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January 23, 2002 EX PARTE OR LATE FILED

BY HAND

Ms. Magalie R. Salas
Federal Communications Commission
236 Massachusetts Ave., N.E.
Suite 110
Washington, D.C. 20002

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

Dear Ms. Salas:

This is to report that on January 22, 2002, representatives of QUALCOMM, Cingular Wireless, and Sprint PCS (collectively referred to as the "Wireless Companies") met with Paul Margie, Legal Advisor to Commissioner Copps to discuss the above-referenced proceeding, and specifically QUALCOMM's recent study demonstrating that QUALCOMM's E911 technology (so-called gpsOne) cannot meet the FCC's E911 mandate in the face of harmful interference from ultra wideband ("UWB") devices. Attending the meeting were Dr. Samir Soliman, Dr. Klein Gilhousen, Kevin Kelley, Jonas Neihardt, and myself on behalf of QUALCOMM; Jim Bugel on behalf of Cingular Wireless; and Luisa Lancetti on behalf of Sprint PCS. At the meeting, we gave Mr. Margie the attached documents.

During the meeting, Dr. Soliman, the author of QUALCOMM's study, summarized its results. He explained that because the major UWB proponents had declined to loan or sell QUALCOMM a UWB device for testing purposes, QUALCOMM's recent testing, like QUALCOMM's testing of last year, was conducted with off-the-shelf equipment which was put together to produce a waveform that has similar characteristics as those of UWB devices as described in UWB literature. He also explained that QUALCOMM used a commercial wireless phone containing the gpsOne technology in these tests. Finally, he stressed that the tests were conducted in a very benign indoor environment and with a relatively strong GPS signal to isolate the impact of UWB emissions, to eliminate other variables, and to generate reproducible results.

Dr. Soliman stated that QUALCOMM found that if a single UWB device is within 15 meters of a wireless phone containing QUALCOMM's gpsOne technology and the UWB device is operating at Part 15 Class B levels, the wireless phone cannot meet the FCC's E911 requirements. He also explained that the wireless phone begins to suffer substantial degradation if the wireless phone is within 75 meters of a UWB device. Dr. Soliman also said that even if the UWB device were operating at 12 dB less than Part 15 Class B levels, the gpsOne receiver still would suffer harmful interference such that it could not meet the FCC's mandate.

Dr. Soliman stated that to mitigate the harmful interference to wireless phones from a single UWB device, he believed that UWB emissions should be limited across all bands to 35 dB below current Part 15 levels, which would protect gpsOne and wireless receivers to within six feet from such harmful interference. He also stated that he did not believe that such an emissions mask would provide adequate protection from the aggregate harmful interference caused by multiple UWB devices. Thus, he stated that there would have to be an additional margin to protect against such aggregate effect. QUALCOMM pointed out that no emissions mask has been tested and asked that such testing occur with actual UWB devices provided by the manufacturers before any mask is adopted.

The Wireless Companies also emphasized during the meeting that UWB devices do not operate like existing Part 15 devices, which do not intentionally radiate dense power into the PCS and cellular bands. The Wireless Companies explained that the peaks of power intentionally generated into those bands by UWB devices are unique, and the dense power from mobile, ubiquitous UWB devices would make it very difficult and costly to mitigate the harmful interference to wireless phones, and to place such a burden upon wireless carriers which would be inconsistent with Part 15. Thus, the Wireless Companies again asked that, consistent with the positions of the Defense Department, the Department of Transportation, and the National Aeronautics and Space Administration, UWB devices not be authorized to operate below 6 GHz.

Sincerely yours,

Dean R. Brenner
Attorney for QUALCOMM Incorporated

cc: Paul Margie

AT&T Wireless
Cingular Wireless
QUALCOMM
January 22, 2002

VIA ELECTRONIC FILING

Ms. Magalie R. Salas
Federal Communications Commission
236 Massachusetts Avenue, N.W.
Washington, D.C. 20002

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

Dear Ms. Salas:

On behalf of AT&T Wireless, Cingular Wireless, and QUALCOMM (collectively, the "Wireless Companies"), this letter responds to a January 3, 2002 written ex parte filing by XtremeSpectrum in the above-referenced proceeding.[1]

I. Summary

The Wireless Companies made several filings in December 2001 in which they urged the Commission not to allow ultra wideband communications devices to operate below 6 GHz because tests of UWB devices have demonstrated that they will cause significant harmful interference to existing wireless services, including safety of life services, if operated in such bands.[2] XtremeSpectrum does not deny that UWB devices, if unabated, will cause such harmful interference. In fact, several months ago, XtremeSpectrum proposed an emissions mask for UWB as low as 35 dB below Part 15 Class B levels, although protection of that magnitude was limited to the GPS bands.[3] Instead, XtremeSpectrum replies to the filings of the Wireless Companies by insisting, on the basis of no actual testing of its own, that its proposed emissions mask will be sufficient, and that the risk of harmful interference has been overstated, relying on the average power levels of UWB devices. XtremeSpectrum supports this argument by

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[1]Sprint PCS also supports this filing, but is filing a separate response to the XtremeSpectrum Ex Parte to submit new test results which rebuts the erroneous claim that UWB devices are just like personal computers and other Part 15 devices in their emissions and impacts on wireless phones operating in the PCS bands.
[2]See QUALCOMM, Verizon Wireless, AT&T Wireless, and Cingular Wireless, Ex Parte (filed Dec. 5, 2001); Verizon Wireless, on behalf of AT&T Wireless, Cingular Wireless, QUALCOMM, Sprint PCS, and Verizon Wireless, Ex Parte (filed Dec. 4, 2001); Sprint Ex Partes (filed Nov. 16 and Dec. 4, 2001); and, Cingular Ex Parte (filed Nov. 13, 2001).

making a series of misstatements regarding the tests carried out by the Wireless Companies.

XtremeSpectrum's argument misses the fundamental problem which the Commission has to resolve before it can conclude that there will not be interference to wireless phones from UWB emissions: the tests in the record have proven that wireless phones suffer harmful interference as a result of transmissions from nearby UWB devices, and no private or public party, including XtremeSpectrum, the other UWB proponents, and the Commission itself, has conducted any test of an emissions mask or other restriction to prove that such protective measures will successfully mitigate the harmful interference.

The fact that overall average power levels across the entire swath of spectrum covered by a UWB transmission are low, in the opinion of the UWB proponents, will not provide solace to the user of a PCS phone who has his or her call blocked or dropped because of dense power received from a nearby UWB device. Laptops, microwave ovens, and other Part 15 devices do not intentionally emit such dense power into the PCS band as UWB devices have been shown to emit. UWB devices are not like current Part 15 devices.

To confirm, the tests in the record uniformly demonstrate that UWB devices will cause significant harmful interference to PCS systems, whether measured in terms of disruption of normal operation or degradation in reception quality. There are no tests in the record which support any contrary conclusion.

In this regard, most recently, on January 11, 2002, QUALCOMM submitted the results of a series of additional tests it recently conducted of the harmful interference from UWB emissions on QUALCOMM's E911 technology, known as gpsOne. These tests proved that wireless phones using QUALCOMM's E911 technology cannot meet the FCC's E911 mandate in the face of UWB emissions.[4] The FCC's E911 mandate was adopted to enhance the public's safety because there are already over 100,000 calls each day to 911 from wireless phones, and Public Safety Answering Points (PSAPs) do not automatically receive the location of such callers. QUALCOMM's tests showed that the presence of UWB emissions within the GPS spectrum significantly raises the noise floor of the GPS sensor to the extent that it will render the GPS device useless in reporting position location information to PSAPs.

Moreover, Assistant Secretary of Defense John Stenbit recently wrote that the Department of Defense has concluded its own technical studies of UWB emissions and believes that emissions below 4.2 GHz will cause harmful interference to DoD systems, including a number of highly sensitive systems.[5] The Commission has not conducted any

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[3] See XtremeSpectrum Ex Parte (filed September 10, 2001).
[4] See QUALCOMM Written Ex Parte (filed January 11, 2002).
[5] See Letter from Assistant Secretary of Defense John Stenbit to Deputy Assistant Secretary of Commerce Michael D. Gallagher, January 11, 2002 (the "January 11th Stenbit Letter").

tests of its own, and no test in the record supports the notion that UWB will not interfere with the services provided by the Wireless Companies. The burden is on the UWB proponents to conduct such tests.

The tests on which the Wireless Companies rely were reasonable and conclusively establish that UWB devices will cause harmful interference to PCS phones. XtremeSpectrum's arguments are erroneous.

Emissions Levels. XtremeSpectrum criticized the UWB emissions levels in the tests as being too high, but the record in this proceeding showed that even at very low power levels, UWB devices will cause harmful interference.

Numbers of UWB Devices. Similarly, XtremeSpectrum claims that the PCS tests assume extremely largenumbers of UWB devices per square kilometer, but at least four tests (QUALCOMM, NTIA, Stanford University, and Sprint PCS/Time Domain) used only one device and showed that the harmful interference is caused by one UWB device at distances that far exceed the normal office size. It is true though that the proliferation of UWB devices will aggravate the situation, as Intel, a proponent of UWB, admitted in a filing with the Commission.

Intrinsic Noise vs. Excess Noise from UWB Devices. XtremeSpectrum asks the Commission to disregard the harmful interference PCS phones will suffer from UWB devices because PCS phones already suffer noise from other PCS callers, but such intrinsic noise is an inherent feature of the multiple access PCS system and is already built into the system's design. On the other hand, excess noise from UWB devices will eat into the system's margin and disrupt the normal operation of the system.

Speculation About Indoor Operation. In a similar vein, XtremeSpectrum speculates that indoor walls, furniture, and within-the-room reflections will minimize interference, but no test of UWB devices supports this speculation. To the contrary, line-of-sight propagation within an office will follow free space. There are countless scenarios in which people could be, wittingly or unwittingly, using UWB devices indoors within the same office or room as PCS phones.

Aggregation. Finally, XtremeSpectrum states without any supporting testing that UWB emissions add, as do other radio-frequency signals, but do not aggregate at a victim receiver. Even Intel has admitted that interference power from UWB devices will add non-coherently, and that this aggregation is a problem. No study in the record establishes that an emissions mask or other regulatory restriction will ameliorate the aggregation of harmful interference.

"Trust Us" vs. the Demonstrated Likelihood of Harmful Interference. Finally, XtremeSpectrum effectively tells all the Wireless Companies to trust it. It won't make devices which interfere with PCS handsets, it says, because the market will ensure that its products are non-interfering, (XtremeSpectrum Ex Parte at Pg. 15). This argument jettisons the entire 67-year history of the FCC and the Communications Act

The FCC has never authorized a new service which has a demonstrated likelihood of causing harmful interference to licensed services, including safety of life services, on the basis of a bare promise from the developer not to make interfering products, and the FCC should never do so. Once the promise is breached, it will be, as a practical matter, impossible to retrieve countless number of interfering devices to cure the interference. The tests prove that UWB communications devices will cause harmful interference to radio receivers, and before these devices are authorized, this problem must be cured.

For these reasons, and consistent with the January 11th Stenbit Letter, the Wireless Companies continue to urge the Commission not to authorize UWB communications devices below 6 GHz. We say above 6 GHz because of the interference not only to PCS systems from UWB devices operating below 3.1 GHz, and DOD systems operating between 3.1 and 4.2 GHz (as reflected in Assistant Secretary of Defense Stenbit's letter), but also because UWB devices operating above 4.2 GHz and below 6 GHz would interfere with other critical aviation systems which are safety of life services. The January 11th Stenbit Letter (at page 3) expressly took account of the interference to these critical aviation systems, referring to other executive branch organizations who also wish to protect their systems from interference.

