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

Re: Written Ex Parte Presentation in ET Docket No. 98-153

Dear Ms. Salas:

On behalf of the U.S. GPS Industry Council (the "Council"), enclosed are the original and one copy of the Council's written *ex parte* presentation in ET Docket No. 98-153. In this presentation, the Council exposes as unacceptable a proposal by ultra-wideband ("UWB") proponent XtremeSpectrum, Inc. ("XSI") to use an emissions mask to regulate emissions from UWB networks directly into the frequency bands between 1164 and 1610 MHz that are used or planned for use by the United States' Global Positioning System ("GPS") satellites. It shows that the mask concept, seen generally in the context of out-of-band emissions ("OOBE") is not appropriate for the regulation of direct and intentional in-band emissions; that the assumptions made in the XSI approach are invalid and tend to understate significantly the extent of the interference problem that UWB transmissions pose to GPS receivers; that if there is to be co-frequency operation of UWB devices in the GPS bands, there will be damaging spectral lines; and the detection bandwidth specified by XSI is insufficient. Cleary, the type of mask envisioned by XSI cannot be used as a means of permitting co-frequency UWB transmissions in the GPS bands.

It is the Council's intention that the enclosed materials be included in the record for purposes of completeness, and serve as a response to XSI submissions in the same proceeding made on April 25, 2001 and May 30, 2001. Please let the undersigned know if there are any questions.

Respectfully submitted,

Stephen D. Baruch
Counsel for the U.S. GPS Industry Council

Enclosure
cc (w/encl.): Julius P. Knapp
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Comments on XtremeSpectrum, Inc. "Emission Mask" Proposal to the FCC

Dr. A. J. Van Dierendonck, AJ Systems
On behalf of the U.S. GPS Industry Council

INTRODUCTION

The comments provided within are with respect to two ex parte submissions by XtremeSpectrum, Inc.: 1) "Comments of XtremeSpectrum, Inc. On Issues of Interference into Global Positioning Receivers, dated April 25, 2001, and 2) XtremeSpectrum, Inc. presentation submitted on May 30, 2001.[1] The XtremeSpectrum proposals contained in those documents fall far short of what rules are required to protect the GPS spectrum. In summary, these proposals fall short as follows:

1. XtremeSpectrum based its proposed mask on the NTIA report.[2] However, this NTIA report did not include two very important safety-of-life uses of GPS – namely, Aviation Precision Approach and Enhanced 911 (E911) Emergency Calling Systems.[3] The validity of the mask is also in question since the proposed UWB emissions would not be classified as Out-of-Band Emissions (OOBE) to GPS, but intentional emissions in the GPS bands – including 1559-1610 MHz, 1215-1240 MHz, and the newly-allocated band at 1164-1215 MHz. That is, part of the UWB spectrum directly overlaps the GPS bands, as opposed to other communication systems (such as Mobile Satellite Services – MSS) that do not.

2. Although bipolar antipodal (±1) data modulation does reduce the level of spectral lines, it does not eliminate spectral lines because of circuit imperfections (±1 imbalance, for example) and because repetition of network synchronization data will still occur, especially if TDMA modulation is used. Furthermore, data content is not truly random, and is definitely not random after passing through the front end of a GPS receiver. The pulses are "stretched" and "collide" when they are filtered in a narrow band. The filtered UWB spectral density at the C/A code correlator is that which is important, not that of the UWB broadcast. The randomness argument made by XtremeSpectrum is only valid when considering the entire UWB spectrum. The filtering has the effect of correlating the random bits.

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[1] *Comments of XtremeSpectrum, Inc. On Issues of Interference Into Global Positioning System Receivers* (filed April 25, 2001) and XtremeSpectrum, Inc. presentation (filed on May 30, 2001).

[2] National Telecommunications and Information Administration Special Publication 01-45, *Assessment of Compatibility between Ultra-Wideband (UWB) Systems and Global Positioning System (GPS) Receivers*, (filed March 9, 2001).

