BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's	)	ET Docket No. 98-153
Rules Regarding Ultra-Wideband	)	
Transmission Systems	)	

COMMENTS OF AERONAUTICAL RADIO, INC. AND THE AIR TRANSPORT ASSOCIATION OF AMERICA, INC. ON TEST REPORTS ADDRESSING POTENTIAL INTERFERENCE FROM ULTRA-WIDEBAND TRANSMISSION SYSTEMS

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April 25, 2001

SUMMARY

The Federal Communications Commission ("Commission") has sought comments on a series of test reports regarding the potential of ultrawideband ("UWB") transmissions to interfere with Global Positioning System ("GPS") and other existing licensed operations. The tests conducted and analyses provided by the National Telecommunications and Information Administration ("NTIA"); Department of Transportation ("DOT") (Stanford University); University of Texas at Austin Applied Research Laboratories ("UT ARL") and Johns Hopkins University ("JHU") on behalf of Time Domain, Inc.; and Qualcomm Incorporated ("Qualcomm") share a common characteristic: they all indicate that UWB transmissions pose a substantial threat of harmful interference to GPS operations, and will in many circumstances inevitably cause such harmful interference. In this regard, they reinforce earlier studies that have been submitted in this proceeding, including an NTIA study regarding interference to federal non-GPS systems and the Sprint Spectrum, L.P. ("Sprint") analysis regarding interference to Personal Communications Services ("PCS") systems. Taken as a whole, these studies indicate the inability of unlicensed UWB devices as proposed to share spectrum, especially in restricted bands, with existing licensed services on a non-interference basis.

Accordingly, Aeronautical Radio, Inc. ("ARINC") and the Air Transport Association of America, Inc. ("ATA") urge the Commission, on the basis of the test results already submitted, to preclude unlicensed UWB operations entirely. If future testing demonstrates persuasively that a certain type of UWB device, categorized by application and specific spectrum bands of operation, cannot create an increased risk of harmful interference to existing licensed operations in the same bands, the Commission might consider licensed deployment of such UWB devices.

Any such licensed UWB devices, however, should still be precluded from operation in the restricted bands and below 5.5 GHz, generally.

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Aeronautical Radio, Inc. ("ARINC") and the Air Transport Association of America, Inc. ("ATA"), by their attorneys, hereby submit these Comments in response to the Federal Communications Commission's ("Commission" or "FCC") March 26, 2001, *Public Notice* in the above-referenced docket in which the Commission requests comments on five reports it has received regarding the potential for ultra-wideband ("UWB") devices to cause harmful interference to the Global Positioning System ("GPS") and other existing radio operations (DA No. 01-753).

I. INTRODUCTION

ARINC[1] and ATA[2] filed comments and reply comments in response to the FCC's Notice of Proposed Rulemaking in this proceeding,[3] in which they expressed substantial concern about

[1] ARINC is the communications company formed by the air transport industry at the suggestion of the Federal Radio Commission, the predecessor to the FCC. ARINC has provided radio communications services and spectrum management to domestic and international aviation

the potential for UWB devices to cause harmful interference to GPS, safety-of-life communications, and other existing operations, including those operating in restricted bands.[4] ARINC and ATA expressed support for the Commission's commitment to require adequate testing and analysis *prior* to any FCC determination whether to permit deployment of UWB

for more than seventy years. In spectrum matters, ARINC is advised by the Aeronautical Frequency Committee ("AFC"), which is composed of representatives of air carriers, business aviation, general aviation, and helicopter operators. Members of the AFC include representatives of Aircraft Owners and Pilots Associations ("AOPA"), America West Airlines, American Airlines, Continental Airlines, Delta Air Lines, Federal Express, Helicopter Association International ("HAI"), National Business Aircraft Association ("NBAA"), Northwest Airlines, Trans World Airways, United Airlines, United Parcel Service, and US Airways. ATA, the International Air Transport Association ("IATA") and the Federal Aviation Administration ("FAA") also send non-voting participants.