II. XtremeSpectrum Makes a Series of Misstatements About the Tests Of UWB Devices

XtremeSpectrum claims that the key PCS studies (the QUALCOMM study, the Telcordia model, and the Sprint PCS/Time Domain tests), while well designed and carried out, used erroneous assumptions. In fact, however, it is XtremeSpectrum which has made errors in this very set of arguments. Each error by XtremeSpectrum is set forth below.

XtremeSpectrum Myth 1: Emissions Limits Can Cure the Harmful Interference.

According to XtremeSpectrum: "Most of the PCS studies were based on UWB emissions levels much higher than any proposals before the Commission. The Commission's NPRM specified a 94% reduction below Class B in the PCS band. XtremeSpectrum has proposed that same level for non-peer-to-peer operations, and a more stringent 98% reduction for peer-to-peer operations. These levels offer substantial protection to PCS, compared to the Class B levels used in the studies." XtremeSpectrum Ex Parte at Pg. 5 (footnotes omitted).

Fact 1: UWB Will Cause Harmful Interference Even If Operated 30 dB Below Class B

No test establishes that the emissions levels proposed by XtremeSpectrum will cure the harmful interference from UWB devices, and this harmful interference will occur at power levels significantly below Part 15 levels. Continuous transmissions from a UWB device cannot be considered spurious emissions along the lines of those emitted by run-of-the-mill Part 15 devices.

In order to see the magnitude of the harmful interference from UWB devices, consider 2 UWB devices transmitting at a power level that is 30 dB (one thousandth) below Part 15 Class B devices. Assume that these devices are at equal distance from a communication device with 8 dB noise figure (very typical for communication devices). The amount of excess noise power spectral density introduced when these devices are at 1 meter separation distance is –166.3 dBm/Hz[6]. This is equivalent to doubling the noise figure of the receiver. Increasing the noise figure is equivalent to making these receivers less sensitive to marginally strong desired signals. Theoretically, it is impossible to restore the victim receiver equivalent noise figure to its original value, unless the UWB devices are disabled. The designer of the communications device needs to decrease the original noise figure to 3 dB to restore the resultant noise figure to one dB higher than the original value (i.e., accepting one dB degradation). Designing a communication device with a 3 dB noise figure is impractical, and sometimes physically impossible because consumers demand small, affordable, and lightweight devices.
Thus, the harmful interference will be substantial and very difficult and costly to ameliorate, if it can be ameliorated.

Indeed, although the testing by Sprint and QUALCOMM was conducted in the PCS bands, the harmful interference in the cellular bands will be even more severe. The interference to that band will be exacerbated because the Part 15 limit for bands below 960 MHz is 1.2 dB higher than for bands above 960 MHz (measured in 1 MHz) and the propagation loss is less at 800 MHz. (While the Part 15 field strength limits below 960 MHz is lower, the resolution bandwidth is also much lower, hence the overall power in 1 MHz is higher.

Two UWB devices in the vicinity of the communication device will be the norm if UWB is authorized for peer-to-peer communications in indoor environments. An example is a cubical office environment with UWB implemented in computers, laptops and palm-type organizers. People around meeting tables exchanging files are usually separated less than 3 meters. People in conference halls exchanging business cards are also separated less than 3 meters. As a matter of fact, we expect more UWB devices at closer distances from the communication device, especially if the UWB devices are used for personal gadgets such as in wireless headsets, CD and MP3 players. Workers in a cubical office environment are separated by less than 3 meters. Recognizing the harmful effects that would be caused by UWB devices if the proposed rules were promulgated, XtremeSpectrum[7] has proposed in correspondence with the FCC emission masks that are as low as 35 dB below Class B levels (although the 35 dB mask would be limited to the GPS bands). This proposal by itself is an admission that these devices if allowed to operate in the restricted bands will cause great harm to the normal operation of licensed devices. Since noise impacts all receivers the same way, any protection to GPS should apply to all licensed bands.

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[6] Excess noise PSD = -41.3 (Class B) – 30 (mask level) –38 (propagation loss) + 3 (two devices) – 60 (1 MHz). These calculations are done at 1900 MHz (the PCS band).
[7] XtremeSpectrum Ex Parte Communications filed September 10, 2001.

Another filing in the record shows that UWB devices will cause interference when operated at the power levels specified in the Notice of Proposed Rule Making. Intel, itself a UWB proponent, showed in its Reply Comments[8] that a UWB device operating with transmit power at the level specified in the NPRM for frequencies above 2 GHz at a distance of 2 meters from a Bluetooth receiver would degrade the noise figure of a Bluetooth receiver by about 21 dB. The Bluetooth receiver under investigation is assumed to have 6 dB noise figure. As mentioned in several reply comments in this docket, any victim receiver (such as a wireless phone) will behave the same as long as the UWB interference is represented as a additive white noise.

XtremeSpectrum Myth 2: The Studies Assume An Unduly High Number of UWB Devices.

According to XtremeSpectrum: "The PCS studies assume extremely large numbers of UWB devices, ranging up to 5,000 to 100,000 active emitters per square kilometer. Even for a population-dense region such as metropolitan New York City, this works out to *ten operating UWB transmitters for every man, woman, and child.* These figures are unrealistic, to say the least. (NTIA's worst case was only 1-10,000 devices per square kilometer. Much of its analysis assumed a value of 200 devices per square kilometer.)" XtremeSpectrum Ex Parte at Pgs. 5-6.

Fact 2: At Least Four Studies Used Only UWB Device .

The QUALCOMM, NTIA, Stanford and Sprint PCS/Time Domain studies each used only one UWB device in their testing and showed that harmful interference is caused by one UWB device at distances that far exceeds the normal office size.

XtremeSpectrum Myth 3: A PCS User Already Hears Noise From Other PCS Users.

XtremeSpectrum states: "The PCS studies assume that the UWB emitters and PCS handset exist alone, unaffected by any other sources of radio-frequency energy. This is never the case. Populated areas always have a background level of ambient radio noise. Some of the background noise into a PCS handset comes from other people's PCS calls. Signals from a competing provider's handset, with its main signal in some other PCS frequency block, are permitted to reach 50 millionths of a watt. Although a small number, this is still *10,000 times higher than the maximum proposed for UWB*. Other noise comes from same provider PCS base stations serving other cell sites nearby. The PCS studies fail to account even for this unavoidable self-generated interference." XtremeSpectrum Ex Parte at Pg. 6.

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[8] Reply Comments of Intel Corporation filed October 27, 2001.

Fact 3: Noise From Other PCS Users Is Taken Into Account In Designing A PCS System.

The above statements demonstrate a lack of understanding of how CDMA works and how cellular or PCS systems work in general. The intrinsic noise due to other users in the system is an inherent feature of multiple access system and is budgeted for in the design of the system. Any excess noise from other sources, such as UWB devices, will eat into the system margin and render the system non-operative as designed. For this reason, Cingular filed example link budgets for TDMA and GSM systems.[9]

XtremeSpectrum Myth 4: UWB Won't Cause Interference Indoors Due to Propagation.

XtremeSpectrum asserts: "The PCS studies assume that interfering UWB signals propagate indoors as they would in outer space. In fact, however, the effects of interior walls, furniture, and within-the-room reflections all diminish the UWB signal strength. One widely accepted technical study shows that a typical indoor environment provides a 94% reduction (12 dB) relative to free space, over a 10 meter range. This greatly reduces the effect of UWB on PCS (and other systems)." XtremeSpectrum Ex Parte at Pg. 7.

Fact 4: Line-of-Sight Indoor Propagation Follows Free Space.

It is well-established that line-of-sight propagation indoor follows free space. When downloading files or exchanging business cards, the two clients are not usually separated by walls and neither is the victim receiver. They will all be in the same office or meeting room and subject to harmful interference.

The Intel Report[10] separates the distance between the UWB transmitter and the victim receiver into two regions, each of which has a different path loss exponent. For distances less than 10 meters, the free space path loss model is used. Most cubical, normal offices, some airport waiting areas, and meeting rooms are less than10 meters in size.

XtremeSpectrum Myth 5. UWB Devices Will Not Cause Any Aggregate Interference.

XtremeSpectrum asserts: "The PCS studies assume that signals from multiple UWB units aggregate to form stronger signals. This is incorrect.

UWB aggregation has taken on the status of an urban myth. Many filings in the docket state with great conviction that aggregation occurs, although none cites any evidence. UWB emissions add, as do other radio-frequency signals, but nonetheless they do not aggregate at a victim receiver. The reason is simple: UWB signals cannot travel

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[9] See Cingular Ex Partes filed October 12, 2001 and May 10, 2001.
[10] See Reply Comments of Intel Corporation filed October 27, 2001.

far. As they propagate, the already small signals fall off much faster than they can add up. As a result, only the nearest UWB emitter can be significant. The signals from all others are so weak as to be negligible.

Suppose we could somehow arrange for 100,000 UWB emitters to be distributed through a building, each one of them 100 meters away from a PCS handset. The total signal received at the handset from all 100,000 units would be well under 1% of the signal from *one* UWB emitter, placed 3 meters away. Only the nearest emitter matters." XtremeSpectrum Ex Parte at Pgs. 7-8.

Fact 5: Interference Power Adds Non-Coherently.

Aggregate interference from UWB devices is by no means an "urban myth." To the contrary, another proponent of UWB, Intel, admitted that the aggregation of UWB devices could have the potential of causing additional interference. In Reply Comments, Intel wrote as follows:

> The aggregation of several UWB devices in the same area could have the potential of further increasing the noise floor of operating devices in the same frequency. If these devices are assumed to add non-coherently (assuming that different UWB transmissions operating in the same geographic area are not synchronized), then the aggregated average interference power will simply add. The additional interference will either reduce the acceptable operational distances of other wireless devices or impact the available link margin and potentially impact the perceived performance levels.

Intel Reply Comments at Pg. 20.

In other words, Intel has admitted that the aggregation of UWB devices will diminish the operation of other wireless devices. To be sure, Intel went on to try to explain away this thorny problem by speculating that the random location of UWB devices, the random data arrival rates, the possible mobility of the devices, and the possibility of ceasing transmissions when it is not necessary could lessen the aggregate interference. This sheer speculation is no substitute for empirical study. At this time, the record shows that the aggregation of UWB devices will exacerbate the harmful interference to existing services, including safety of life services, and no test in the record shows conclusively how this interference can be ameliorated. The Commission cannot just assume that the problem will not exist, as XtremeSpectrum suggests.

And, the problem of aggregation of UWB devices is most pronounced in office or home environments in which there could be as many as 4 UWB devices within 2 meters or less of the victim receiver. Someone using a PCS phone to call 911 to report an emergency, or a police officer, firefighter, or other first responder using a PCS phone to call for help, who is in the middle of an office cubical could be surrounded by at least 4

UWB devices within 2 meters. There is no basis for the Commission just to ignore the aggregate harmful interference from UWB devices.

III. Conclusion

In sum, the Wireless Companies urge the Commission to disregard the erroneous arguments put forth by XtremeSpectrum. In light of the tests in the record proving harmful interference to wireless phones from UWB emissions and consistent with the January 11th Stenbit Letter, the Wireless Companies urge the Commission not to authorize UWB communications devices below 6 GHz. We say above 6 GHz because of the harmful interference not only to PCS systems from UWB devices operating below 3.1 GHz, and DOD systems operating below 4.2 GHz (as reflected in Assistant Secretary of Defense Stenbit's letter), but also because UWB devices operating above 4.2 GHz and below 6 GHz would interfere with other critical aviation systems which are used to provide safety of life services. The January 11th Stenbit Letter expressly took account of this interference to such systems, referring to other executive branch organizations who also wish to protect their systems from interference.

