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May 22, 2001

RAUL R. RODRIGUEZ
(202) 416-6760

Ms. Magalie R. Salas
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: *Ex Parte* Presentation of US GPS Industry Council; ET Docket 98-153

Dear Ms. Salas:

This letter provides notice that on May 18, 2001, Dr. Charles Trimble, Ms. Ann Ciganer, Dr. A.J. Van Dierendonck and undersigned counsel, representing the U.S. GPS Industry Council, met with representatives of the Office of Engineering and Technology copied below, to discuss matters concerning the referenced proceeding. More specifically, Dr. Van Dierendonck provided an assessment of the effects of ultra wideband ("UWB") interference on GPS receive equipment, based on the test results presented to the Commission and a matter of record in this proceeding. A copy of Dr. Van Dierendonck's presentation is attached to this letter.

Dr. Trimble presented a possible solution to the current proceeding, whereby UWB applications could be authorized in identified frequency bands where there are no safety-of-life services and where a "band manager" would be assigned to manage use of the spectrum. A copy of Dr. Trimble's presentation is also attached to this letter.

An original and one copy of this letter are being submitted for inclusion in the record of the subject proceeding. Please direct questions concerning this letter and the attached presentations to undersigned counsel.

Respectfully submitted,

No. of Copies rec'd 0+1
List A B C D E

Raul R. Rodriguez
For the U.S. GPS Industry Council

Attachments

cc (by e-mail, w/ attach.):
Julius Knapp
Michael Marcus
John Reed
Karen Rackley
Ron Chase

An Assessment of UWB Effects on GPS Receiving Equipment

Dr. A. J. Van Dierendonck
AJ Systems
for the US GPS Industry Council

Outline

- Executive Summary
- UWB Interference Testing and Analysis
  - NTIA Testing & Analysis
  - DOT Sponsored Testing & Analysis
    - Stanford University & Rockwell Collins
  - Time Domain Sponsored Testing & Analysis
    - UT-ARL & JHU-APL
  - IGEB Sponsored Analysis
    - JSC Analysis of UT-ARL Test Data
- Enhanced E911 Considerations
- Summary and Conclusions

Executive Summary I

- Extensive testing of GPS receiving equipment in a UWB interference environment has been performed in recent months
  - DOT sponsored Stanford and Rockwell Collins tests
  - NTIA tests
  - Time Domain sponsored UT-ARL tests

Executive Summary II

- Extensive analysis of test data has been performed
  - Stanford, Rockwell Collins and NTIA analyzed their own test data
  - JHU-APL (sponsored by Time Domain) and the Joint Spectrum Center (JSC) (sponsored by the IGEB) analyzed the UT-ARL test data

Executive Summary III

- With some minor differences, the bottom-line results of these analyses were similar, with one major exception
  - The JHU-APL analysis was flawed and, thus, incorrect, resulting in erroneous conclusions
  - The other analyses show severe GPS degradation in a UWB environment

Executive Summary IV

- No testing of E911 devices was performed
  - However, analysis shows that these devices will be inoperable in the presence of UWB interference
- In summary, all GPS receiving equipment will be severely affected if UWB emissions are allowed into the RF environment
  - The FCC should prohibit the use of UWB devices below 3.1 GHz to protect all GPS operations

UWB Interference Testing and Analysis

UWB/GPS Test Data Analysis

- Reports on all UWB/GPS testing and analysis mention above have been submitted
  - We will only concentrate on the JHU-APL analysis here

JHU-APL Analysis Problems I

- The UT-ARL test data from outdoor radiated test should have been completely ignored
  - The environment was uncontrolled and GPS antenna characteristics were miss-modeled, resulting in baseline received UWB emission levels (at the GPS receiver ports) that were attenuated to far below Part 15 emission limits
  - The conductive test data could have been analyzed independent of the radiated test data
    - JSC and Rockwell Collins were able to do that

JHU-APL Analysis Problems II

- JHU-APL used the radiated test data to calibrate the conductive test set-up
  - Unfortunately, GPS antenna gain patterns were not accounted for
    - Thus, calibration of UWB signal levels was in error and much lower than Part 15 levels
  - Even JHU-APL recognized a large discrepancy as indicated in the next chart
    - However, they never corrected their analysis results and conclusions

JHU-APL Chart Comparing Theory to ARL Radiated Test Link Analysis

Link Comparison

	Meeting Calc.	ARL Test	
Field Strength	500	250	μv/m-MHz$^{-1/2}$
Power Density	-91.8	-97.8	dBw/m-MHz
GPS Antenna Aperture Area	-25.4	-41.2 to –35.2	dBsm
Received P_d	-177	-199 to -193	dBw/Hz
N_0	-201	-201	dBw/Hz
P_d/N_0	+24	+2 to 8	dB