[3] RTCA Paper No. 086-01/PMC-139, *Second Interim Report to the Department of Transportation: Ultra-Wideband Technology Radio Frequency Interference Effects to Global Positioning System Receivers and Interference Encounter Scenario Development*, Prepared by RTCA Special Committee 159, March 27, 2001.

Just like other communication systems, the data is not truly random. In other systems, this fact limits the performance of FEC algorithms, unless randomization techniques (whitening) are used. These techniques require additional overhead.

Even if the above techniques are used, circuit imperfections would then be the biggest cause of spectral lines. Of course, if the UWB spectrum did not overlap the GPS bands, the presence of spectral lines would not be an issue.

3. Using the 30 kHz bandwidth test to detect CW components is not sensitive enough. The noise power in the measured band must be significantly less than the power in the maximum CW component to detect the power in the CW components (say at least 10 dB). Thus, the detection bandwidth should be more on the order of 10 kHz or less so that the effect of the noise component is much less.

4. XtremeSpectrum overstates the extent of in-building attenuation. Many modern buildings -- i.e., those that would probably contain the UWB wireless networks XtremeSpectrum describes -- will have outside surfaces that are mostly windows. These windows provide negligible RF attenuation. Furthermore, it is likely that wireless networks would also be used out-of-doors, and, of course, E911 Emergency Calling Systems would be expected to coexist in-doors and out-of-doors with the UWB wireless networks.

5. The argument against linear addition of aggregate emissions is not valid. In the case of E911 Emergency Calling Systems that would coexist with the UWB devices, the victim receiver can be equidistant from a number of UWB devices. GPS receiver filtering also causes delaying, stretching and overlapping of the pulses, so pulses arriving from different sources will add together inside the receiver.

6. As a point of education, all civil GPS receivers track the C/A code, even the semi-codeless receivers, and all GPS C/A code-tracking receivers are vulnerable to spectral lines that are aligned with spectral lines of the GPS spreading codes. Furthermore, not all C/A codes have their sensitive spectral lines at the same frequency, so all spectral lines have to be eliminated.

DETAILED DISCUSSIONS

The following discussions are expansions of the points presented above.

1.0 Spectral Mask: An interference mask is normally applied to out-of-band emissions (OOBE), such as spurs, harmonics, amplifier noise, etc., that are controlled through the use of filters. It describes emissions outside of the allocated frequency band for the information signal. This concept is different than describing the spectral density limits of the information signal itself as it is proposed in the XtremeSpectrum comments.[4] The information signal is

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[4] *Comments of XtremeSpectrum, Inc. On Issues of Interference Into Global Positioning System Receivers* (filed April 25, 2001), attached technical statement *XtremeSpectrum, Inc. Technical Statement on Reports Addressing Potential GPS Interference from UWB Transmitters*, dated 25 April 2001, Section 2, and XtremeSpectrum, Inc. presentation (filed on May 30, 2001), Chart 2.

intentional. In addition, the proposed UWB devices are likely to have very little control of that spectral density, relying on filtering provided by the antenna. These elements can vary significantly from one device to another, and can even be nonlinear. Thus, the spectral density of unlicensed devices will not be controlled sufficiently to overlap with a frequency band allocated for safety-of-life operations. UWB devices must be prevented, through filtering or perhaps by other means, from emitting directly into the GPS bands. Only when UWB is relegated to a truly OOBE situation to the GPS bands would it be appropriate even to consider an emission mask of the category suggested by XtremeSpectrum.

Impulse excited antennas have been shown (MSSI NPRM response dated 12 September 2000)[5] to be able to be readily modified to significantly change their spectral content by simply externally tampering or adjusting the antenna.

Furthermore, the spectral density limits discussed by XtremeSpectrum were derived from the NTIA report.[6] However, that report did not address the emission limits for the operation of GPS during aircraft precision approach, nor did it address the emission limits for E911 position determination. The RTCA report presents a derivation of an OOBE noise level of –90 dBW/MHz and an OOBE CW level of –100 dBW/MHz for the precision approach applications. These OOBE values are very close to the XtremeSpectrum mask levels, but, of course, they are for OOBE, not for intentional emissions.