Respectfully submitted,

Jonas Neihardt
Vice President
Federal Government Affairs
QUALCOMM Incorporated

Brian F. Fontes, Ph. D.
Vice President
Federal Relations
Cingular Wireless

Douglas I. Brandon
Vice President, Regulatory Affairs
AT&T Wireless Services, Inc.

cc: Chairman Michael Powell
Commissioner Kathleen Abernathy
Commissioner Kevin Martin
Commissioner Michael Copps
Deputy Assistant Secretary of Commerce Michael Gallagher
Assistant Secretary of Defense John Stenbit
Secretary of Transportation Norman Mineta
Bruce Franca
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APCO International

Association of Public-safety Communications Officials International, Inc.

January 16, 2002

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The Honorable Michael Powell
Chairman
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

RE: Ex Parte Communication in ET Docket 98-153

Dear Mr. Chairman:

I am writing to express serious concerns regarding the potential for Ultrawideband (UWB) operations in bands below 6 GHz, as discussed in the above-referenced pending proceeding. While some proposed UWB applications may be useful for public safety agencies, a greater concern is that widespread unrestricted deployment of commercial UWB devices could cause harmful interference to public safety radio systems and to critical GPS-based technologies used to locate emergencies.

Even minor levels of interference to public safety land mobile radio equipment can disrupt police, fire, EMS, and other operations that are protecting the safety of life, health and property. We are particularly concerned with uncontrolled, unpredictable UWB operations in indoor settings. Within buildings, low power portable public safety radios (all of which operate below 1 GHz) may be susceptible to signal degradation caused by increased noise levels produced by UWB devices. In the 800 MHz band, such radios are already facing interference from Nextel and other adjacent channel commercial systems using cellular architecture. Adding potential UWB interference to that scenario is unacceptable.

NTIA and others have recently submitted information to the Commission regarding the possible harmful effects of UWB transmissions on GPS signals. Pursuant to Commission regulations, commercial wireless carriers are currently implementing technologies to locate wireless emergency calls to 9-1-1. Many of those technologies utilize GPS signals to provide necessary accuracy. We are concerned, therefore, that such accuracy could be compromised as a result of UWB deployment.

Therefore, we urge the Commission to proceed with great caution in its consideration of this important issue.

Respectfully submitted,

Glen Nash
President

cc: All Commissioners
Bruce Franca, Chief, OET
Thomas Sugrue, Chief, WTB
Michael Gallagher, Deputy Assistant Secretary, NTIA

ASSISTANT SECRETARY OF DEFENSE
6000 DEFENSE PENTAGON
WASHINGTON, DC 20301-6000

January 11, 2002

COMMAND, CONTROL, COMMUNICATIONS, AND INTELLIGENCE

Mr. Michael D. Gallagher
Deputy Assistant Secretary for Communications and Information
U.S. Department of Commerce
HCH Building, Room 4898
1401 Constitution Ave., NW
Washington, D.C. 20230

Dear Mr. Gallagher:

As National Telecommunications and Information Administration (NTIA) is reopening discussions with staff members of the Federal Communications Commission (FCC) regarding ultra-wideband (UWB) communications technologies, it is essential to clarify and emphasize the extremely serious concerns of the Department of Defense (DoD) regarding the potential effects of such UWB operations upon federal government systems—including those that are vital to national defense and homeland security. These discussions are important because of likely imminent FCC action in its UWB proceeding. The FCC has indicated it plans to proceed with a report and order as soon as its February 14, 2002 public meeting.

We believe that UWB is a revolutionary technology that holds strong potential for important military and commercial uses. United States military forces have been early and ardent advocates for testing and deploying UWB systems. We also strongly agree that DoD will benefit from cost savings and technical advances brought about by commercial and military deployment of UWB systems and applications. In short, DoD supports UWB development. However, DoD seeks to ensure that such development will proceed in a prudent manner consistent with core national security needs and objectives.

As Deputy Secretary of Defense Wolfowitz noted in a letter to Secretary Evans, dated November 11, 2001, the current FCC draft rules for UWB contain emission limits that will not protect DoD systems, including a number of highly sensitive systems. We are particularly concerned about the potential effects of UWB operations on the global positioning satellite (GPS) system that, as you know, is necessary to satisfy certain critical military missions. DoD, in keeping with our national defense responsibilities, cannot accept any interference with its systems. This requires that there be no intentional emissions below 4.2 GHz, except for imaging systems. In addition, out-of-band emissions must meet the stringent standards previously provided by DoD to NTIA staffers. We believe that compliance with these parameters can easily be achieved, by installation at the input to UWB transmitting antennas of a high pass filter with a cut-off at 4.2 GHz to produce an emission mask that meets the limitations provided to your staff.

The current FCC draft order poses at least two additional significant issues. First, the FCC is proposing to approve the unlicensed and uncoordinated use of UWB devices in all bands—including bands in which Part 15 intentional transmission currently is restricted. Never before has the FCC considered authorizing such unconstrained usage of spectrum that includes restricted bands. This holds the dangerous potential to set a precedent whereby the FCC could eliminate protection of restricted government bands, which are essential to national security, safety of life, and the economic security of the nation.

Second, in its proposed order, the FCC is not seeking to impose aggregation controls in the licensing process. This lack of any aggregation limits may pose a threat to vital national security systems and operations.

DoD has concluded its technical studies of UWB emissions and provided updated numbers to NTIA that would allow full implementation of UWB technology above the 4.2 GHz frequency range. We believe this demonstrates DoD's good-faith efforts to seek a "win-win" technical and policy solution that will protect critical Defense systems and also allow commercial growth of this industry. We wish to emphasize that our analysis clearly points to the fact that emission limits imposed by the FCC must be based on conservative technical values. All emissions, including emission spikes, must be below the emission limits provided by DoD.

DoD's proposal to prohibit emissions below 4.2 GHz (with some limited, niche-market exceptions, such as ground-penetrating radar and see-through-wall applications) is not a position that can be altered according to the success or failure of initial commercial UWB deployments. It is a long-term position taken to protect vital DoD systems that ensure our national security. That position is further justified by recent public reports that such initial roll-outs may constitute just the "camel's nose under the tent" of commercial investment in UWB. We must be concerned about the long-term, cumulative effect of decisions made at this juncture.

We are at a policy crossroads that will determine the safe operation of DoD systems as commercial UWB systems are deployed. We have worked hard and will continue our efforts to develop approaches that will permit commercial deployment of UWB technologies in a manner which will not pose risks to sensitive and vital national security and defense systems. It would be an abdication of responsibility on our part, however, not to stress our severe reservations about potential FCC actions in the strongest possible terms.

We note that other executive branch organizations use restricted bands above the 4.2 GHz cutoff that we propose. Those organizations also wish to protect their systems from interference and can benefit from a high pass filter having a cutoff point at a higher frequency. Therefore, a corollary attribute of the high pass filter would be to limit the range of UWB devices and thus reduce their potential for interference.

The Department of Defense asks NTIA to use its discussions with the FCC to clearly and strongly express DoD's position and continuing concerns regarding the FCC's UWB proposals, as currently drafted. Furthermore, considering the importance of this issue, we would ask that DoD representatives be present during these discussions with the FCC. We look forward to continuing to work with you, other federal agencies, and the White House to ensure that Presidential authority under the Communications Act of 1934, as amended, is appropriately preserved in discussions within the Executive Branch and with the FCC.

Thank you for your consideration and attention to this matter.

Sincerely,

John P Stenbit

John P. Stenbit

Executive Summary

QUALCOMM recently conducted a series of laboratory tests to assess the impact of ultra-wideband (UWB) emission on GPS enabled PCS phones. QUALCOMM's tests have shown that close proximity of UWB devices to GPS enabled wireless phones will prevent the location of wireless callers to 911 from being determined in compliance with the Commission's E-911 mandate. The presence of UWB emissions within the GPS spectrum significantly raises the noise floor of the GPS sensor to the extent that it will render the GPS device useless in reporting position information to Public Safety Answering Points (PSAPs), and hence it will not be possible to meet the safety of life system requirements embodied in the Commission's E-911 rules in the face of UWB emissions.

Thus, QUALCOMM urges the Commission not to permit operation of UWB devices within the GPS band until suitable measures have been taken to limit sufficiently the UWB emissions within the band, and empirical testing conclusively proves that there will be no further system degradation once these measures have been implemented.

1. Introduction

In June 1996 the FCC adopted a Report and Order for enhanced 911 wireless service (E-911). The mandate requires that cellular and broadband PCS licensees relay a caller's telephone number to the appropriate PSAP, automatically route 911 calls to the PSAP and provide the location of the originating mobile station. For handset based solutions, the FCC specifies that wireless carriers locate wireless callers to E-911 67% of the time to within 50 meters and 95% of the time to within 150 meters.

QUALCOMM has developed an enhanced GPS technology called gpsOne™ , to support the FCC mandated handset based solution. This solution has been integrated into commercially available CDMA chipsets found in cellular and PCS handsets and other wireless devices. The gpsOne™ solution has several modes of operation. In one mode, the mobile station collects measurements from both the GPS constellation and the terrestrial infrastructure and sends the information to a location server in the network. The location server has GPS navigation information and is able to compute the phone's position and relay it back to the mobile station or to the requesting entity such as PSAP. The gpsOne™ receiver has enhanced sensitivity and is able to acquire GPS signals as low as -150 dBm. As a result, wireless devices enabled with this technology can work indoors and under severe shadowing conditions.

The presence of UWB interference will hinder the operation of the GPS receiver in environments with marginally strong GPS signals. Since UWB devices transmit very narrow pulses, they inherently occupy a vast spectrum including the GPS band. This in turn is likely to cause degradation in the gpsOne™ performance. The goal of QUALCOMM's study was to quantify the performance of the gpsOne™ receiver in the presence of UWB interference in the GPS band. Only a single UWB emitter was considered and a favorable indoor channel scenario was emulated.

Section 3 will go over the performance metrics used in this study. Section 4 will describe the measurement setup and data collection process. Section 5 will discuss the test results and finally, the conclusions will be summarized in Section 6.

2. Performance Metrics

The metrics used to characterize the gpsOne™ functionality are different from those used in traditional GPS receivers. The traditional receivers, upon power-up, utilize carrier/phase tracking to acquire, and stay in lock with the satellites. The two important parameters that are normally tested are (1) Break Lock power (BL) and (2) Re-acquisition time (RQT). The BL is defined as the interference power level that causes the receiver to re-enter the acquisition mode. The RQT is defined as the time it takes a receiver that has been forced from tracking (maybe due to shadowing of satellite signal), to re-enter tracking mode in the presence of interference.

When a position location session is initiated on the gpsOne™ enabled device, the GPS device obtains navigation assistance information from the location server. The initiating GPS device uses this information to search for satellites and reports pseudo range measurements to the location server. The location server in turn computes the device's position and relays it back to the requesting entity. Each GPS measurement is independent of the previous one, *i.e.*, the phone does not track the incoming GPS signal or have any sort of memory to help it re-acquire it if there is shadowing. Thus, we cannot use BL as a performance metric. RQT is also not important since each measurement is independent of the previous one. Essentially, each measurement is like a new (cold) acquisition.

More meaningful metrics for gpsOne™ are (a) Position Error, (b) Satellite Availability (Yield) and (c) Signal-to-noise (C/No) Degradation.

2.1 Position Error

The purpose of this metric is to determine the mobile station's capability to obtain precise location. The FCC mandated limit is: *The error in location shall be < 50 meters for 67% of calls and < 150 meters for 95% of calls.*

2.2 Satellite Availability

This metric measures how many satellites are detected by the mobile station in the presence of interference. Ideally, at least 4 satellites need to be visible to the mobile to obtain a 3-dimensional position fix. If the interference power is sufficiently large, it could degrade the C/No of the satellite signals resulting in fewer than four satellites being visible to the mobile. A reduction in satellite availability directly translates to a reduction in yield (position determination).