[2] ATA is the principal trade and service organization of the major scheduled air carriers, both passenger and cargo, in the United States. ATA was formed to represent the interests of its members before Congress, federal agencies, state and local governments, and federal and state courts. Its twenty-two members account for more than 95% of the passenger and cargo air carrier traffic flown annually on U.S. scheduled airlines. In 2000, ATA members had nearly 7 million departures and carried nearly 600 million passengers. ATA was founded in 1936. ATA's members are Airborne Express, Alaska Airlines, Aloha Airlines, America West Airlines, American Airlines, American Trans Air, Atlas Air, Continental Airlines, Delta Air Lines, DHL Airways, Emery Worldwide, Evergreen International, Federal Express, Hawaiian Airlines, Midwest Express Airlines, Northwest Airlines, Polar Air Cargo, Southwest Airlines, Trans World Airlines, United Airlines, United Parcel Service, and USAirways. Associate members are Aerovias de Mexico, Air Canada, KLM-Royal Dutch Airlines, and Mexicana de Aviacion.

[3] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket 98-153, Notice of Proposed Rulemaking, 15 FCC Rcd 12086, (rel. May 11, 2000) ("*UWB NPRM*"). ARINC and ATA also filed comments on February 23, 2001, in response to a Commission Public Notice seeking comment on National Telecommunications and Information Administration's ("NTIA") January 2001 reports regarding the Administration study of the effects of UWB transmissions on several federal non-GPS radio systems.

[4] *See* 47 C.F. R. § 15.205. Moreover, not all safety-of-life services in the vicinity of the GPS band have been subject to tests regarding potential interference from UWB systems. For example, the aeronautical mobile satellite (R) service at 1.5 and 1.6 GHz is considered a safety-of-life service. It requires a lower noise floor than GPS, and is also deserving of protection from interference by UWB devices.

devices (beyond that permitted by the limited waivers that have already been granted) in any frequency band.

As discussed herein, the test reports on which the Commission has sought public comment consistently demonstrate that UWB transmissions create harmful interference to GPS receivers and other services operating in restricted bands.[5] Consequently, ARINC and ATA

[5] Although not the principal focus of ARINC's and ATA's analysis herein, the test reports identified in the *Public Notice* and the January 2001 *NTIA UWB Special Report* on federal non-GPS systems also demonstrate substantial interference potential to several other existing services. *See* Lawrence K. Brunson et al., *Assessment of Compatibility Between Ultrawideband Devices and Selected Federal Systems*, NTIA Special Publication 01-43, *at* http://www.ntia.doc.gov/osmhome/reports/uwb/uwb.pdf (last visited April 25, 2001*)("NTIA UWB Special Report*"). Because of the interference experienced by the systems it tested, NTIA observed that "[o]perations of UWB devices below 3.1 GHz will be quite challenging." NTIA concluded that for Air Route Surveillance Radar ("ARSR-4"), Distance Measuring Equipment ("DME"), Search & Rescue Satellite ("SARSAT") Ground Station Land User Terminals ("LUT"), for example – all operating below 1610 MHz – at a minimum, "a significant reduction (on the order of 20 dB) in UWB device emission levels below the current levels permitted by Part 15 would be required to meet the receiver protection criteria" in the presence of a *single* UWB emitter. NTIA reached similar conclusions about radar systems in the 1610-3100 MHz band. *See NTIA UWB Special Report* at 6-2, 6-3. Despite the limited number of non-GPS systems tested, the potential for interference to existing authorized radio operations appears sufficiently great as a general matter to warrant the FCC proceeding extremely cautiously. The NTIA results are supported by other tests, such as those regarding 2 GHz mobile systems. *See, e.g.*, Report of Qualcomm Incorporated, ET Docket No. 98-153, filed March 8, 2001, at 25 ("The proposed UWB rule . . . will have harmful impact on the normal operation of CDMA wireless devices in voice, data, and GPS modes."); Sprint PCS Supplemental Comments, ET Docket No. 98-153, filed October 6, 2000, at iii ("UWB devices *will* cause harmful interference to [Personal Communications Services ("PCS") Code Division Multiple Access ("CDMA")] networks – even at the more stringent –53.2 dBm/MHz average power level suggested in the [*UWB NPRM*]. *Id.* (emphasis in original)). Accordingly, before the Commission can determine whether it even should articulate proposed rules permitting the operation of UWB devices in the same spectrum band as an existing service – rules which should be subject to public comment before any final decision is made – testing of the potential for interference to such services in particular by UWB transmissions from the devices that will be used in that band – must be conducted and analyzed. The test reports submitted so far convincingly demonstrate that a "one size fits all" approach cannot be pursued with respect to UWB devices operating within the radio spectrum.