Appendix A provides an emissions budget for E911 position determination. It is shown that the proposed XtremeSpectrum emission limits fall about 20 dB too high for this application of GPS, primarily because the GPS signals are attenuated by walls and foliage, and the E911 receivers are located within an aggregate of UWB devices without any attenuation.

2.0 <u>Spectral Lines:</u> XtremeSpectrum criticized the NTIA and Stanford tests because of the presence of spectral lines in the spectrum of the UWB signals. This is somewhat unfair because UWB proponents would not reveal the characteristics of the UWB signals until after the tests were conducted. However, in the end, those tests were not that far off the mark considering the following reasons why bipolar (antipodal) modulation will not eliminate spectral lines.[7]

First, the sequence a_k will never be completely random, as was stated by XtremeSpectrum, especially in the TDMA format. Synchronization will have to be implemented somehow and

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[5] *Response to FCC Notice of Proposed Rule Making ET Docket No. 98-153 "Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems"*, Multispectral Solutions, Inc. Submittal to the FCC, 12 September 2000, Sections 2 and 3.

[6] National Telecommunications and Information Administration Special Publication 01-45, *Assessment of Compatibility between Ultra-Wideband (UWB) Systems and Global Positioning System (GPS) Receivers*, (filed March 9, 2001).

[7] *Comments of XtremeSpectrum, Inc. On Issues of Interference Into Global Positioning System Receivers* (filed April 25, 2001), attached technical statement *XtremeSpectrum, Inc. Technical Statement on Reports Addressing Potential GPS Interference from UWB Transmitters*, dated 25 April 2001, Section 3.

synchronization requires bit pattern repetition. Also, written languages are not made up of random characters – some characters are used much more often than others. Thus, in a communication system, encode characters will cause correlated sequences.

Futhermore, for an *infinite* observation window (as assumed in Fourier theory), it is certainly true that spectral lines can be removed by antipodal (i.e., perfectly matched ± 1) signaling; however, such is not the case with any finite observation window. Indeed, with multi-user TDMA architectures as proposed by XtremeSpectrum, the transmission duration is finite for each emitter. In fact, the larger the number of emitters, the smaller this available transmission time, with the result that spectral lines are only partially suppressed.

This problem might be alleviated somewhat if a CDMA format is used. However, normally, CDMA code lengths are not very long. Thus, code repetition generates spectral lines (such as the GPS C/A code). The use of long codes would not be practical.

Second, the electronic equivalent of the sequence to implement bipolar modulation will not result in symmetric voltage modulation, especially if the devices are to be inexpensive. This is further compounded by antenna non-linear effects.[8]

All of this is further compounded by the fact that the front end of a GPS receiver runs the pulses together and further turns the sequence of pulses into a correlated sequence before correlating with the C/A code.

3.0 Testing for Spectral Lines: XtremeSpectrum suggests a test for spectral lines that scans the UWB emissions by measuring power in a 30 kHz bandwidth.[9] One question regarding this is how the two powers are allocated with respect to the proposed emission mask. Is it assumed that the noise density is already at the mask level and the spectral line power is in addition to that? What if there is more than one spectral line? If all these add up, total power density will exceed the proposed mask level.

For the sake of simplicity, let us assume that the noise emission is at the proposed level (-89.3 dBW/MHz), and that there is one spectral line at the proposed level (-104.3 dBW). Then, in a 30-kHz bandwidth, the two powers are equal at –104.3 dB, so the total power will increase to -101.29 dBW in that bandwidth when adding in the spectral line. This really doesn't provide enough measurement precision. For example, suppose the spectral line power exceeds the proposed mask and has a power level of –103.3 dBW. Then, the total power is now -100.76 dBW. This is only 0.53 dB more. Considering the fact that the spectral line will be changing based upon data modulation, we feel that the distinction for

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[8] *Response to FCC Notice of Proposed Rule Making ET Docket No. 98-153 "Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems"*, Multispectral Solutions, Inc. Submittal to the FCC, 12 September 2000, Sections 2 and 3.