2.3 C/No Degradation

This metric is a fundamental metric that helps quantify the RF performance of the GPS receiver. It is identical to the degradation in the GPS receiver noise figure.

3. Laboratory Measurements

QUALCOMM recently conducted a series of laboratory tests to assess the impact of UWB emission on gpsOne™ enabled PCS phones. The focus of this investigation was to try to quantify the impact of UWB interference on gpsOne™ performance. The testing was performed using a live GPS constellation in a controlled conducted environment. Data was simultaneously collected on two phones- a Test phone with UWB injected and a Reference phone without UWB. The two phones were isolated from each other using shielded boxes. Due to the dynamic satellite geometry, the Reference phone was needed to compare the Test phone data with. This section goes over the measurement equipment, the test setup and preliminary lab measurements.

3.1 Test Equipment

This section goes over the equipment used during the testing. All instruments used were commercial off-the-shelf test equipment.

Table 1: Test Equipment

Equipment	Manufacturer	Model	Purpose
Arbitrary Waveform Generator	Tektronix	AWG2021	Trigger waveform for UWB
Spectrum Analyzer	Advantest	R3465	UWB power measurements
Power Meter/Sensor	Gigatronix	8541C(meter) 80601A(sensor)	Test setup path loss calibration
Signal Generator	Agilent	ESG-D3000A	Test setup path loss calibration
UWB Device	HyperLabs Inc	HL9200	Interference source

3.1.1 Base Station/Mobile Station

The base station signal was generated by a commercial Base Station compliant with the IS-95A Air Interface Standard. The base station was configured as a single sector. The phones used in the testing were commercial equivalent PCS phones enabled with the gpsOne™ technology. The phones were complaint with the IS-95A CDMA Air Interface Standard. The phones were programmed/tuned to receive and transmit on PCS channels 500 and the base station was also configured to transmit on PCS channel 500 for all tests. A position location session was initiated from the mobile using standardized service negotiation call (Service Option 36).

3.1.2 UWB Pulse Generator Module

QUALCOMM contacted several UWB companies in order to buy or borrow an UWB pulse generator module. All the companies contacted declined the request due to lack of resources. QUALCOMM subsequently decided to buy the HL9200 pulse generator module from HyperLabs Inc. The HL9200 has the following listed features:

Rise time: 35 pico seconds
Fall time: 50 pico seconds
Duration: 70 pico seconds
Output Amplitude: 2 V minimum
Trigger rate: DC to 20 MHz
Trigger input: 0 to +5, Schmitt Trigger at +2V

The time-domain structure of UWB signals are such that emission bandwidths are very large and could overlap many licensed wireless bands. The output of the pulse generator captured by a sampling oscilloscope is shown Figure 3-1.

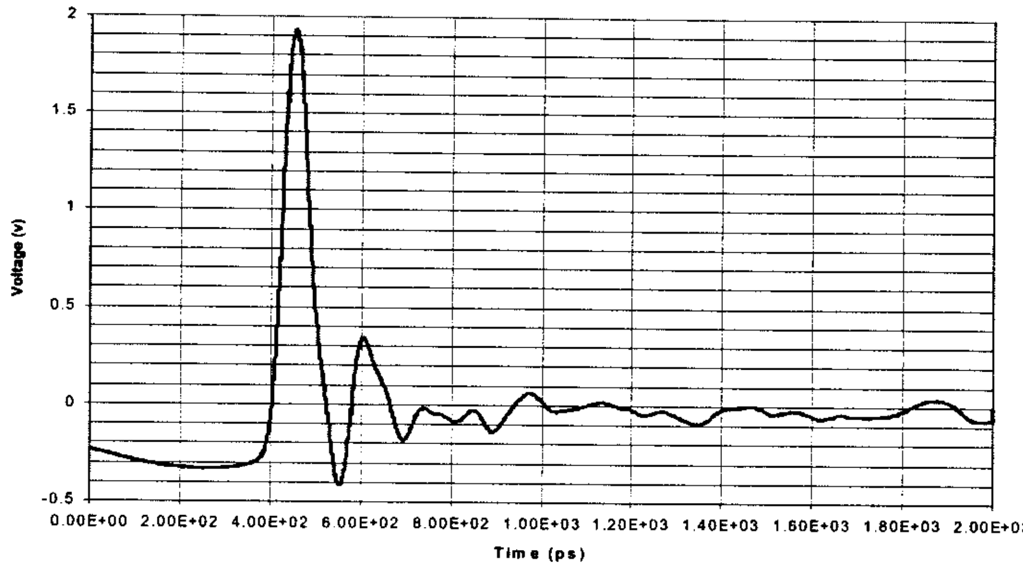

Figure 3-1: UWB Pulse Shape

3.2 Test Setup

The test setup consisted of a live GPS satellite feed injected into a test phone and a reference phone via an RF Matrix as shown in Figure 3-2. Since the satellite geometry was dynamic, the second phone was needed to act as a reference. Both phones were connected to the serial port of 2 separate PCs. The GPS messages were logged on the PCs using a Qualcomm developed tool QXDM (Qualcomm Extensible Diagnostic Monitor). Both PCs had automation software running on them to facilitate remote control of test equipment and synchronized data logging. The test phone data was compared to the reference phone data to quantify the performance in the presence of UWB interference. The tests were performed in a conducted environment with the phones placed in isolation boxes to prevent any unintentional interference from skewing the test results.

Each RF path was calibrated using a CW tone injected at one end of the path and the power measured at the other end using a power sensor. The calibration reference was defined at the output of the GPS feed, the output of the UWB module and the input to the phone antenna ports. This reference is labeled "CAL REF" in Figure 3-2. The measured calibration factors for paths used in the testing are summarized in Table 3. The programmable attenuator was set to 0 dB during the calibration. The entire lab setup is shown in Figure 3-3 and Figure 3-4.

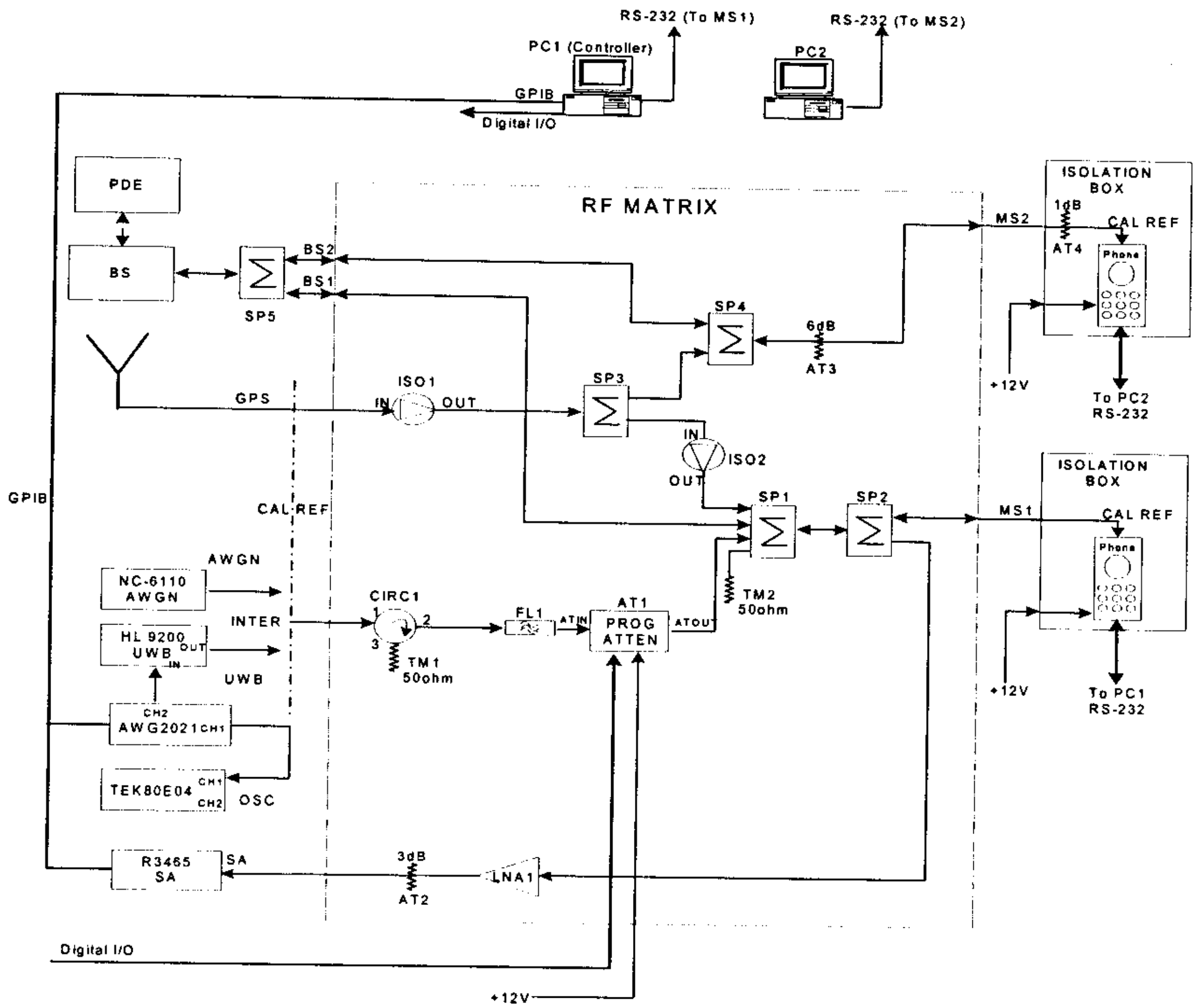

Figure 3-2: Test Setup

Table 2: RF Parts List

Ref	*Description*	*Manufacturer*	*Qty*
AT1	Programmable attenuator	Weinschel	1
AT2	3dB attenuator	n/a	1
AT3	6dB attenuator	n/a	1
At4	1dB attenuator	n/a	1
CIRC1	Circulator, 1.25-2.5GHz	UTE Microwave	1
ISO1,ISO2	Isolator, 1.25-2.5GHz	UTE Microwave	2
FL1	GPS 20 MHz bandpass filter,	ComNav Engineering Inc.	1
LNA1	LNA, 10Mhz-3000Mhz,G=18 NF=3dB, Po1dB=9.7dBm	Mini-Circuits	1
SP1	Splitter, 4 way, 0.5-2Ghz	KDI Triangle	1
SP2,SP3,SP4,SP 5	Splitter, 2 way, 0.5-2Ghz	KDI Triangle	3

Table 3: Measured Path Gain

Path		*Path Gain (dB)*	*Calibration Frequency(MHz)*
From	*To*		
GPS	MS1	-15.4	1575.42
GPS	MS2	-15.4	1575.42
INTER(UWB)	MS1	-19.3	1575.42
INTER(UWB)	MS2	< -80	1575.42