submit that UWB devices should not be permitted to operate in the GPS bands[6] as well as other restricted bands. This is a conclusion that further testing will not alter. On the basis of the current record, the Commission should continue to prohibit intentional radiators from emitting energy into the restricted bands.

In their October 27, 2000, Reply Comments in this docket, ARINC and ATA urged the Commission to consider precluding unlicensed UWB operations entirely at this time.[7] The test results submitted to the Commission to date squarely support such action. Only if future testing of particular UWB devices convincingly show no risk of harmful interference to existing licensed operations in bands where the consequences of interference are less critical, namely above 5.5 GHz and outside the restricted bands above that frequency, should deployment of UWB devices be considered – and then only on a *licensed* basis.[8]

II. DISCUSSION

The FCC has recognized from the outset of this rulemaking that it is "vitally important that critical safety systems operating in the restricted frequency bands, including GPS operations, are protected against interference."[9] The Commission indicated that it would "*consider* allowing access [by UWB devices] to [spectrum below 2 GHz] *provided that* test results and detailed

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[6] GPS operates in the 1559-1610 MHz band, with additional safety-of-life operation in the 1164-1215 MHz band.

[7] *See* Reply Comments of ARINC and ATA, Docket No. 98-153, at 2-3, 17-20 (filed October 27, 2000).

[8] *Id.* As ARINC and ATA noted in their reply comments, even at least one UWB proponent, Multispectral Solutions, Inc. ("MSSI"), concedes the wisdom of UWB operation limited to bands above 5.47 GHz due to the majority of current and potential licensed users of the spectrum below 3.1 GHz and important safety-of-life and other restricted bands below 5.5 GHz. *See id.* at 6 (citing comments of MSSI at 17 (filed Sept. 12, 2001)); *see also* Reply Comments of ARINC and ATA at 6, n.22 (describing location of safety-of-life bands); Comments of ARINC and ATA, Docket No. 98-153, at 7-8, n.17 (filed Sept. 12, 2000).

technical analyses are submitted demonstrating that there is ***no*** *risk of harmful interference* to GPS, to other services operating in restricted frequency bands, or to TV broadcasting."[10] The Commission rules reflect the importance of keeping certain bands, *i.e.*, the restricted bands, free from emissions from intentional radiators, except those emissions that are spurious.[11] Before altering its well-planned spectrum management regime in such a drastic manner as requested by UWB proponents, *i.e.*, allowing unlicensed devices to intentionally emit in restricted bands, the Commission must be certain that GPS systems and other services operated in restricted bands will not be compromised.

In their Comments responding to the *UWB NPRM*, ARINC and ATA explained the potentially grave consequences of harmful interference to GPS and other critical aeronautical systems.[12] Beyond GPS and these other aviation-related systems, many entities have built systems and invested billions of dollars on the assumption that in the restricted bands there would be no intentional radiation or harmful interference from unlicensed devices. The issue, therefore, is whether the test reports demonstrate that there is "*no risk* of harmful interference to GPS" and other protected operations from UWB transmissions.

On this critical point, the reports clearly and consistently demonstrate that UWB transmissions do, in fact, cause harmful interference. Accordingly, the Commission should not allow operation of UWB devices in restricted bands. Instead, UWB device developers should be

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9 *UWB NPRM*, 15 FCC Rcd. at 12096-97, ¶24.

10 *Id.* at 12099, ¶30 (emphases added).