Observed GPS aperture area was 8 to 16 dB lower than calculation (3 dB attributable to polarization mismatch)

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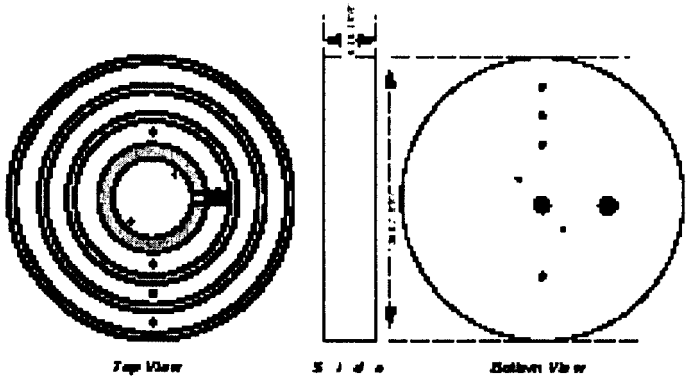
Antenna Gain Discrepancies

- JHU-ARL basically assumed 0 dB gain towards UWB device for GPS antennas in the radiated tests
- GPS antennas used had "choke rings"
  - UWB signal was "choked"
  - Unfortunately, most GPS applications can't use choke rings to attenuate UWB emissions