Figure 3-3: Lab Setup

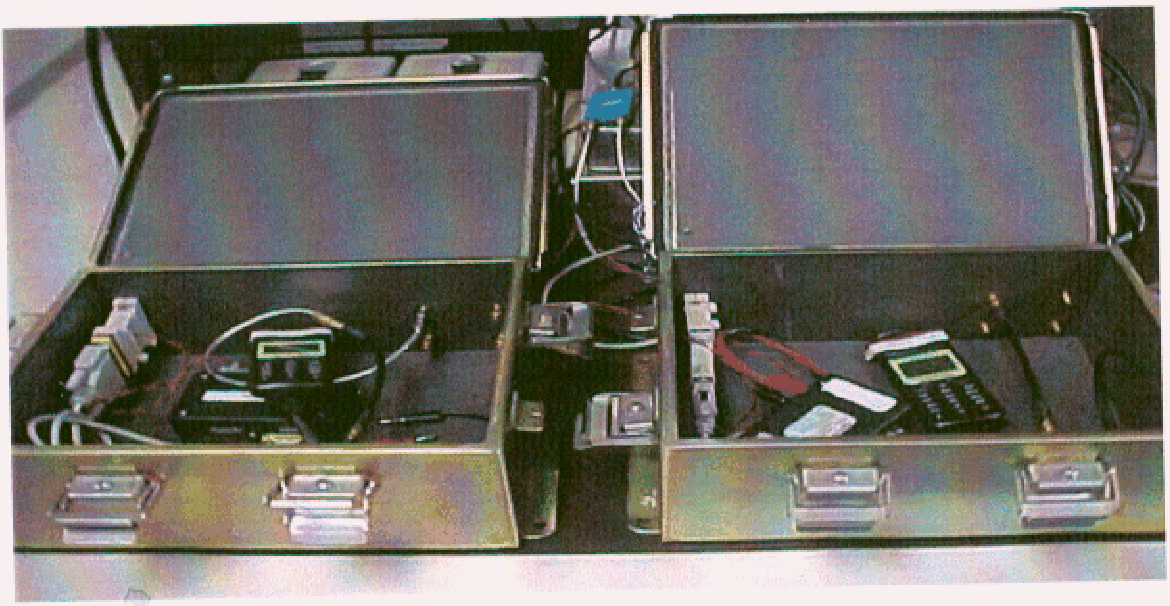

Figure 3-4: Phone in Isolation Box

3.3 Test Cases

The gpsOne™ receiver was characterized in the presence of UWB interference using the combinations specified in Table 4. The UWB power was swept for each combination of UWB parameters given in the table for a total of 8 tests. All tests were performed in a controlled conducted environment.

Table 4: Test Cases

Parameter	Value
PRF (MHz)	1, 5,15,17.5
Modulation	UPS (uniform pulse spacing), dither

3.4 UWB Power

The UWB power was swept from -112 dBm per 2 MHz to -92dBm per 2 MHz[1] as measured at the phone antenna port. The output of the UWB module was calibrated using the channel power option of the spectrum analyzer. The power was measured in 1 MHz and 2 MHz bandwidths for each UWB PRF and modulation scheme. These values were stored in a table for use by the automation software. The absolute interference power in a 2 MHz bandwidth was set at the input of the phone antenna port by using the pre-stored UWB power and applying the appropriate UWB to phone path loss factor and adjusting the programmable attenuator. The spectrum analyzer was pre-calibrated against a power meter in the frequency range 1570 MHz to 1580 MHz to ensure accurate absolute power levels.

Note that although the UWB power is set in a 2 MHz bandwidth, most of the data presented in the subsequent sections has been translated to 1 MHz bandwidth by using empirical correction factors. This facilitates comparison with FCC emissions limits.

3.5 UWB Waveform Generation

The UWB module was triggered using the Tektronix AWG2021 waveform generator. The trigger waveform for the UPS (uniform pulse spacing) and dithering cases was generated using the procedure described in a previous filing[2].

3.6 Live GPS Constellation

An amplified GPS signal from the output of an external GPS antenna having a clear view of the sky was fed into the test lab. The external antenna was located on the rooftop of one of the Qualcomm buildings and the coaxial feed was run into the test lab. The GPS signal was attenuated using a step

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[1] 2 MHz is the proposed bandwidth for receivers utilizing the gpsOne™ technology as specified in the 3GPP2 *Recommended Minimum Performance Specification for IS801-1 Spread Spectrum Mobile Stations*

[2] Report on PCS phones by Qualcomm Incorporated (filed March 8, 2001)

attenuator to bring it down to levels emulating an indoor or in-vehicle environment having favorable channel conditions (i.e. with no multipath). This attenuated signal was then injected into the RF test setup.

Through extensive field testing, QUALCOMM was able to characterize the C/No within buildings to be around 34dB-Hz 95% of times. GPS measurements collected inside vehicles demonstrated similar behavior. The cumulative distribution function of in-vehicle C/No indicates that 82% of the time C/No will be less than 34 dB-Hz. The attenuator was adjusted until approximately the same C/No was observed in the lab setup.

3.7 Baseline Phone Measurements

To ensure that the Test and Reference phones had identical performance, GPS data was simultaneously collected on the two phones in the absence of any interference. The cumulative distribution function of position error and C/No for the two phones is shown in Figure 3-5 and Figure 3-6. From these plots we can clearly see that the two receivers perform almost identically.

3.8 Spectrum Analyzer Plots

The UWB emissions in the GPS L1 band (1575.42 MHz) for the dithered and UPS (uniform pulse spacing) UWB case are shown in Figure 3-7 and Figure 3-8, respectively. The spectrum analyzer resolution bandwidth was set to 10 kHz. The plots are shown for a PRF of 1 MHz. For the UPS case, two spectral lines separated by 1 MHz are clearly visible. The dithered spectrum exhibits no spectral lines indicating that the dithering used was sufficient to whiten the data within the GPS band.

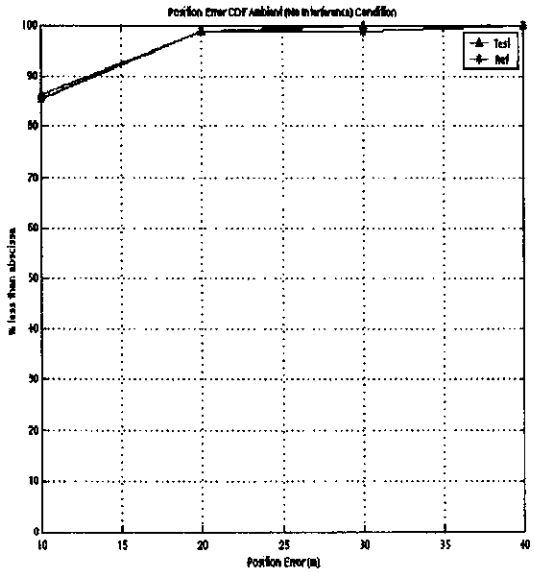

Figure 3-5: Baseline Position Error CDF

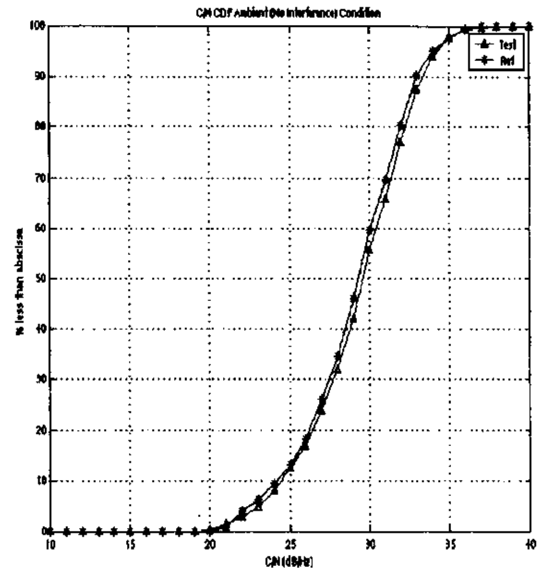

Figure 3-6: : Baseline C/No CDF

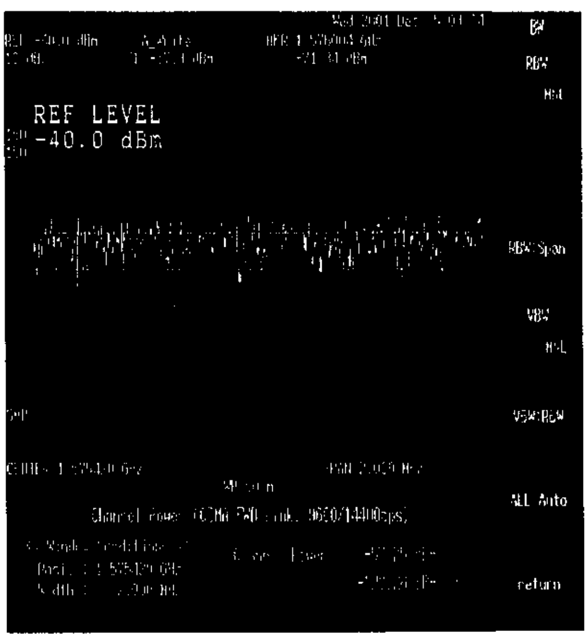

Figure 3-7: PRF 1MHz dithered in GPS Band

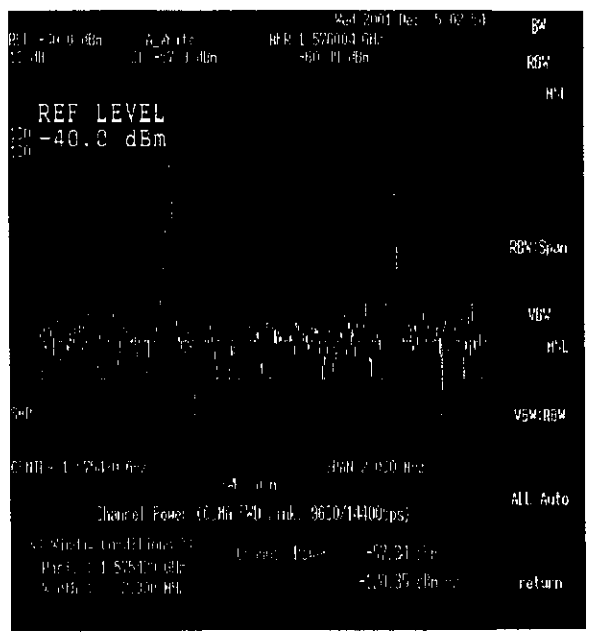

Figure 3-8: PRF 1MHz UPS in GPS Band

4. Impact on gpsOne™ Receivers

This section discusses the experimental data collected in the laboratory. In all the plots it should be noted that each curve is a separate test case taken at different time and hence, under different GPS satellite geometry. As a result, for the same average UWB power, the position errors can be slightly different for different test cases. No attempt should be made to infer the GPS performance as a function of UWB PRF or modulation. At times, the plots are separated into UPS and Dither cases for visual clarity only.

4.1 UWB Impact versus Time

Figure 4-1 shows the impact of UWB interference as a function of time. This plot uses PRF 1MHz UPS at -96dBm per 2 MHz. The x-axis depicts the call number (each call is an independent GPS fix). The left y-axis shows the position error for a given GPS fix and the right one shows the number of visible satellites for the given fix. The position error and the satellites visible are plotted as function of call number. The reference phone data is also shown for comparison. From the plot we see that the test phone has an extremely large spread in position errors (uppermost curve) and the number of visible satellites ranges from 1 to 4 (lowermost curve). In contrast, for the reference phone, the position error is close to 10 meters in most of the samples and the number of visible satellites ranges from 8 to 10. This plot clearly exhibits the adverse impact of the UWB device on the test phone.

Note that the ~800 meters position error is a default value that is returned by the location server when it does not have sufficient information to obtain a position measurement. Hence, this reported error means that there were no enough measurements to determine a position.