11 *See* 47 C.F.R. § 15.205; Reply Comments of ARINC and ATA, at 14-17 (changes proposed by UWB proponents, particularly operation in restricted bands, would contravene FCC's well-considered spectrum management policies).

12 Comments of ARINC and ATA, at 5-8.

encouraged to continue to work on their products to find ways that enable them to work while complying with the current Part 15 rule and respecting limitations on operations in restricted bands.

In the *Public Notice*, the FCC identifies five reports on potential interference by UWB systems to GPS and other existing systems on which comment is sought:

- NTIA report addressing interference potential to certain GPS receivers, filed March 9, 2001.
- Department of Transportation ("DOT") report addressing interference potential to certain GPS receivers, conducted through Stanford University, filed March 21, 2001.
- Time Domain, Inc. sponsored test report addressing the interference potential to certain GPS receivers, conducted through the University of Texas, Applied Research Laboratories ("UT ARL") and analyzed by the Johns Hopkins University ("JHU") Applied Physics Laboratory, filed March 9, 2001.
- DOT also submitted an earlier, preliminary report on October 30, 2000, addressing interference to GPS receivers as part of its Reply Comments in this docket.
- Qualcomm report addressing the interference potential to the operation of PCS telephones, and related GPS operations, filed March 5, 2001.

ARINC and ATA will focus on the NTIA, DOT, and Time Domain reports because they address specifically the potential for UWB interference to aeronautical GPS operations. In addition, we note that the Qualcomm report – consistent with these other reports – revealed that there will be UWB interference to the enhanced GPS receivers incorporated into Qualcomm phones for emergency location applications. The interference observed in the Qualcomm testing would frustrate the GPS capability of Qualcomm phones to transmit the location of persons

making E-911 calls.[13] The Qualcomm test also demonstrated a substantial risk of interference to CDMA mobile operations at 2 GHz in restricted PCS bands.[14]

On the whole, the tests at issue convincingly demonstrate that UWB devices will pose a threat of significant interference to radio operations in restricted bands, especially but certainly not limited to GPS aviation receivers. As a result, the Commission should not allow the use of unlicensed UWB devices in the restricted bands. Allowing UWB devices to operate in the restricted bands compromises the assumptions used in designing critical safety-of-life radio operations such as GPS, and devalues the spectrum used by others who obtained licenses through competitive bidding or provide important services over the nation's airwaves. In essence, changing Part 15 of the Commission's rules to allow UWB devices to operate in restricted bands turns the Commission's regulatory regime on its head, potentially turning all bands into "junk" bands like those set aside especially for use by unlicensed devices.[15]

Significantly, as a general matter, the tests on which the Public Notice seeks comment were very limited as to both types of UWB devices[16]and GPS devices.[17] However, because these

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13 Report of Qualcomm Incorporated, ET Docket No. 98-153, filed March 8, 2001, at 25.

14 *Id*.

15 For example, at 2.4 GHz, the Commission has made spectrum available for use by Part 15 devices. The proliferation of unlicensed Part 15 devices in this band has made it difficult for all to use. As a result, it is sometimes referred to as a "junk" band of spectrum.

16 It is questionable whether the UWB transmissions tested can be said to stand as representative of the multifarious types of UWB devices and applications that have been identified or advocated in this proceeding. In fact, none of the test reports make a claim that a fully representative sampling of possible UWB transmissions have been tested, an issue of serious concern given the wide ranging, almost limitless, applications for unlicensed UWB devices that have been discussed by proponents.

17 No certified GPS receivers were tested by Time Domain or NTIA. The Time Domain-sponsored test conducted by UT ARL analyzed two GPS receivers, a Garmin International, GPS 150 SSL (a hand held receiver use as an aid to visual flight rules ("VFR")), and a NovAtel Millennium (a ground based GPS receiver). The UT ARL test measurements did not include

tests clearly demonstrate that UWB devices will cause harmful interference, ARINC and ATA submit that the Commission's questions have been answered and further testing is not required. For these reasons, unlicensed UWB operations in GPS bands should not be allowed.