GPS Antenna with Choke Ring

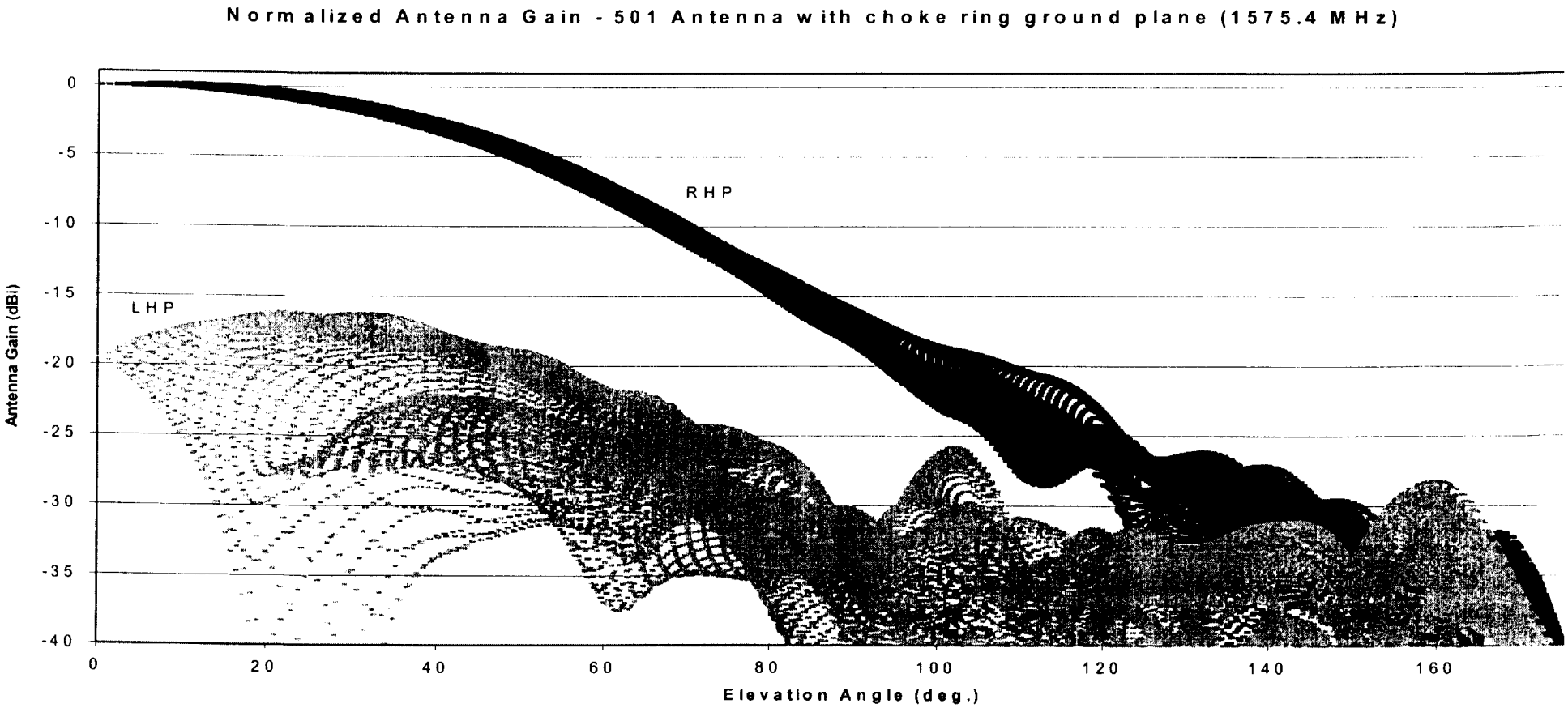
SPECIFICATIONS

Diameter:	368.70 mm
Height:	64.64 mm
Weight:	5.2 kg
Mounting:	5/8" - 11 UNC, tripod bolt mount



- GPS Antenna used in ARL testing
- Note size and weight of antenna
  - Primary use is for surveying
  - Not appropriate for aviation and hand-held receivers

Choke Ring Antenna Gain Pattern



E911 GPS Considerations

E911 GPS Description

- The FCC has mandated selling and activating cellular devices with position reporting (ALI) on 911 calls by October 2001
- Various FCC memorandums and report and orders imply that the use of GPS is necessary to meet that date and subsequent implementation schedules

E911 GPS Description (Cont.)

- Cell phone providers who do not have a GPS capability have asked for schedule relief
  - Has not been granted
- The mandate applies to both indoor and outdoor operations
  - It is generally stated that some GPS signals are degraded by 20 dB indoors
  - Signals also realize multipath fading

E911 GPS Indoors

- Receiver is aided with information obtain from the cellular base station
  - Ephemeris and Almanac data/bits
  - Doppler and approximate timing determined from cellular signal
- For some satellites, windows help
  - But windows also let in external interference

E911 GPS Outdoors

- Can be similar scenario as for indoors
  - Operation in urban canyons, under trees, etc.
  - Multipath fading
- More susceptible to other interference
- UWB radiated from many sources
  - Including through windows from WLANs
  - WLANs could also exist outdoors

E911 Scenario Description

- Most critical indoors
  - UWB is being proposed for Wireless LAN applications
    - Buildings would be saturated with PCs, etc., using UWB WLAN (including multipath)
    - UWB devices would be close to E911 users
  - UWB WLAN would have high PRFs
    - Announced by Time Domain at COMDEX
      - 10 MHz now to 1 GHz in the future

UWB E911 Interference Link Budget

- Link budget for E911 GPS is trivial – no testing is really required
- Through walls, GPS signal is attenuated by 20 dB
  - P_{GPS} = -160 dBW – 20 dB = -180 dBW
- At 3 meters, Part 15 level is 24 dB above thermal noise (See JHU-APL chart)
  - $P_{d,UWB}$ = -177 dBW/Hz
- GPS Carrier-to-Noise Density
  - C/N0 = $P_{GPS} - P_{d,UWB}$ = -180 dBW + 177 dBW/Hz = -3 dB-Hz (23 dB below required 20 dB-Hz)

UWB/E911 Link Budget Summary

- From previous chart, one UWB WLAN emitter at 3 meters results in a 23 dB short-fall for E911 GPS device
  - This does not include safety-of-life margin (5.6 dB) nor multiple UWB emitters
    - Add another 15.6 dB
- Thus, UWB WLAN devices must limit radiation to 38.6 dB below Part 15 levels

Summary and Conclusions

Summary and Conclusions

- In summary, recent tests and analysis show that all GPS receiving equipment will be severely affected if UWB emissions are allowed into the RF environment
- All analyses of test data basically agree with exception of JHU-APL analysis
  - Did not account for GPS Antenna gain properly
- No E911 GPS devices were test, but trivial link budget shows that these devices would be inoperable in a UWB WLAN environment

A Solution Path Forward

Presentation to the FCC

Charles R. Trimble

Chairman, U.S. GPS Industry Council

UWB Is Important

- Spectrum for mobile internet
- Breaks narrow band paradigm
- Low-power/maximum spectral reuse
- US Com Tech Leadership

Problems To Resolve

- Tragedy of the spectrum commons
- Noise-floor with overlapping networks
- Common carrier/device manufacturer balance

Carrot of Free Spectrum

- Incentivize industry management of commons
- Drive Wideband Comm technology
- Preserve US tech leadership

Solution

- Strategic experiment:
- 3 GHz above 3.1 GHz (no safety-of-life band)
- 6 GHz above 6 GHz
- SIA to be designated “band manager”