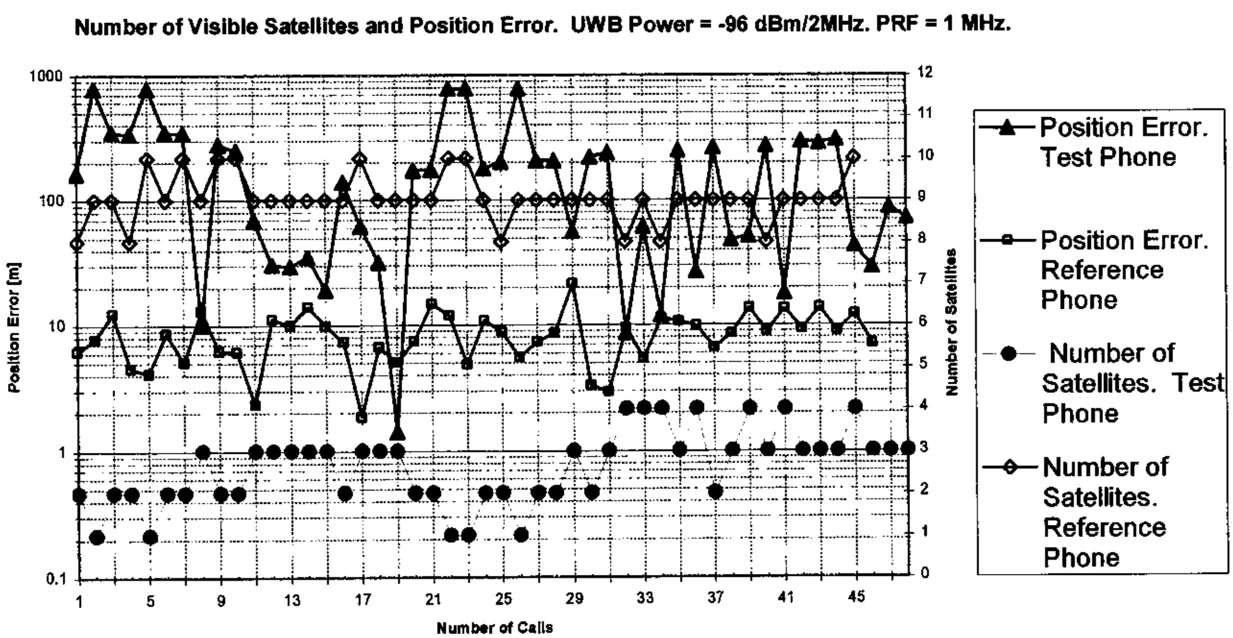

Figure 4-1: UWB Impact versus time

4.2 Position Error

The error in positioning as a function of UWB power is shown in Figure 4-2 and Figure 4-3 for the UPS and dithering cases, respectively. These plots are for the 50th percentile position error, *i.e.*, at a given UWB power level, 50% of the times the position error will exceed the measured error at that power as shown in the plots. For example, for 1 MHZ PRF at-96dBm per 2 MHz, the position error will exceed 175 meters in 50% of the calls. In contrast, the reference phone error is around 6 meters. Note that these plots show the UWB power expressed in dBm per 2 MHz.

Position error versus UWB power plots are converted to GPS-UWB separation distance using the free space model. The UWB power levels are converted from dBm per 2 MHz to dBm/MHz using empirical correction factors obtained from the spectrum analyzer. The UWB is assumed to be transmitting at the FCC Part 15 limit of -41.3dBm/MHz and both UWB and GPS antenna gains are assumed to be 0dBi. The resulting position error versus separation distance plots are shown in Figure 4-4 and Figure 4-5 for the UPS and dithering cases, respectively. An examination of these plots shows that as the UWB device gets within 75 meters from the victim receiver there will be a noticeable degradation in the noise figure. A sharp degradation in positioning performance, to the extent of not meeting the FCC mandated requirements, will start to happen when the UWB device is as far as 14.5 meters from the GPS receiver.

Figure 4-6 through Figure 4-9 show the power level and separation distance to achieve a position error of 50 meters or 150 meters in 50% of the calls. For 15MHz dithering case, and a UWB power of -100.9dBm/MHz at the GPS receiver, 50% of the calls will produce an error exceeding 50 meters. Alternatively stated, a UWB transmitter located 14.5 meters away from a GPS receiver can result in positioning errors greater than 50 meters in 50% of the calls. Similarly, at a UWB received power level of -100dBm/MHz (corresponding to 12.9 meters separation), the same UWB device can result in position errors greater than 150 meters in 50% of the calls. This clearly violates the FCC E-911 mandate. What this means is that one out of every two Safety of Life 911 calls is likely to fail the FCC mandate if a UWB device is located 12.9 meters away from the GPS receiver.

Although the functionality of E-911 complaint handset is impacted at distances of 12.9 meters, the actual RF degradation occurs much sooner as exhibited by Figure 4-10. If a maximum noise figure degradation of 1dB is allowed, a UWB device transmitting with an EIRP of -41.3dBm would need to be more than 75 were to consider the nearest emitters, the aggregation effect could significantly raise the noise floor of the GPS receiver, thus rendering it useless in making any emergency calls.

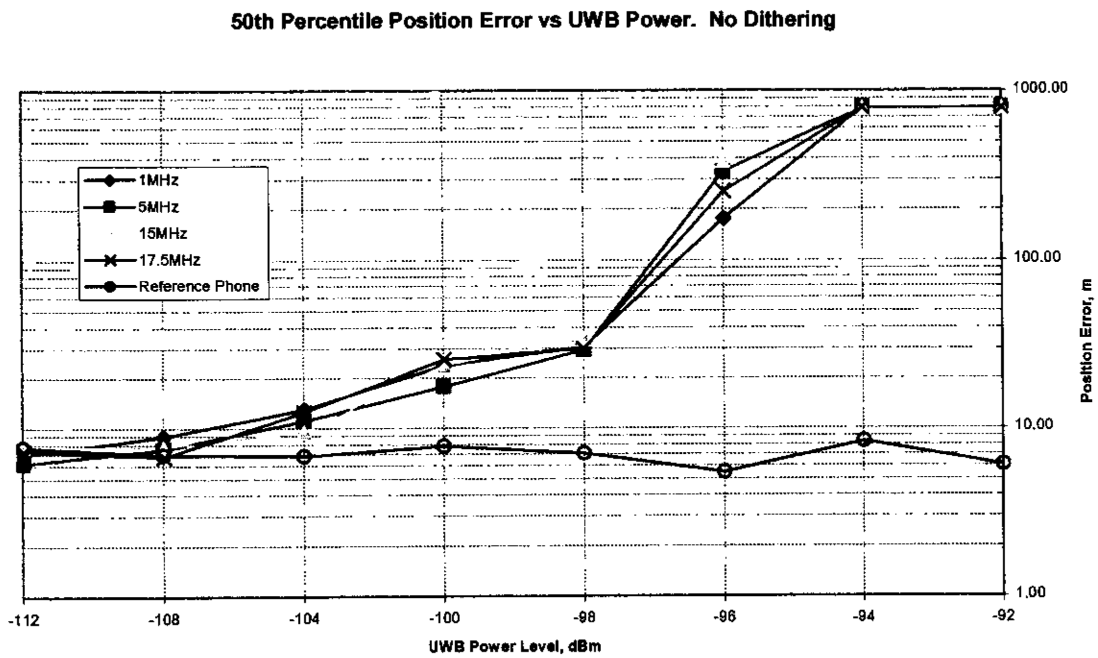

Figure 4-2: Percentile Position Error Vs UWB Power in dBm per 2MHz, UPS

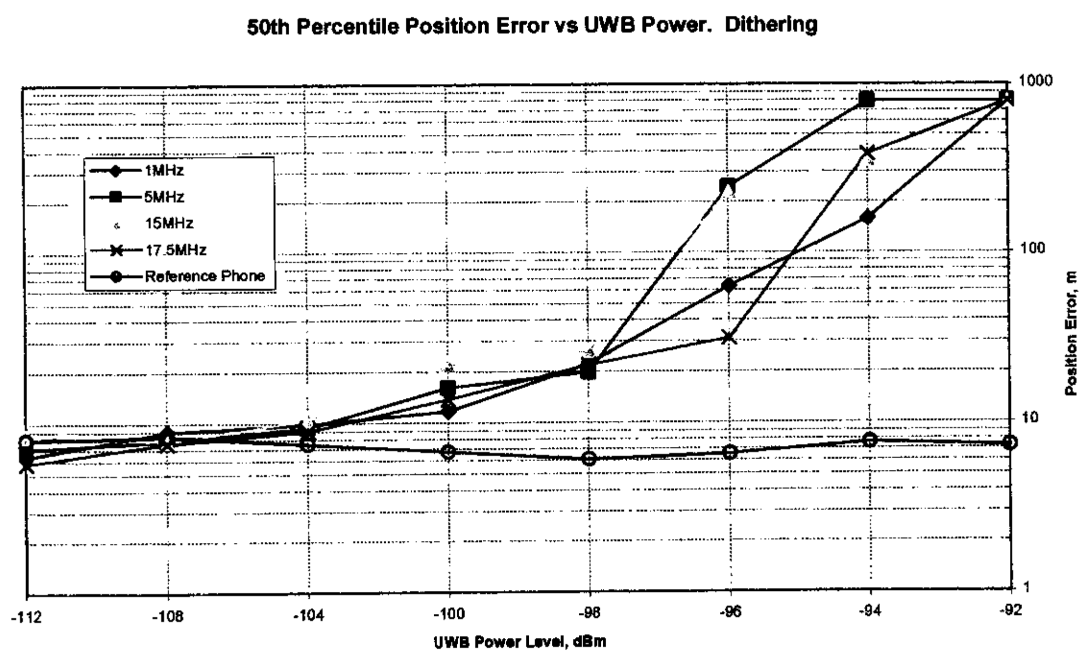

Figure 4-3: 50th Percentile Position Error Vs UWB Power in dBm per 2MHz, Dithering

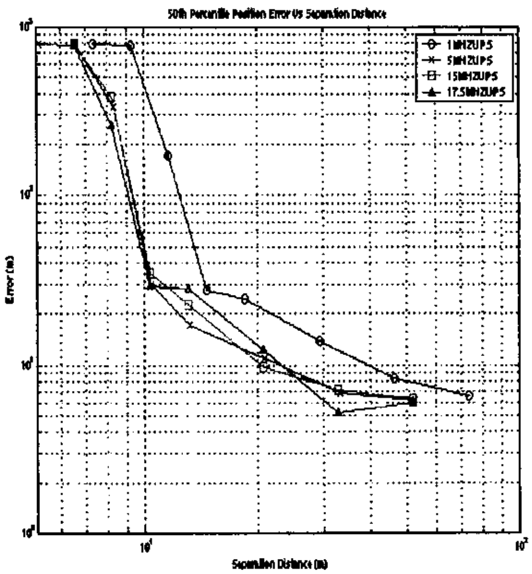

Figure 4-4: 50th Percentile Position Error Vs UWB-GPS separation distance, UPS

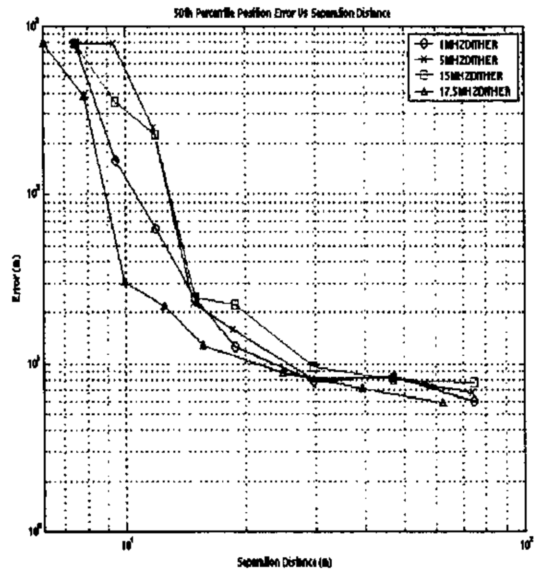

Figure 4-5: 50th Percentile Position Error Vs UWB-GPS separation distance, Dithering