A. NTIA Report

The NTIA UWB-GPS compatibility study demonstrates that UWB operations pose a substantial risk of causing harmful interference to GPS receivers. In particular, NTIA found that as the pulse repetition frequency ("PRF") of a single UWB signal exceeds increases beyond 100 kHz,[18] GPS receivers began to experience increasing levels of interference. As the PRF increased, the interference became more prevalent.[19] More specifically, NTIA found that interference to GPS receivers occurred in 42% of NTIA's test cases involving UWB transmission with PRFs of 100 kHz at current Part 15 levels. In cases involving aviation

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Technical Standard Order ("TSO") certified receivers, military aviation receivers, or GPS receivers common in general aviation. Most certified GPS receivers in use today comply with RTCA DO-208 and FAA TSO C129A, which address supplemental operation. Although not considered in its recent reports, NTIA plans to test a certified C129A GPS receiver that can be used for instrument flight rules ("IFR"). Further, Wide Area Augmentation System ("WAAS") GPS receivers meeting TSO C144 and C145 are anticipated to become common when precision approach operation with WAAS is certified. Therefore, if the Commission still somehow believes that operation of UWB in the restricted GPS bands may be feasible despite the current test data before it that strongly suggests to the contrary, it is imperative that the potential for UWB interference to other GPS receivers, including both C129A and WAAS receivers, also be tested adequately.

[18] "PRF" is the number of pulses transmitted per unit time, *i.e.*, one second. "PRF governs both the magnitude and spacing of the spectral lines, and the percentage of time that pulses are present." David S. Anderson *et al.*, *Assessment of Compatibility between Ultrawideband Systems and Global Positioning System Receivers*, at vi, NTIA Special Publication 01-45, February 2001 ("*NTIA Special Publication 01-45"*).

[19] *NTIA Special Publication 01-45*, at viii; *see also Measurements to Determine Potential Interference to GPS Receivers from Ultrawideband Transmission Systems*, February 2001, at 6-1 to 6-5 and figures 6.2.1 to 6.2.4., NTIA Report 01-384, February 2001.

receivers, that number rises to 67%.[20] Overall, considering all PRFs analyzed, NTIA found interference in 88% of its test cases. That number climbs to 93% of cases when considering just aviation GPS receivers.[21]

Notably, NTIA identified this interference potential while the GPS receivers were operating in tracking mode, and its study did not provide data for reacquisition.[22] Maintaining lock is less sensitive to interference, by about 6 dB, than reacquisition of signal lock.[23] Furthermore, NTIA did not address aviation GPS surface applications, in which acquisition of lock will be more frequent. Accordingly, the NTIA results, serious as they are, actually understate the already considerable potential for harmful interference that UWB devices can cause GPS operations.

Finally, while the NTIA report suggested less potential for interference from individual UWB devices with PRFs below 100 kHz, the study does not support a conclusion that interference from lower PRF UWB transmissions do not present a threat of harmful interference. The NTIA concluded that noise-like UWB transmissions add in average power.[24] Accordingly,

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20 *NTIA Special Publication 01-45*, at x, Table 1.

21 *Id.* at x-xiii. Accordingly, NTIA assumes (GPS receiver in tracking mode) that for non-precision approaches, UWB sources taken together, regardless of number, that are non-noise-like need to be constrained by up to 16.3 dB below Part 15 levels. Multiple noise-like UWB devices taken together would have to be constrained by up to 14 dB below Part 15 levels.

22 *Id.* at ix.

23 According to RTCA DO-229, Appendix C and International Civil Aviation Organization ("ICAO") Standards and Recommended Practices for Global Navigation Satellite Systems, the difference in sensitivity between acquisition and tracking is 6 dB. Meeting the DO-229 standard is a requirement for GPS in an interference environment. It should be noted that reacquiring or acquiring a target is much more important than maintaining lock. If a lock cannot be acquired in the first place, the lack of ability to maintain lock becomes irrelevant.

