



**SPACE-BASED POSITIONING
NAVIGATION & TIMING**
NATIONAL ADVISORY BOARD

July 5, 2017

Deputy Secretary of Defense Robert O. Work
Deputy Secretary of Transportation Jeffrey A. Rosen
National Executive Committee for Space-based Positioning, Navigation and Timing
Herbert C. Hoover Building, Room 2518
1401 Constitution Ave., NW
Washington, D.C. 20230

Subject: Adjacent Band Harmful Interference to Global Positioning System (GPS) Users

Dear PNT EXCOM Co-Chairs,

I am the Chair of your Space-based Positioning, Navigation, and Timing (PNT) Advisory Board (PNTAB), a group of nationally recognized experts in PNT and the Global Positioning System (GPS). We are tasked to provide independent technical and policy advice to all members of the PNT Executive Committee (PNT EXCOM) that you jointly chair on behalf of the U.S. government.

I call your attention to an immediate regulatory proceeding that will gravely affect GPS-based PNT services as determined from analysis conducted by your own agency technical experts and your independent PNTAB. We intend to ensure that you are apprised of these latest developments.

The policy choices before the government are:

- 1) Protect current and evolving uses of GPS, military and civilian, as a matter of national priority,

or

- 2) Approve high power terrestrial mobile broadband application in frequency bands adjacent to the GPS that would very likely cause harmful interference to both government and private sector GPS applications.

We as your Advisory Board recommend the first choice.

The item under review is a proposal to operate a new terrestrial mobile broadband service in Space-to-Earth Mobile Satellite Service (MSS) bands that are adjacent to the protected spectrum where GPS operates. Initial proposals were made in 2011 and subject to extensive government testing that culminated in a letter from the PNT EXCOM, dated January 13, 2012, to the National Telecommunications and Information Administration (NTIA) stating the unanimous conclusion of the PNT EXCOM agencies that the proposed mobile network would cause harmful interference to many GPS receivers.

A revised proposal was reviewed by PNT EXCOM agencies in 2016. At the October 27, 2016 PNT EXCOM meeting, the acting co-chairs strongly concurred with PNT stakeholders and the PNT EXCOM departments and agencies that the revised proposal to the Federal Communications Commission (FCC) is ***fundamentally unchanged*** from a previous proposal reviewed in 2011. **Extensive government testing in 2011 and in 2016, clearly shows that both proposals cause definitive harmful interference to many classes of GPS receivers.**

The PNTAB recommends that the PNT EXCOM reaffirm the conclusion in the 2012 letter. Our recommendation is based on the similarities of the current proposal with the previous one. It is further supported by recent testing by the Department of Transportation (DOT) which confirms the previous data. We believe that the current PNT EXCOM will reach the same conclusions, with time, but believe the urgency deserves immediate action. We therefore provide you with the following summary / synopsis for your review and consideration for action.

At our meeting in June 2017, just concluded, we reexamined the two key facts supporting our previous recommendations. We confirmed that the current proposal is fundamentally the same as the proposal tested in 2011. A summary of these findings is included in Appendix A. The DOT GPS Adjacent Band Compatibility (DOT GPS ABC) tests confirmed the conclusions of the 2011 tests that the proposed system does in fact interfere significantly with classes of receivers and operating modes which are significant today.

Of course, GPS is an essential infrastructure element for virtually every PNT application in the United States. Examples include national defense, aviation, safety-of-life, precision timing for computer networks and financial transactions. Decisions on potential interference must be based upon scientific and procedurally-valid testing and analysis. **Appendix B lists the Interference Protection Criteria (IPC) which must be examined in analysis and testing of proposals for any system which will use frequencies near the GPS and Global Navigation Satellite System (GNSS) bands. They were carefully developed by our panel of experts and discussed in earlier PNT EXCOM meetings.**

We were briefed at our meeting on recent tests by the National Advanced Spectrum and Communications Test Network (NASCTN), an element of the National Institute of Standards and Technology (NIST). Their presentation acknowledged that they did not meet many of our recommended test criteria. They also did not discuss worst case results and did not consider actual user scenarios. Further, the test funding was provided by the private entity that stands to benefit from a favorable regulatory ruling.

GPS radio navigation is fundamentally different from radio communications when assessing how to avoid harmful interference. Therefore, shared spectrum concepts that might be made to work for radio communication services do not work for radio navigation services such as GPS. The GPS frequencies are used by literally dozens of satellites and ***the number of worldwide receivers is now estimated to be over 5 Billion.***

Some supporting testing details and impact categories follow.

The performance of GPS receivers degrades rapidly as interference increases. To limit performance degradation, the GPS and GNSS technical community worldwide has long endorsed an interference protection criterion that allows no more than a one decibel (12.2%) rise in the noise floor of the GPS receiver. This is the same recognized criterion used in the government sanctioned DOT GPS ABC testing. However, that fundamental criterion has never been accepted by the company that seeks to operate a potentially harmful terrestrial network in the MSS radio band.

