevant conditions," then there are many constructive suggestions that satnav experts can provide. Some of them are outlined here, but NASCTN's willingness to consider and incorporate them, only indicated today, does not allow time to provide them before the comment deadline on 13 June.	To have credibility with the PNT community, it is clear that real PNT expertise must be added to the test team. If the plan is to answer the real question, the satnav community can provide assistance.	The NASCTN process for obtaining feedback on the proposed test plan has resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA).
14	-	-	The test plan should be subject to a regular, formal comment process, since its results are likely to influence a decision that will potentially affect hundreds of millions of PNT users. Note that the manufacturers generally do not represent the major classes of users.	The test plan review process should be open and formal.	The NASCTN process for obtaining feedback on the proposed test plan has resulted in comments from Federal agencies, GPS manufacturers, and both spectrum regulators (FCC and NTIA).