24 The NTIA definition of noise is not much better than that found in the JHU analysis. Neither can or should be relied on, especially where safety-of-life concerns are involved.

even noise-like signals present the potential for interference at a significantly increased rate when *multiple* UWB signals are present,[25] a very real concern when unlicensed UWB devices would have the ability to proliferate without control. For example, two UWB signals at the same power and distance from a GPS receiver would add 3 dB more interference power than one alone. Five UWB signals at the same level would mean 7 dB more interference at the GPS receiver.[26] At bottom, the NTIA UWB-GPS reports, although interim in nature, reveal a wide range of interference in a variety of UWB operating modes and more than adequately support the action urged herein to preclude UWB operation in the GPS bands.

B. DOT/Stanford University Test Report

The recently submitted DOT/Stanford University test report analyzed interference effects of UWB emissions on a "typical" GPS aviation receiver.[27] In its Reply Comments submitted in this proceeding, DOT concluded on the basis of an "interim" study submitted on October 30, 2000, that "test results to date demonstrate that UWB can cause interference with GPS receiver accuracy and loss-of-lock in satellite signals."[28] The more recent DOT study confirmed the findings of interference potential in the earlier study and extended that to the more sensitive

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25 *See NTIA Special Publication 01-45* at 4-27.

26 Similarly it must be noted that UWB devices may not be the only source of emissions in the band. For example, a mobile satellite service station operating in the band adjacent to the GPS bands and ultra-wideband devices operating within the proximity of a GPS device would eliminate any safety margin and lead to potential danger, and the GPS receiver could experience harmful interference affecting accuracy, lock, or acquisition.

27 Like the other tests discussed herein, the DOT test only looked at two GPS receivers, one of which was an aviation receiver. DOT advised that "additional GPS receiver types should be tested, and it is important to consider the impact of aggregate UWB transmitters" Stanford University, *Potential Interference to GPS from UWB Transmitters*, II Test Results, at 48 (March 16, 2001) ("DOT Report").

28 Reply Comments of the United States Department of Transportation, Interim Test Results and Analysis, filed October 30, 2000, at 6-7.

scenario of reacquisition.[29] UWB operating parameters, such as PRF, modulation, and duty cycle all can exacerbate the devices interference potential to UWB receivers. As in the NTIA test, the most troubling cases reported were where PRF exceeded 100 kHz and where discrete spectral lines were generated, leading DOT to observe that UWB signals that generate spectral lines "will likely be damaging for most GPS receivers rather than being a problem for only a specific receiver type."[30] DOT emphasized, moreover, that the results obtained from its testing regarding the impact of discrete spectral lines "should not be considered worst case as the UWB spectral lines resulting from this testing do not overlap with those most sensitive GPS spectral lines for the specific PRN code utilized."[31]

The DOT report concludes soberly that "UWB transmissions that overlap *or come close* to the GPS band must be carefully regulated to insure there is no adverse impact to GPS."[32] ARINC and ATA submit that the best regulation is already in place: the GPS bands and other restricted bands should continue to be off limits to UWB and other intentional radiators.

C. Time Domain: UT ARL and JHU Reports[33]

Time Domain funded both the UT ARL testing and the JHU analysis of the measurement data generated by the UT ARL procedures. Despite the positions advocating UWB operations in the restricted bands taken by the sponsor to these efforts, the JHU analysis further confirms the findings of the NTIA and DOT test reports. This is particularly noteworthy give the pro-UWB

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29 *DOT Report* at 46-47.

30 *Id.* at 47.

31 *Id.*

32 *Id.* at 3 (emphasis added).

33 The UT ARL measurement data are currently being analyzed by Department of Defense's ("DOD") Joint Spectrum Center. ARINC and ATA understand that this review is expected to be available within the next two months.

"spin" contained in the executive summary of the JHU analysis which belies the evidence regarding the very substantial risk of interference in the main body of the report.