[9] *Comments of XtremeSpectrum, Inc. On Issues of Interference Into Global Positioning System Receivers* (filed April 25, 2001), attached technical statement *XtremeSpectrum, Inc. Technical Statement on Reports Addressing Potential GPS Interference from UWB Transmitters*, dated 25 April 2001, Section 2.2, and XtremeSpectrum, Inc. presentation (filed on May 30, 2001), Chart 4.

above and below the mask is not sufficient. The scan should be performed using a narrow bandwidth.

Usually in the testing world, it is desirable to have a 10 to 1 (10 dB) level difference between the desirable and undesirable condition. With this in mind, a 3-kHz bandwidth is more appropriate. Then, the noise power would be –114.3 dBW, and the total power would be -103.8 dBW at the spectral line power limit. Then, the spectral line power is easily detected. If the spectral line power is increased by 1 dB, the total power is -102.97 dBW, a 0.83 dB increase.

4.0 <u>Building Attenuation:</u> The building attenuation scenarios presented by XtremeSpectrum and by NTIA do not account for walls that consist mostly of glass.[10] Even coated film windows (i.e., those used to prevent sun loading) have very little attenuation to microwaves below about 2 or 3 GHz. At the higher microwave frequencies (e.g., 5 GHz and higher), these coated windows have somewhat more attenuation but are still fairly transparent to microwave energy.

Furthermore, neither XtremeSpectrum nor the NTIA account for the E911 Emergency Calling System scenario that also operates within the same buildings whose walls do not consist of glass. Thus, provision for any UWB attenuation due to walls, etc. is invalid.

5.0 <u>Aggregate Emissions:</u> Neither XtremeSpectrum nor NTIA considered aggregate emissions for the E911 Emergency Calling Systems.[11] For this application of GPS, the aggregate emissions are real and serious. Furthermore, the aggregation is not statistical, but very deterministic. Inside of an office building using wireless UWB local area networks, UWB transmitters will be everywhere.

XtremeSpectrum also questioned the assumption that UWB signals add linearly. The truth is that they do internal to the GPS receiver, as long as the receiver is not saturated. For the proposed emissions mask, the receiver would not be saturated and the UWB signals would certainly add. Furthermore, the front end filtering delays and stretchs the pulses so that UWB pulses transmitted at different times and at different distances add linearly as well. Multipath pulses do as well.

Indoors, the communications channel can exhibit extreme amounts of multipath (reverberation) as shown in the following typical pulse response down a hallway (2.0

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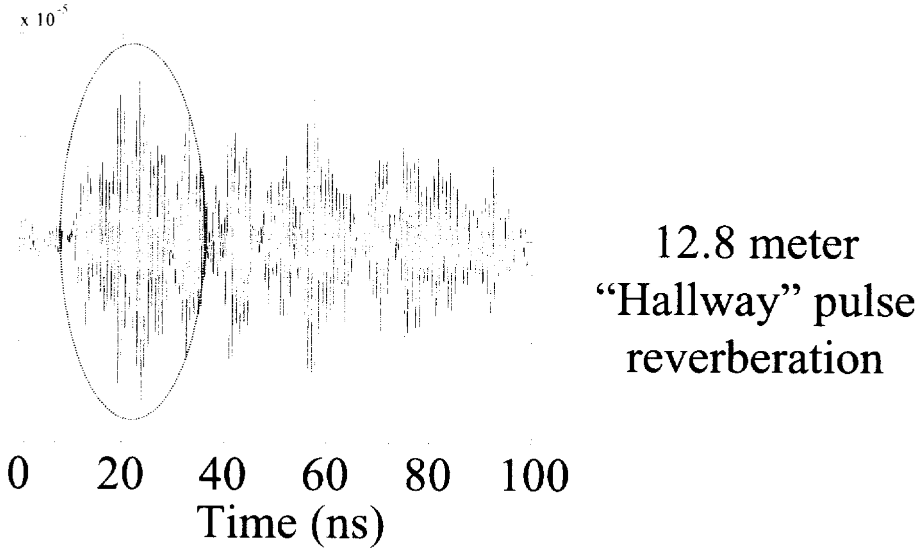
[10] *Comments of XtremeSpectrum, Inc. On Issues of Interference Into Global Positioning System Receivers* (filed April 25, 2001), attached technical statement *XtremeSpectrum, Inc. Technical Statement on Reports Addressing Potential GPS Interference from UWB Transmitters*, dated 25 April 2001, Section 4 and XtremeSpectrum, Inc. presentation (filed on May 30, 2001), Chart 3.