Expected scenarios, such as interference to rescue and emergency helicopters, general aviation receivers, and Unmanned Aerial Vehicles (UAVs), would create chaos in the U.S. National Airspace System (NAS), and interfere with most of the nation's critical infrastructure sectors. The well-reviewed DOT GPS ABC testing clearly shows that **harm can occur to precision GPS users at a half mile from each of the several thousand ground transmitter**

sites planned under the proposal, even at the reduced (by a factor of 100 from that of the original proposal) 15.8 Watt (W) power level that the new proposal claims.

The PNT EXCOM and all GPS stakeholders **should be wary of any incremental approaches to deploying mobile broadband services** in the MSS band. For example, initial services could operate at reduced power levels on a temporary basis to protect only a subset of GPS users, before moving to full-power levels that will cause widespread interference to many other classes of GPS users. Regulatory decisions must be based on the ultimate end-state of any systems proposed for operation in the bands adjacent to GPS, and must protect all classes of GPS users.

Unfortunately, the latest industry proposal does not acknowledge the legitimacy of, and the need to protect, dozens of precise applications of great national importance. Nor does it recognize future applications which depend on current frequency allocations in the quiet MSS band.

In addition to numerous technical concerns, the PNTAB also has serious concerns with the way the government interagency process has been conducted in this matter. The PNTAB spent a great deal of time offering constructive, written suggestions for the company sponsored test efforts -- submitting them within the standard interagency coordination processes to NIST, the government sponsor of the NASCTN testing. (See Appendix B summary of six key spectrum protection criteria points.) In response, the PNTAB comments on technical flaws in the sponsored tests were inadequately addressed (see the reason in Appendix B). Therefore, **we consider the company-sponsored test efforts to be neither credible nor complete.**

The PNTAB strongly believes that approval of the new license modification application is not in the public interest, and the proposed use should not be permitted. All members of the PNTAB, who have not otherwise recused themselves, are unanimous in this view.

Respectfully,



John Stenbit
Chair, National Space-based PNT Advisory Board

Enclosures: (2)

- Appendix A: Comparison between the 2011 and 2016 Proposals
- Appendix B: Interference Protection Criteria

cc:

NASA Acting Administrator Robert Lightfoot
PNT National Coordination Office (NCO)
PNT EXCOM Departments and Agencies

2011 Tested and **2016** proposed Base Stations –
 no significant changes to configuration
 that has **now failed USG tests twice**

<u>Parameter</u>	<u>2011 LSQ Proposal</u>	<u>2011 NPEF Test**</u>	<u>2016 Proposal</u>	<u>Observations</u>
Transmit Power (EIRP)	42 dBW	32 dBW**	32 dBW*	NPEF/2016* Identical
Frequency Range	1526-1536 and 1545-1555 MHz	1526-1536 MHz**	1526-1536 MHz	NPEF/2016 Identical
Emissions into RNSS Band (1559-1610 MHz)	- 100 dBW/MHz	- 100 dBW/MHz	- 100 dBW/MHz	NPEF/2016 Identical
Emissions into MSS Band (1541-1559 MHz)	No commitment	- 81 to - 135 dBW/MHz (Measured values)	- 85 dBW/MHz (Commitment)	New proposal significantly worse across MSS band compared to NPEF test measurements

* Ligado studies submitted by FAA to RTCA on October 20, 2016. No consensus in RTCA and FAA has not agreed. Nominal eirp per tower could be as low as 10-13 dBW near airports to protect certified aviation. Network deployment undefined. 32 dBW eirp is per Public Notice of April 2016, which FCC notes is the same value tested in 2011.

** Revised proposal by LSQ in 2011.

Correction to Public Statements: The “New Proposal” Does not differ from the one that failed NPEF Testing, except the interference emissions are Worse

PNTAB view: Minimum Criteria for Testing/Evaluation of Interference Potential of High Power terrestrial transmitters in repurposed radio bands

1. **Accept and strictly apply the 1 dB degradation Interference Protection Criterion (IPC) for worst case conditions.** (*This is the accepted, world-wide standard for PNT and many other radio-communication applications*)
2. Verify interference for **all classes of GPS receivers is less than criteria, especially precision** (*Real Time Kinematic - requires both user and reference station to be interference-free*) **and timing receivers** (*economically these two classes are the highest payoff applications – many \$B/year*)
3. Test and **verify interference for receivers in all operating modes** is less than criteria, particularly **acquisition and reacquisition** of GNSS signals under difficult conditions (see attachment of representative interference cases)
4. **Focus analysis on worst cases:** use **maximum** authorized transmitted interference powers and **smallest-attenuation propagation models** (antennas and space losses) that do not underrepresent the maximum power of the interfering signal (including multiple transmitters).
5. Ensure **interference to emerging Global Navigation Satellite System (GNSS) signals** (*particularly wider bandwidth GPS L1C – Galileo, GLONASS*), is less than criteria
6. All testing must include **GNSS expertise** and be **open to public comment** and scrutiny.

Above is the six-point Interference Protection Criteria of the PNTAB. None of the points was satisfied by either sets of company-sponsored tests. For the NASCTN tests a more detailed 14-point summary was also developed, but **the NASCTN claimed the company had not provided enough money to do a complete job**. Thus, these tests were totally inadequate in evaluating the impacts.