JHU concedes that the choice of time coding parameters in the UWB device can have a significant impact on the performance of GPS receivers.[34] The JHU contends that time coding that produces "non-white noise-like" signals will have a greater impact on GPS receiver performance than UWB emissions that are "white noise-like."[35] However, JHU failed to define the term "white noise-like," or explain whether "white noise-like" transmissions have discrete spectral lines on the same order as noise. Moreover, JHU's conclusions about "non-white noise-like" coding schemes must be qualified. It is possible that UWB coding schemes other than the limited ones measured by UT ARL may significantly affect GPS receiver performance more than the schemes tested.[36]

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[34] The Johns Hopkins University/Applied Physics Laboratory, *Final Report, UWB-GPS Compatibility Analysis Project*, ET Docket 98-153, at ES-1 (March 8, 2001) ("JHU Report").

[35] *JHU Report* at ES-1.

[36] ARINC and ATA note that the references to white-noise like transmissions appear *only* in the Executive Summary of the JHU report and that the body of the report itself neither uses this term nor provides criteria whereby compliance with a "white-noise" criterion could be evaluated. In addition, it should be noted that neither the FCC in its UWB NPRM nor any UWB proponent has suggested that unlicensed UWB devices should only be permitted if their transmissions are "white noise like." Therefore, the fact that UWB transmissions that might meet some condition of being white-noise like present less of an interference threat to GPS operations is of questionable relevance. Further, as discussed above in the context of the NTIA study, the interference potential from noise like sources are additive and multiple UWB devices present an increasing interference threat, even were they each to meet some definition of being white-noise like and individually fall below same interference threshold.

Analysis by an ARINC consultant showed that a single UWB source with a power of -76.3 dBW/MHz (5 dB below general Part 15 limits), would impact GPS tracking at about 14 meters if there was 0 dB antenna gain in the direction of a GPS satellite with a -160 dBW signal and 0 dB antenna gain in the direction of the UWB and no safety margin. If the power of a single UWB device is -71.3 dBW/MHz, the distance increases to about 26 meters. Increasing the number of UWB devices emitting energy at the selected level would exacerbate these results.

Nonetheless, despite these shortcomings in the data, JHU's report notes that a UWB device may cause a "severe" degradation of GPS receiver performance (at a separation of 3 meters).[37] JHU suggests that where the separation is greater than 3 meters, GPS receiver performance "converges" to nominal levels, depending on user requirements.[38] But JHU does not explain why, how, or at what distance that convergence occurs, rendering the earlier reference to 3 meters arbitrary and, almost meaningless.[39] Moreover, by focusing on a standard of "severe" degradation wherein GPS system satellite lock is lost, JHU understates the potential for harmful interference to safety-of-life applications as a result of a loss in ranging accuracy prior to satellite lock.[40] The conducted test data in the UT ARL report of test measurements, for example, shows that there was a degradation to GPS performance up to at least an equivalent range of 25 meters in satellites lost (*see, e.g.*, JHU Report, Figure 6.2).[41]

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[37] *JHU Report* at ES-1. The JHU report is not clear how the three meters was chosen as a relevant parameter and what power was assumed for the UWB transmitter at the GPS frequency. The RTCA and other parties are meeting with JHU in an effort to ascertain these items and the rationale behind them.

[38] *Id.* at ES-2.

[39] Furthermore, review of the JHU analysis provided by the US GPS Council through a March 16, 2001, *ex parte* filing in this proceeding indicates that a more appropriate separation factor for the analysis – assuming 3 meters was meant to be such, which is doubtful – would have been 30 to 300 meters, based on the UT ARL results. *See* Attachment to March 16, 2001, Letter from Raul Rodriguez, attorney for the US GPS Council, to Magalie Salas (Letter from the Chairman, US GPS Council, to William R. Brody, President, JHU, dated March 16, 2001).

[40] *See* Stanford University, *Potential Interference to GPS from UWB Transmitters*, II Test Results at 47 (March 16, 2001) (loss of accuracy occurs at lower levels of interference into the GPS receiver than loss of lock).

[41] Figures 6-2 and 6-3 show satellite loss at least out to 25 meters. It is unclear what happens at distances greater than 25 meters because the test data is not shown. Figure 6-2, the number of satellites tracked, and Figure 6-3, the number of satellites used in the navigation solution, demonstrate that there can be an impact on satellite availability and continuity out to at least 25 meter. *See JHU Report* Figures 6-2, 6-3. Such impact likely extends beyond 25 meters. Unfortunately, the report fails to address data on distances beyond 25 meters.