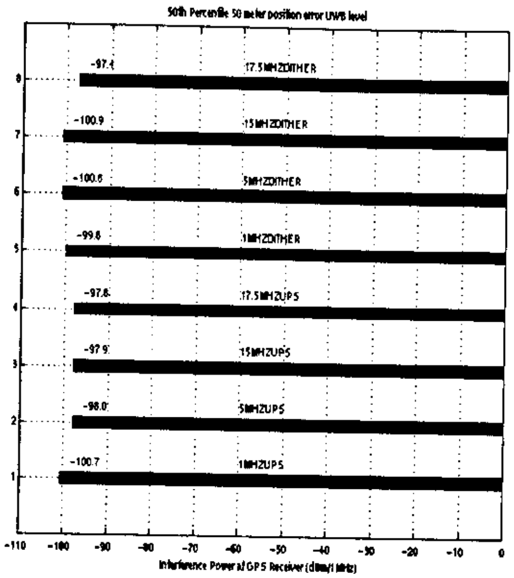

Figure 4-6: UWB power for 50m error 50% of times

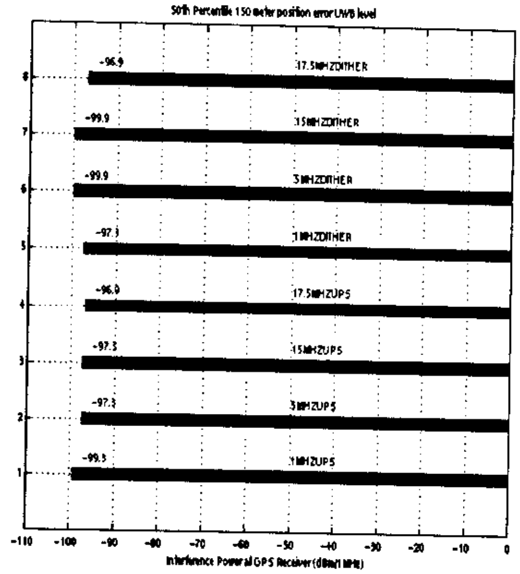

Figure 4-8: UWB power for 150m error 50% of times

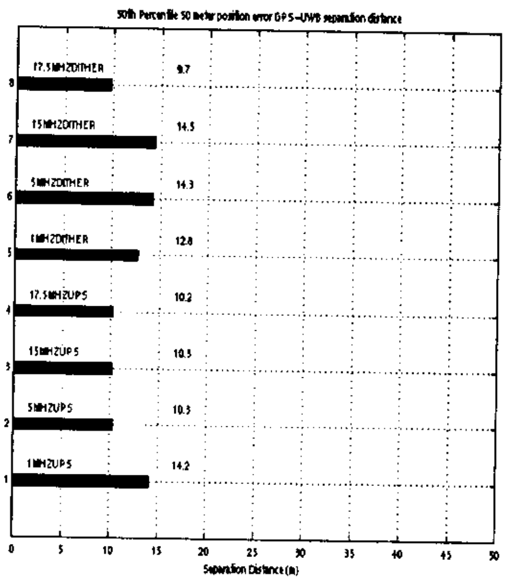

Figure 4-7: UWB-GPS separation distance for 50m error 50% of times

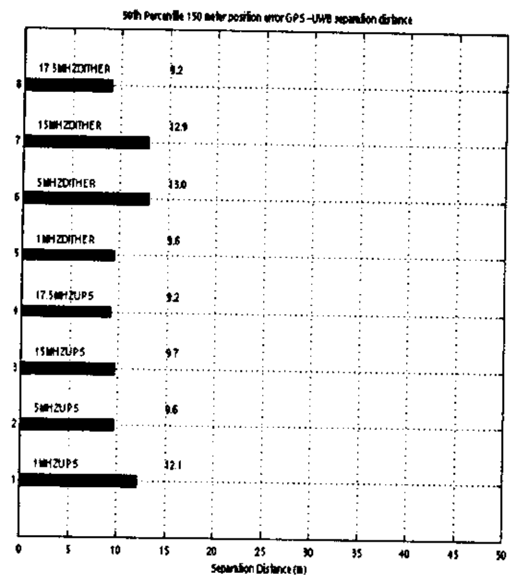

Figure 4-9: : UWB-GPS separation distance for 150m error 50% of times

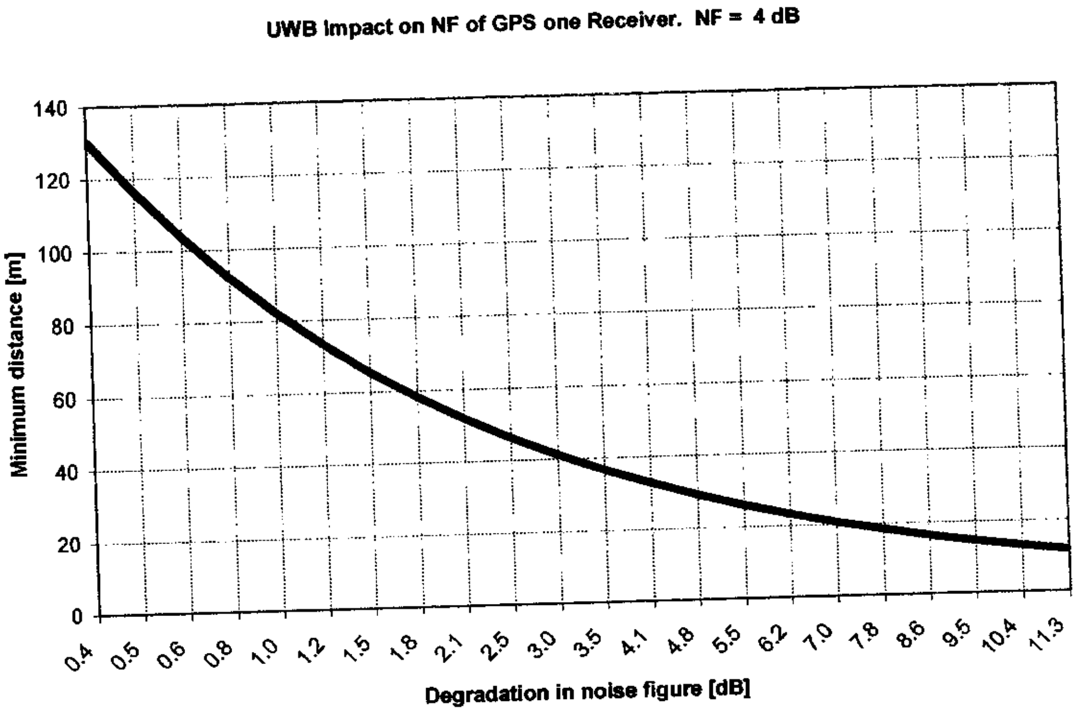

Figure 4-10: Theoretical noise figure degradation versus UWB-GPS separation

4.3 Satellite Availability (Yield)

Figure 4-11 through Figure 4-14 shows the satellite availability of the strongest 4 satellites as a function of UWB power. For each UWB power level, the strongest 4 satellites were first found in the test phone data. By strongest, we mean those satellites that were visible (detected) most often during the course of sample collection. The cumulative detection rate of the 4 satellites is referred to as Satellite Availability or % Availability. Next, the detection rates of the same 4 satellites are found in the reference phone data to obtain the reference satellite availability. A sample scatter plot of the detection rate for PRF 17.5 MHz dithering, -98dBm/2MHz is shown in Figure 4-15. The x-axis of this plot shows the satellite number (SVPRN) and the y-axis shows the detection rate. The strongest 4 test phone satellites numbers are [9,23,29,4] with corresponding detection rates of about [100,100,90,60]%. Thus, the satellite availability in this case is 87.5%. In contrast, the same 4 satellites are visible by the reference phone close to 100% of the times.

For the reference phone, the availability is almost 100% for most of the test cases. During the same period, the test phone exhibits a significant reduction in satellite availability due to the excess noise generated by UWB. This reduction directly translates to (a) Reduction in yield and (b) Degradation in location accuracy.