[11] *Comments of XtremeSpectrum, Inc. On Issues of Interference Into Global Positioning System Receivers* (filed April 25, 2001), attached technical statement *XtremeSpectrum, Inc. Technical Statement on Reports Addressing Potential GPS Interference from UWB Transmitters*, dated 25 April 2001, Section 5, and XtremeSpectrum, Inc. presentation (filed on May 30, 2001), Charts 6 and 7.

nanosecond UWB burst at 1.5 GHz center frequency). Thus, one cannot assume that, even without GPS filtering, UWB pulses remain distinct and non-overlapping, especially with multiple emitters.



Appendix A – Enhanced 911 Scenarios and Link Budget

A.1 <u>Background</u>

One very important Public Safety scenario is that of the Enhanced 911 (E911) Emergency Calling Systems. CC Docket No. 94-102, *Third Report and Order*, dated October 6, 1999, stated, "To improve public safety and extend ALI to wireless callers, the Federal Communications Commission has established a schedule, subject to certain conditions, for deployment of E911 features by wireless carriers." Without repeating the schedule dates, the following are excerpts from that Report and Order:

"In Phase I, Public Safety Answering Points (PSAPs) were to receive a rough estimate of a caller's location and a dialable call-back number. In Phase II PSAPs are to receive a much more precise location identification, within 125 meters or about 410 feet of the caller's location."

"Wireless carriers who employ a Phase II location technology that requires new, modified or upgraded handsets (such as **Global Positioning Systems (GPS)-based technologies**) may phase-in deployment of Phase II subject to the following requirements:

Without respect to any PSAP request for Phase II deployment, the carrier shall:

1. Begin selling and activating ALI-capable handsets;
2. Ensure that at least 50 percent of all new handsets activated are ALI-capable; and
3. In addition to the 50 percent requirement, ensure that at least 95 percent of all new digital handsets activated are ALI-capable.

Once a PSAP request is received, the carrier shall, in the area served by the PSAP:

1. Within six months:
    a. Ensure that 100 percent of all new handsets activated are ALI-capable;
    b. Implement any network upgrades or other steps necessary to locate handsets;
    c. Begin delivering to the PSAP location information that satisfies Phase II requirements.
2. Within two years, undertake reasonable efforts to achieve 100 percent penetration of ALI-capable handsets in its total subscriber base.

To be allowable under our rules, an ALI technology that requires new, modified, or upgraded handsets shall conform to general standards and be interoperable, allowing roaming among different carriers employing handset-based location technologies."

The FCC adopted the following revised standards for Phase II location accuracy and reliability: For handset-based solutions: 50 meters for 67 percent of calls, 150 meters for 95 percent of calls.

