Global Positioning Systems Directorate

GPS Adjacent Band Compatibility

Capt Robyn Anderson

Lead, GPS Spectrum Management

Space-Based PNT Advisory Board

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Where we've been…

Mar 2011: FCC TWG Test
"Based on the analysis performed, LightSquared should not be permitted to use the L-Band spectrum for a densely-deployed, non-integrated terrestrial-only network."

Mar 2011: NPEF Test
"LightSquared should not commence commercial services per its planned deployment for terrestrial operations in the 1525-1559 MHz Mobile-Satellite Service (MSS) Band due to harmful interference to GPS operations."

Oct 2011: NPEF Follow-On Test (included military receivers)
"Based on the test results, LightSquared's lower 10 MHz signal configuration causes harmful interference to the majority of general navigation GPS receivers tested."

Jul 2015: RAA Test
"After analysis of the test results, [RAA] conclude that Ligado's proposed LTE deployment is clearly compatible with existing GPS operations as implemented by leading device manufacturers."

May 2016: NASCTN Test
"Data was presented without defining or use of pass/fail criteria as the establishment of those criteria was not part of this project."

Apr 2016: DOT Test
"At 1530 MHz, the tolerable EIRP values for standoff distances of 10 m and 100 m are -42 dBW and -22 dBW, respectively."

What we've done…

- When: April 2016
- Where: White Sands Missile Range
- Agenda:
  - Week 1: Set-up, Verification, Validation
  - Week 2: Dry-Runs, UUT Set-Up
  - Week 3: Military UUT Test Week
  - Week 4: Civilian UUT Test Week
- Results:
  - Air Force developed Interference Tolerance Masks for military GPS receivers
  - DOD ABC test results build upon the results observed during the "Follow-on Assessment of LightSquared Ancillary Terrestrial Component Effects on GPS Receivers"
  - Like the NPEF test for military GPS receivers, the DOD ABC test results for military GPS receivers are classified
  - Results from the DOD ABC test support the conclusions drawn by the Department of Transportation's Adjacent Band Compatibility Assessment
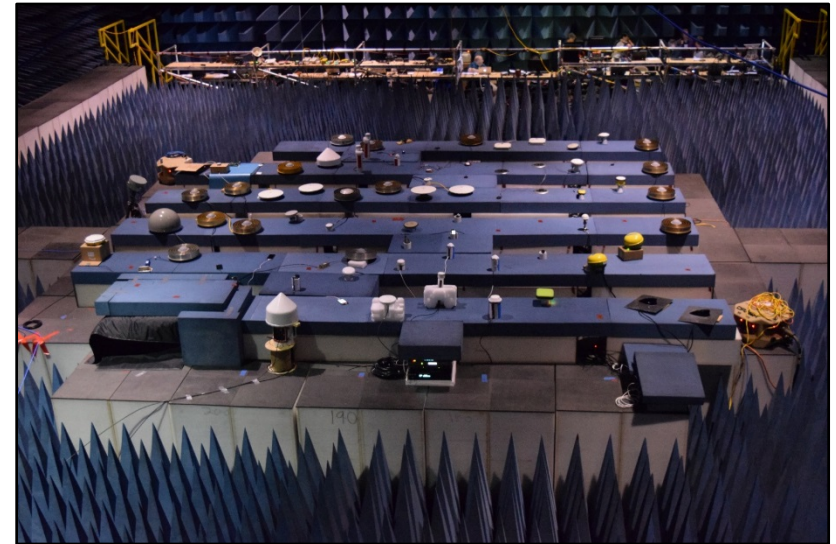
DATA-DRIVEN

TRANSPARENT

GOLD STANDARD

Continue to promote data-driven decisions that support transparency and uphold the Gold Standard for ALL users

1 dB Interference Protection Criterion

BACKGROUND PAPER

ON

USE OF A 1-dB DECREASE IN C/N_0 AS GPS INTERFERENCE PROTECTION CRITERION

1. **Purpose:** This paper provides extensive background regarding the use of the 1 dB decrease in the carrier-to-noise density ratio (C/N_0) as the appropriate interference protection criterion (IPC) for GPS and other Radionavigation Satellite Service (RNSS) receivers. The use of the 1 dB IPC has significant domestic and international precedence, is consistent with the protection afforded other radiocommunication services, and is the only reliable mechanism to ensure adequate protection for civilian and military GPS receivers. The 1 dB IPC is consistent with the National Space Policy for managing and sustaining the RF environment in which these systems operate.

2. **Explanation of Parameters:** A brief explanation of the relationship between a (post-correlation) 1 dB drop in C/N[1] and an interference to noise ratio (I/N) of – 6 dB is shown below. This relationship is pivotal to the references throughout this paper.

Relationship of 1 dB C/N Degradation to I/N = -6 dB

C = Carrier (Signal) Power N = Power of Existing Noise Floor C/N determines if signal is useful	Pre-Interference: C/N Post-Interference: C/(N+I) I = Power of Interference

$$\text{Degradation of C/N} = \frac{Pre-interference\ C/N}{Post-interference\ C/N} = \frac{C/N}{C/(N+I)}$$

$$= \frac{N+I}{N} = 1 + \frac{I}{N} = \frac{New\ noise}{Old\ noise}$$

$\frac{I}{N}$ = Change in the Noise Floor due to the New Interference, I, relative to previous Noise Floor, **N**

Sample Calculation:

$$\frac{(N+I)}{N} = 1.26, \quad \frac{I}{N} = 0.26$$

$$\frac{(N+I)}{N} \ (dB) = 10\times\log(1.26) = 1\ dB\ C/N\ degradation$$

$$\frac{I}{N} = (dB) = 10\times\log(0.26) = -5.9\ dB$$

[1] Note that the difference between noise density (noise in a 1 Hz bandwidth or N_0) and noise in a reference bandwidth (N) is immaterial as long as the bandwidth for the noise and interference source is the same throughout the calculation.