It is also noteworthy that JHU reached its alarming conclusions regarding the "severe" impact to GPS receivers *without* adequately addressing aeronautical requirements for GPS operation. Under the RTCA DO-229 standard, GPS receivers must meet certain performance criteria in an interference environment, but JHU failed to analyze whether the GPS receivers UT ARL tested did so.[42] Moreover, in coming to its conclusions regarding the "severe degradation" to GPS receiver performance, JHU did not account at all for the safety margin incorporated into RTCA DO-229. Under these standards, the threshold JHU found for "severe degradation" to GPS receivers would have been even higher.[43] Further, JHU assumed a minimum GPS signal level requirement of –130 dBm, whereas the aviation community, in order to account for propagation loss from low-elevation satellites that are critical to aeronautical applications, assumes a minimum level of –134.5 dBm, revealing another measure of real world requirements the JHU analysis failed to take into account. Additionally, a GPS receiver operating in reacquisition mode is even more sensitive to noise then a receiver in tracking mode. Properly accounting for the safety margin, the need to track low-elevation satellites, and would only increase reacquisition sensitivity the potential for harmful interference from UWB operations found through the UT ARL measurement data. In sum, JHU's criteria for when "severe degradation" occurs is totally inconsistent with the degree of protection, GPS signal availability, and ranging accuracy required in aeronautical safety-of-life applications.

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[42] RTCA DO-229 has been approved by RTCA and SC-159 and is accepted as the industry standard. The FAA has also approved RTCA DO-229 and requires it when a pilot obtains TSO certification for WAAS operation.

[43] The aviation requirements are set forth in a number of readily available standard publications, so it is a bit surprising that the JHU analysis fails to consider them. ARINC and ATA understand that RTCA is analyzing the JHU report that uses the UT ARL data in conjunction with these standards. ARINC and ATA reserve the right to comment on RTCA's analysis when it becomes available.

Finally, the potential for interference identified by the JHU analysis for a single UWB receiver, of serious concern in itself, becomes even more troublesome in the presence of multiple UWB signals. For white noise-like signals, the JHU report recognizes that such interference accumulates as added average power,[44] as did NTIA, as discussed above. However, the *JHU Report* fails to remark on the increased interference potential from multiple UWB device even from so called "white noise-like" devices.

III. CONCLUSION AND RECOMMENDATION

The foregoing review of the test reports submitted to date on the UWB interference potential to GPS receivers demonstrates concurrence that there is a real risk of harmful interference to GPS operations. The test reports dispel the claims of UWB proponents that unlicensed UWB devices can co-exist on a non-interference basis in the restricted GPS bands. Rather, the test reports show that the introduction of UWB devices as proposed would pose a substantial threat to GPS and other critical safety-of-life operations. While the tests did not examine a full cross-section of GPS receivers and operational scenarios, the results are significant and additional testing would only further demonstrate the potential for harmful interference to GPS.

In addition to the studies regarding interference to GPS from UWB transmissions, the January 2001 NTIA report regarding non-GPS systems, as well as other reports submitted in the record (*e.g.* by Sprint and Qualcomm regarding PCS), reveal a serious potential for harmful interference to other services, including safety-of-life services, in restricted bands. Accordingly, the Commission now has sufficient data in this proceeding to answer the question it posed at the outset of this proceeding, *i.e.*, whether UWB operations will cause harmful interference to GPS

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[44] *JHU Report* at ES-1.

and other existing services. The data support only one rational conclusion: Yes. Accordingly, ARINC and ATA submit that the FCC's rules should *not* be modified to allow operation of unlicensed UWB devices at this time. Should future testing persuasively demonstrate that a certain type of UWB device, categorized by application and spectrum bands of operation, cannot create an increased risk of harmful interference to existing licensed operations in those same or adjacent bands, then the Commission might consider *licensed* deployment of such devices as described and qualified herein and in the October 27, 2000, Reply Comments of ARINC and ATA.

Respectfully submitted,

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April 25, 2001