Later, in the 4th Memorandum Opinion and Order, dated September 8, 2000, the schedules were modified.
In that memorandum, some manufacturers raised questions on the feasibility of the schedule. Others agreed that it was feasible – those who were using GPS for the capability. Sprint stated "the only way to ensure compliance with the phase-in rule would be to sell only Global

Positioning System (GPS) handsets (by the scheduled date), which would limit consumer choice and potentially force consumers to pay high prices for first generation handsets." However, in the discussions part of the memorandum, it was pointed out by the Commission "At the time of the adoption of our current rules, substantial evidence existed establishing that ALI solutions had been tested successfully in field trials." Most of these solutions used GPS. Some were network-based CDMA solutions. The increased availability of GPS chips for the handset solution was also stated.

It is obvious that, to meet the FCC mandate for E911 ALI services within schedule, GPS will be an integral part of the E911 services. This includes the use of GPS anywhere – inside of buildings, under trees, in urban canyons. This is not to say that GPS will be the only sensor. Some of the proposed solutions are "hybrid" solutions that use both GPS and network-based CDMA measurements, but GPS is still an integral part of this safety-critical service.

A.2 <u>E911 GPS Indoors</u>

For the E911 handset application, GPS must be used indoors. That technology has been developed. QUALCOMM now owns the technology originally developed by SnapTrack. QUALCOMM developed an enhanced GPS sensor gps*One*™ to support E911 Phase II services using a handset-based technology mandated by the FCC. The technology takes advantage of the communication link between the wireless device and the infrastructure and has many modes of operation. In one mode of operation, the wireless device collects measurements from the GPS constellation and the terrestrial network and sends the information back to a location server in the network. The server also receives terrestrial measurements made by the base stations. The location server fuses the measurements together to produce an accurate position. Alternatively, the wireless device may compute the location itself instead of sending the measurements to a location server. Because of the enhanced sensitivity, gps*One*™ based sensors are able to work indoor and under severe shadowing conditions. This is an important life saving feature as far as E911 is concerned, and, as indicated above, very important to meet the FCC mandated schedules.

The specification for the GPS signal level under clear view of the sky is –130 dBm. Building penetration, shadowing, and foliage could degrade the signal by more than 20 dB. These weaker signals require more processing gain (longer integration) for successful acquisition. Knowing "true" GPS time at the wireless device and the approximate range to the satellite enables the wireless device to integrate the GPS signal coherently over much more than 20 milliseconds (one GPS navigation bit period). This is because the base station can predict the bit sequence for some parts of the navigation message, and the bit polarity can be sent to the wireless device to help with integrating coherently over multiple bits. The bit prediction algorithm developed at QUALCOMM achieves an accuracy of about 99.5%. gps*One*™ based GPS sensors are able to acquire and track GPS signals as weak as –150 dBm. Doppler and timing information used for signal acquisition are also established via CDMA communication with the base station.

However, in order to do this, the environment has to be essentially interference free. At –150 dBm, the C/N_0 is no more than about 20 dB-Hz, considering that the wireless device must run on batteries and will have some implementation losses. Signals can further be degraded by severe multipath inside of buildings causing additional signal fading. To be essentially interference free means that any interference levels shall be at or below thermal noise.

A.3 E911 GPS Outdoors

The E911 GPS scenario outdoors can be similar to the scenario for GPS indoors due to operation in urban canyons, under trees, etc. There can also be severe multipath fading because of structures, and the wireless device will be more susceptible to other interference (other than UWB).

A.4 E911 UWB Environment

The interference with the most serious potential for the indoor environment is that from UWB Wireless Local Area Networks (WLANs). Buildings could be saturated with PCs, etc., operating on the WLAN, including multipath signals from the WLAN. These WLAN devices can be very close to an E911 user, and are very high PRF devices.