1

GPS.gov — Official U.S. government information about the Global Positioning System (GPS) and related topics

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GPS Jamming
Adjacent-Band Compatibility

GPS Adjacent-Band Compatibility Assessment

Demand for commercial spectrum to support broadband wireless communications has led the government to consider repurposing various radio frequencies, including the satellite communications bands next to GPS.

In 2012, the National Executive Committee for Space-Based Positioning, Navigation, and Timing proposed to draft new GPS spectrum interference standards to inform future proposals for non-space, commercial use of the bands adjacent to the GPS signals. *LEARN MORE*

On this page:
- Assessment Plan
- Device Testing
- March 2017 Workshop
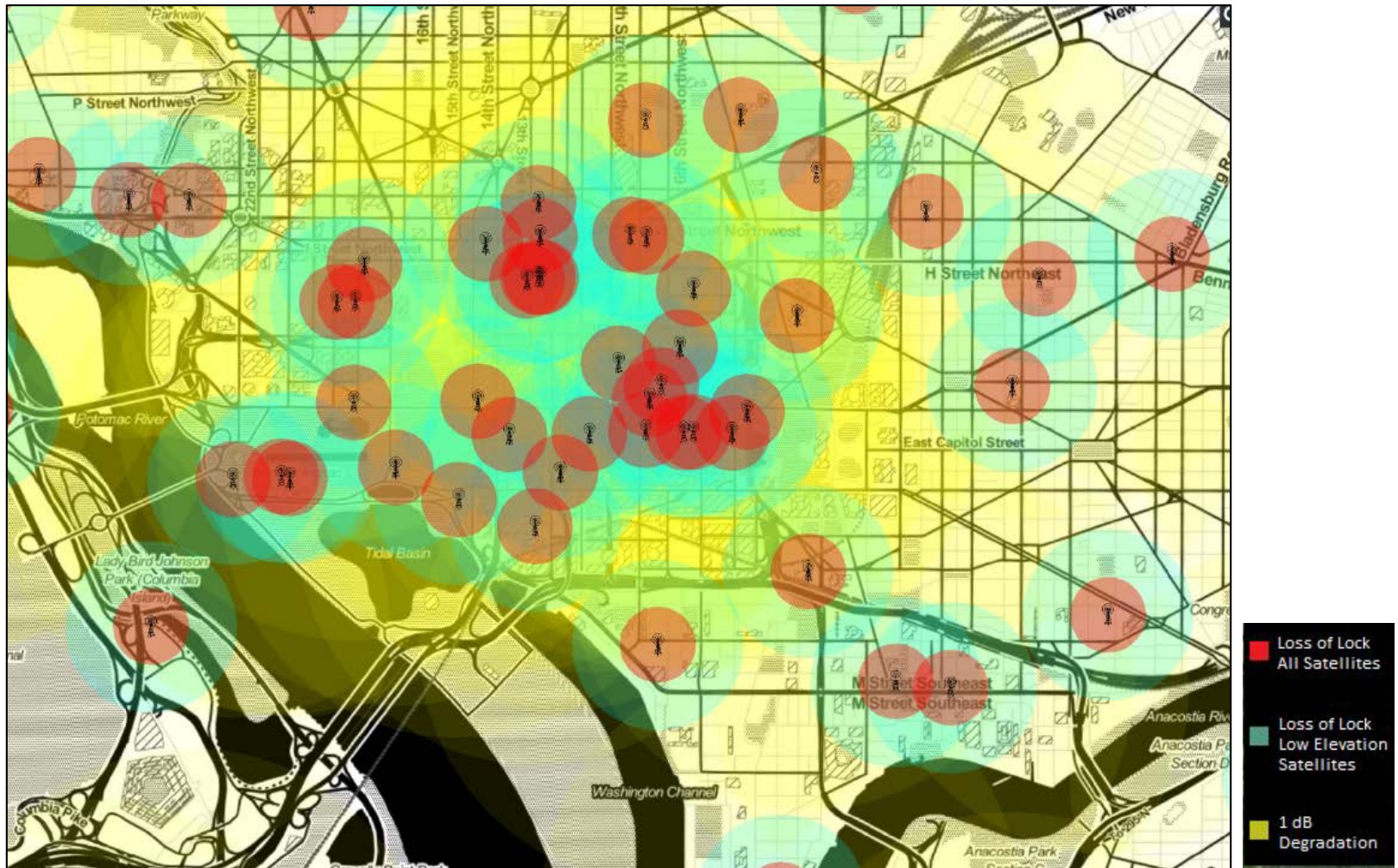- Previous Workshops

Background paper available at GPS.gov discusses:
- Difference between harmful interference and interference protection criteria
- Domestic and International Precedence of 1 dB interference protection criteria
- Comparison of interference protection criteria for other radio services
- Impracticality of other metrics for the protection of RNSS
- Application of interference protection criteria to different *types* of interference

Illustrating Potential Impacts

Legend:
- **Loss of Lock All Satellites** (red)
- **Loss of Lock Low Elevation Satellites** (teal)
- **1 dB Degradation** (yellow)

Conclusions

- Various organizations conducted tests to characterize the compatibility of proposed systems in the adjacent band with the existing GPS radiofrequency environment

- Results from the DOD Adjacent Band Compatibility Assessment support the conclusions drawn from Department of Transportation's ABC Assessment

- The Air Force remains committed to equipping decision-makers with the information required to make data-driven, transparent decisions that maintain the GPS Gold Standard

> **National Space Policy (2010)**
> **"Sustain the radiofrequency environment in which critical U.S. space systems operate."**