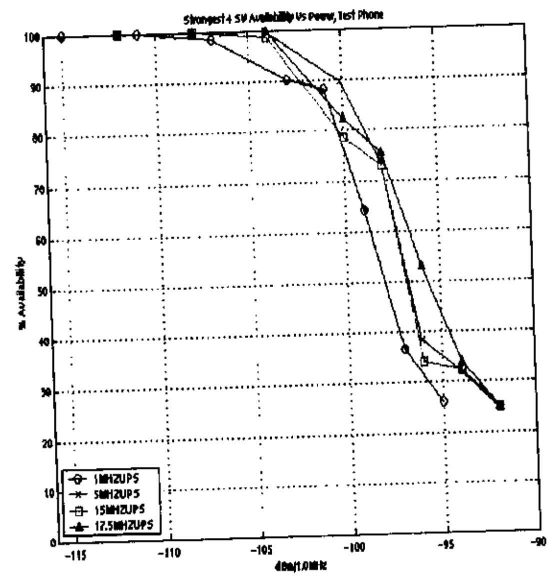

Figure 4-11: Test Phone SA, strongest 4 sats, UPS

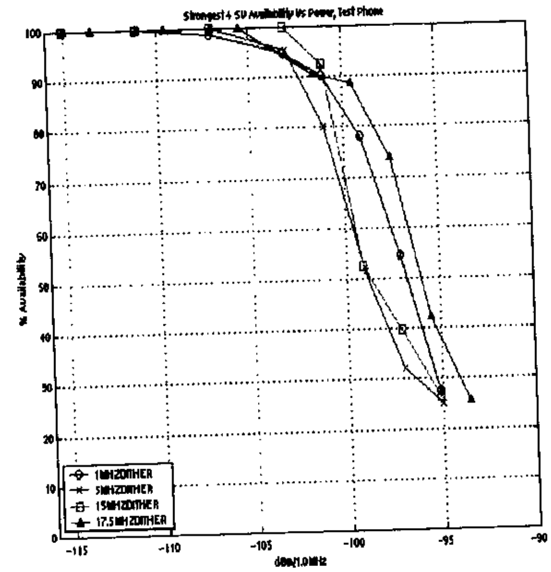

Figure 4-13: Test Phone SA, strongest 4 sats, Dither

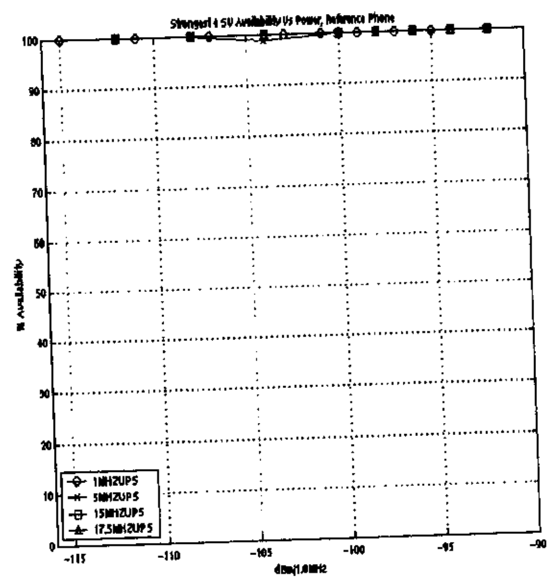

Figure 4-12: Ref Phone SA, strongest 4 sats, UPS

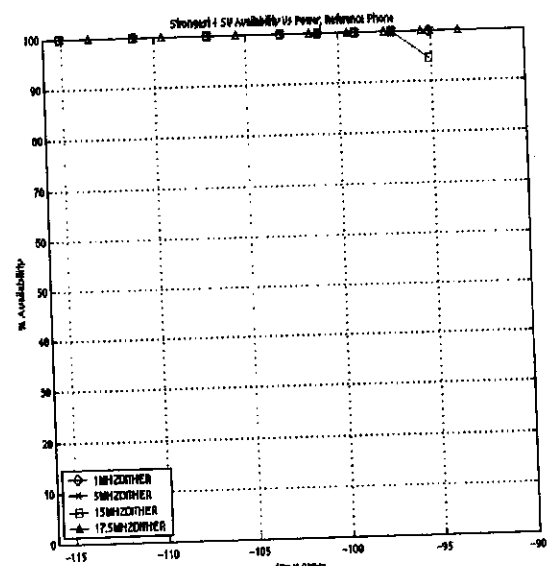

Figure 4-14:Ref Phone SA, strongest 4 sats, Dither

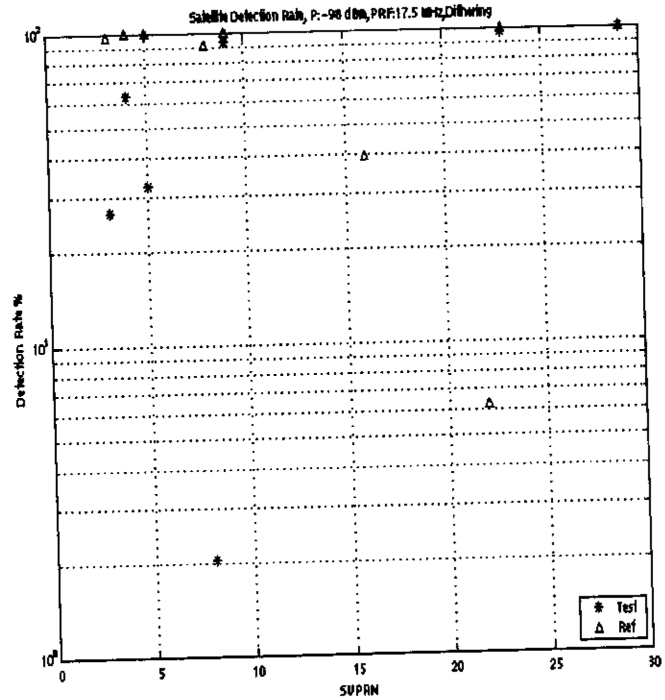

Figure 4-15: Satellite Detection Rate: PRF 17.5MHz Dither, Power = -98dBm/2MHz

4.4 C/No Degradation

The phone estimated C/No ratio at the antenna port is shown in Figure 4-16 and Figure 4-17 for the test and reference phones respectively. The reference phone C/No varies from around 31dB-Hz to 35dB-Hz at the antenna port. In the presence of UWB interference, the noise floor of the test phone is substantially raised causing a reduction in C/No ranging from less than 20dB-Hz to 33dB-Hz. The C/No degradation for the test phone is obtained by taking the difference of the test and reference phones C/No for each test case. This degradation as a function of UWB power is shown in Figure 4-18. This is equivalent to the degradation in noise figure of the GPS receiver. From the figure it is evident that even at power levels as low as -115dBm/1 MHz, there is about 1dB loss in C/No. A theoretical plot of the noise figure degradation in shown in Figure 4-19. The empirical degradation for PRF 1 MHz UPS is shown on the same plot for comparison.

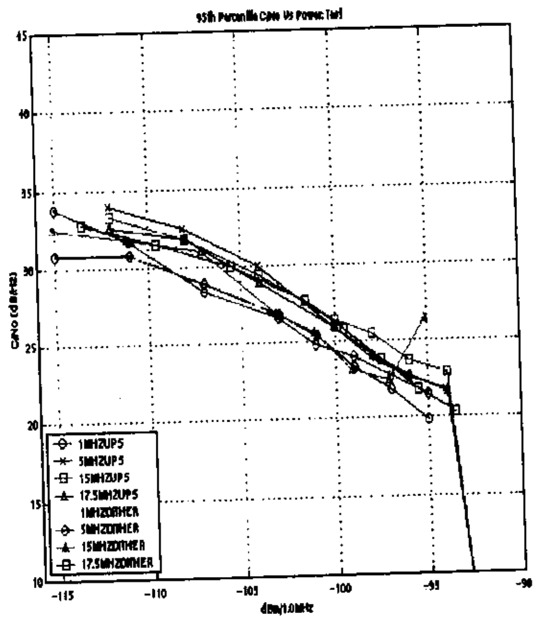

Figure 4-16: Test Phone C/No

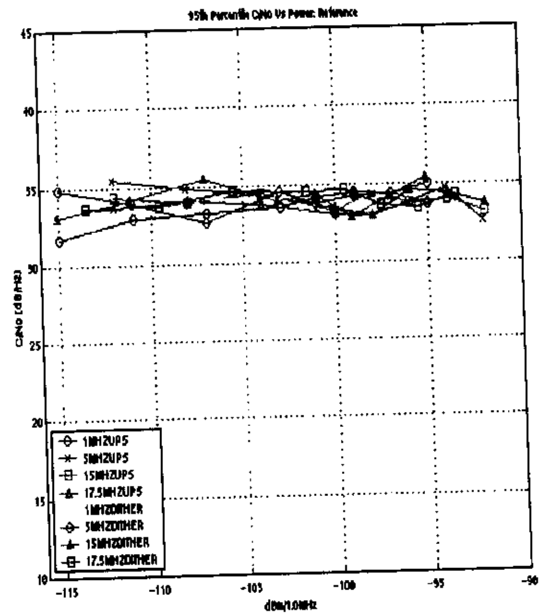

Figure 4-17: Reference Phone C/No

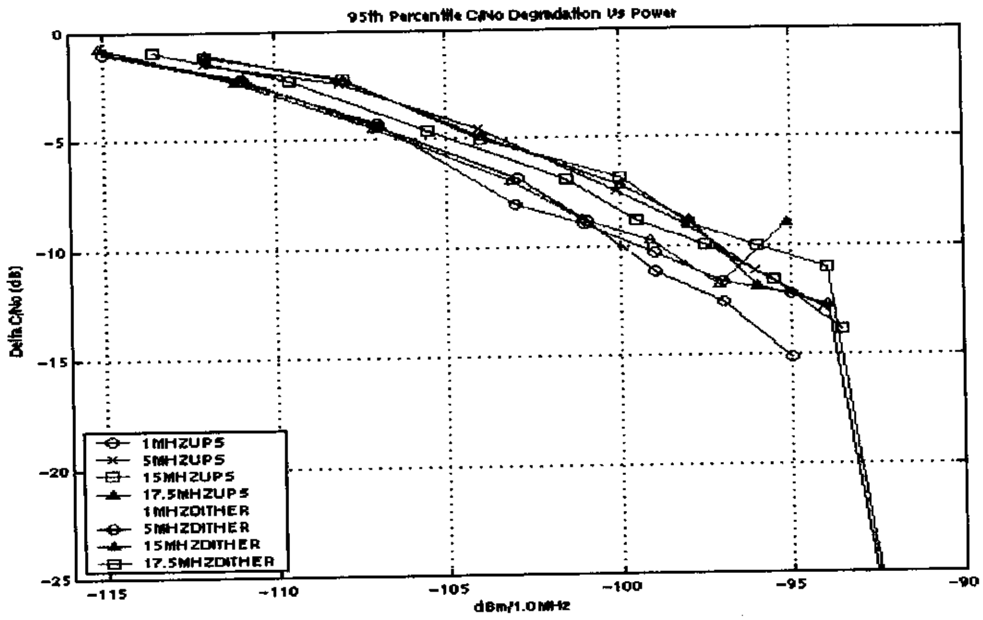

Figure 4-18: C/No degradation

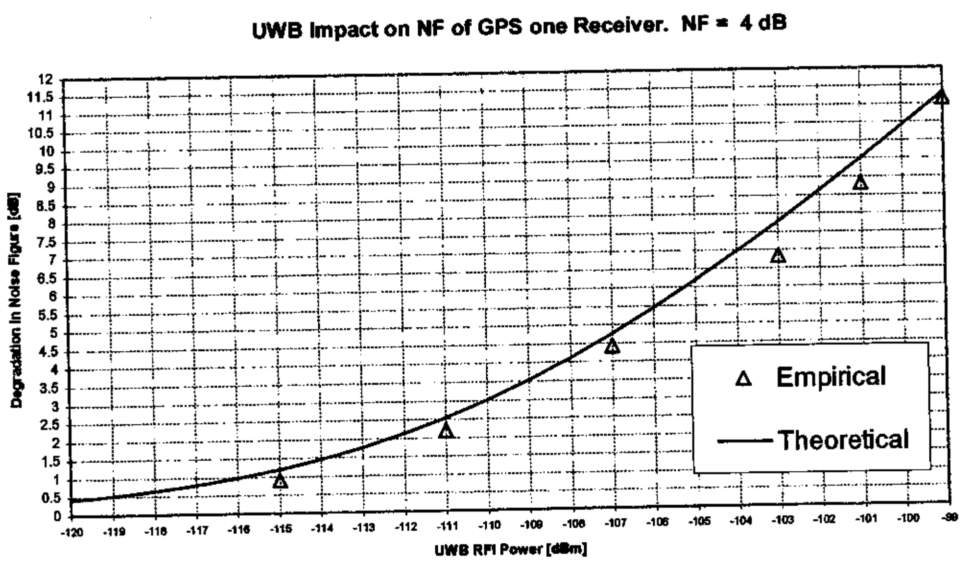

Figure 4-19: Theoretical noise figure degradation vs. UWB power

5. Conclusion

The FCC must not permit UWB operation within the GPS band until significant steps have been taken to limit the UWB emissions, and empirical testing conclusively proves that there will be no further system degradation.

The tests conducted by QUALCOMM clearly show that UWB emissions adversely impact the performance of the gpsOne™ system. Summarizing the results from the preceding sections, the interference from a single UWB device degrades performance in the following ways:

1. Raises the effective noise floor of the gpsOne™ receiver
2. Significantly reduces the satellite availability
3. Negatively impacts position accuracy
4. Degrades the C/No even at UWB receive power levels as low as -115dBm/MHz (corresponds to 75 meter away from Part 15 Class B device)

For Public Safety systems such as E-911, obtaining the GPS user's location is of utmost importance. The test data demonstrates that a UWB device located 12.9 meters away from a GPS receiver, can cause position errors greater than 150 meters in 50% of the calls. One out of every two Safety of Life 911 calls is likely to fail the FCC mandate if a UWB device is located 12.9 meters away from the GPS receiver. Since it is envisioned that the UWB devices will be used for short range communication in various handheld devices, a separation distance of 12.9 meters is very plausible. In addition to the positioning degradation, the RF performance of the GPS receiver degrades much sooner. A UWB device would need to be more than 75 meters away to cause a 1 dB degradation of the GPS receiver noise figure. QUALCOMM has invested huge engineering efforts and substantial sums of money to reduce the noise figure of it's enhanced GPS receiver to ensure optimal performance of E-911 in indoor and in-vehicle environments. It would be iniquitous to have unlicensed devices operating within the GPS band and taking away the design margin that was put in place to ensure a more sensitive and robust location determination system.

The QUALCOMM tests performed only considered a single UWB emitter. QUALCOMM is concerned that the aggregation of many of these devices will further degrade the performance of the gpsOne™ system by raising the noise floor even more. Permitting UWB devices to be commercially marketed on an unlicensed basis will result in a large proliferation of non-policed devices all having adverse effects on Safety of Life systems. If at a later date it is determined that these UWB devices degrade systems more than is currently presented in the proponent's studies, the task of recalling them would be extremely daunting if not entirely impossible. Once marketed to the general public, it is virtually impossible to police the operation of these devices.

QUALCOMM urges the Commission not to modify the Part 15 rules until all the questions regarding the impact of UWB devices on safety of life and other wireless services are fully and thoroughly answered.