UWB WLAN is under development by Time Domain. The following is an Article from *Wireless* on Time Domain at COMDEX:

> "LAS VEGAS -- A new radio technology that will yield super-fast wireless networks, personal radar devices and in-home location systems is being shown at Comdex for the first time. Time Domain, a startup from Huntsville, Alabama, is at the convention showing off just some of the many uses for its ultra-wide-band (UWB) technology -- a pulse radio system with the potential to shake up telecommunications and usher in a new era of personal radar systems and short-range location devices. Previously, the technology has been demonstrated mainly in private. Comdex is its first big, public showing.
>
> Unlike traditional radio signals, which are transmitted on a single frequency, UWB signals are carried on many different frequencies at once. But they are transmitted at such low power, they hardly rise above background radio noise and therefore don't interfere with other radio devices. Information is transmitted as a stream of short-wave radio pulses, which can penetrate walls and the ground. Depending on the power, operational range is between a few feet and a few miles. In a hotel suite near the convention center, Time Domain executives demonstrated a 10 Mbps wireless network, which is based on the company's first generation UWB chip, called the PulsON.
>
> The second generation PulsON chip, which goes into production at the end of the year, transmits data at 40 Mbps -- four times the speed of 802.11, a popular wireless networking standard. Time Domain hopes to see the first home wireless networking products released in early 2002, operating at 40 Mbps. Within four years, it expects to boost data rates to 1 Gigabit per second and to have shrunk the chip so that it can be easily incorporated into cell phones and handhelds. ...."

Such devices are also being proposed by XtremeSpectrum, Inc.[12]

Since these type of WLANs can be collocated with E911 GPS devices, obviously there is a potential for serious GPS reception degradation.

A.5 E911 UWB Interference Link Budget

Table A.1 presents an interference link budget for the E911 operation scenarios. As stated above, the interference susceptibility level is set at the thermal noise floor because of the very weak GPS signals received through walls. A public safety margin is applied, as is a "correction factor" for CW-like interference. Allotments for multiple UWB WLAN devices are included, because that is very likely scenario.

Table A.1 E911 RFI Link Budget

Parameter	E911 Scenario	Comments
Receiver Susceptibility Mask (broadband noise), dBW/MHz	-141.5	Receivers are designed to operate at thermal noise level with no interference
Public Safety margin, dB	-6	Accepted by WRC 2000. Protects against unknown errors in link budget estimates
Total Allowed Broadband RFI (at receiver input), dBW/MHz	-147.5	
Multiple System Allotment (Excluding MSS), dB	-3	Used for composite of all UWB and all future RFI Sources; Outdoors environment is same as for Aviation. In the case of Indoor Operation, UWB has to be negligible with respect to the thermal noise level.
Single Emitter Allotment	-6	Above allocated to a single emitter; E911 would operate amongst the UWB devices. 4 emitters.
UWB RFI limit @GPS receiver, dBW/MHz	-166.5	
GPS Antenna gain direction of RFI source, dB	0	
Separation Distance, meters	3	E911 devices are amongst the UWB devices
Propag. Loss (Separation dist.), dB	46.0	
Noise-Like RFI Emission Limit, dBW/MHz	**-110.5**	Allowed at emitter
Part 15 limit, dBW/MHz	-71.3	
Delta over Part 15, dB (Noise-Like)	**-39.2**	Amount allowed compared to Part 15 limit.
Worst Case UWB Noise Equivalent Correction Factor, dB, for CW-Like Emissions	-10	Determined using standardized test/analysis procedures
Delta over Part 15, dB (Noise-Like)	**-49.2**	Amount allowed compared to Part 15 limit.

[12] *Comments of XtremeSpectrum, Inc. On Issues of Interference Into Global Positioning System Receivers* (filed April 25, 2001), Page 2.

A.6 Summary and Conclusions

In conclusion, E911 will rely heavily on GPS for position reporting. Furthermore, indoor, urban canyon and foliage make GPS operations for that application much more sensitive to interference. UWB Wireless Local Area Networks have already been announced that would use very high PRFs and be operated indoors. Such networks are likely to cause excessive interference to GPS. To put this in perspective, Part 15 UWB Noise Density at a distance of 3 meters (equivalent to −71 dBW/MHz) is 24.3 dB above a typical GPS receiver thermal noise floor. Thus, also considering aggregate emissions and other interference sources, the emission mask required for E911 is about 20 dB below that proposed by XtremeSpectrum, Inc.