Before the
Federal Communications Commission
Washington DC 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's Rules	)	ET Docket 98-153
Regarding Ultra-Wideband Transmission	)	
Systems	)	

OPPOSITION TO PETITIONS FOR RECONSIDERATION

Mitchell Lazarus
FLETCHER, HEALD & HILDRETH, P.L.C.
1300 North 17th Street, 11th Floor
Arlington, VA 22209
703-812-0440
Counsel for XtremeSpectrum, Inc.

July 31, 2002

TABLE OF CONTENTS

Before the
Federal Communications Commission
Washington DC 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's Rules	)	ET Docket 98-153
Regarding Ultra-Wideband Transmission	)	
Systems	)	

OPPOSITION TO PETITIONS FOR RECONSIDERATION

Pursuant to Section 1.249(f) of the Commission's Rules, XtremeSpectrum, Inc. hereby opposes the Petitions for Reconsideration of the Commission's First Report and Order[1] (collectively, "Petitions") filed by the following parties: Aeronautical Radio, Inc. and the Air Transport Association of America, Inc.; Cingular Wireless LLC; Multispectral Solutions, Inc.; Qualcomm Inc.; Satellite Industry Association; Sirius Satellite Radio Inc. and XM Radio Inc.; and Sprint Corp.[2]

On July 22, 2002, XtremeSpectrum filed a timely Motion for Leave to Exceed Page Limit with respect to this filing.

I. SUMMARY

This has been a long and demanding proceeding. From initiation to First Report and Order took 44 months. When the Commission finally adopted the First Report and Order, the docket held over 900 filings, many of them lengthy technical studies and responses. Dozens of

---

[1] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems,* 17 FCC Rcd 7435 (2002) (First Report and Order).

[2] XtremeSpectrum manufactures ultra-wideband communications systems as its sole business, and takes no position on ultra-wideband radar applications. In particular, XtremeSpectrum takes no position on the reconsideration petitions filed by American Gas Ass'n and American Public Gas Association; GPR Service Providers Coalition; Ground Penetrating Radar Industry Coalition; Kohler Co.; National Utility Contractors Association; Siemens VDO Automotive AG; and Time Domain Corp.

parties reported on scores of meetings with Commission staff. The First Report and Order ultimately ran to 118 single-spaced pages.

Now the Petitioners claim this work is inadequate. They allege the Commission ignored parts of the record, provided inadequate analysis, and failed to explain its rules. They say the Commission violated licensees' rights; promulgated an irrational rule; and set UWB limits that will cause interference with several services.

At the outset, however, we note that no Petitioner contests the strong public interest in UWB. And none, at least in principle, disputes the long-settled rule of deference to the Commission's decisions, especially on technical issues. So long as the Commission considers the record, applies reasoned standards, and explains its decision, then the decision must stand. Here, the Commission has amply met all of the requirements.

The petitioning PCS carriers, however, allege the Commission failed in carrying out its obligations. They say it provided an inadequate analysis of interference; it irrationally set the UWB limit higher for indoor than for outdoor operation (even though PCS signals are weaker indoors); and it infringed on carriers' exclusive licenses. Several other Petitioners allege UWB will cause interference into their respective services.

Adequacy. The PCS carriers criticize the Commission's interference analysis as inadequate, but they really seek to fault the result. The Commission's treatment is detailed and thorough, taking up and addressing each major result from all the submitted studies. The PCS carriers may disagree with the Commission's explanations, but they cannot deny that the explanations exist.

Rationality. The PCS carriers object to the Commission's assigning higher emissions limits for indoor units than for handhelds. This is irrational, they say, because indoor PCS handsets receive less signal, and so need a lower UWB limit for protection. But the Commission showed that the indoor (higher) limit is adequate to protect PCS under all realistic conditions, including indoor PCS use. The lower limits for handhelds were established to protect not PCS, but Federal systems on both sides of the PCS band. Again, the PCS carriers may dislike the result, but they cannot fault its rationality.

Exclusivity. The PCS carriers claim that UWB operation in the PCS band violates their exclusive licenses to those frequencies. But that position has several serious problems. First, a recent case in the U.S. Court of Appeals says it is wrong.[3] Second, UWB in fact does *not* operate in the PCS band, but only puts out-of-band emissions there, as do transmitters in many services -- most at much higher permitted levels than UWB. Third, the PCS carriers knew when they placed their spectrum bids that the Commission allowed even intentional Part 15 emissions in the PCS band, at levels far higher than UWB. The carriers presumably valued the spectrum accordingly.

Technical issues. Finally, several petitioners allege potential interference to their services from UWB. But none of these have merit, and for the same reason: Each argues from hypothetical conditions that cannot arise in practice. Whatever their theoretical value, these arguments have no bearing on real-world operation.

In short, the Commission did its job well. The rules for UWB communications devices are technically sound, well reasoned, thoroughly explained, and serve the public interest. The

---

[3] *AT&T Wireless Services, Inc. v. FCC*, 270 F.3d 959, 964 (D.C. Cir. 2001).

Petitioners have not presented either factual or legal grounds for reconsideration. The Commission should let the rules stand.

II. INTRODUCTION

A. The First Report and Order Is Supported by Statutory Mandate.

All but one of the Petitions assert that UWB communications devices pose a risk of interference to licensed services.[4] But none of the Petitions supports its claim. The rules adopted in the First Report and Order adequately constrain UWB devices and eliminate any realistic threat of interference.

Innovation in every field faces opposition. When those who now contest UWB first sought to bring the benefits of their own technologies to the public, many had to overcome opposition from then-incumbents who feared competition, interference, or both. Over time, of course, each of those innovators was able to show the concerns of their opposition were overstated. UWB expects to do the same.

Congress recognizes that innovation is vulnerable even to unfounded opposition. Accordingly, it established a national policy in favor of new communications technologies:

> It shall be the policy of the United States to encourage the provision of new technologies and services to the public. Any person or party (other than the Commission) who opposes a new technology or service proposed to be permitted under this chapter shall have the burden to demonstrate that such proposal is inconsistent with the public interest.[5]

---

[4] The other Petition, filed by UWB developer Multispectral Solutions, Inc., seeks a redefinition of UWB devices to exclude devices it alleges (incorrectly) are especially interfering, including those manufactured by XtremeSpectrum. We respond in Section IV.G, below.

[5] 47 U.S.C. Sec. 157(a).

This statute also answers Petitioners' claims that the Commission misapplied the burden of proof. In Petitioners' view, the Commission required opponents to show interference, rather than requiring UWB to show lack of interference.[6] We disagree with this characterization: The Commission pressed both sides to make their cases. But even if Petitioners were correct as to the Commission's allocation of the burden, they would have no basis for complaint. The statutory language places the burden of showing harm squarely on the opponents.

As we show in detail below, the Petitioners have failed establish any significant defect in the First Report & Order, on either legal or technical grounds, that would justify reconsideration. The Commission should leave the rules for communications UWB device unchanged.

B. Ultra-Wideband Is in the Public Interest.

The first generation of UWB communications devices (as implemented by XtremeSpectrum) will reliably carry 100 megabits per second over a range of 10 meters, with extremely low power consumption, at a very low equipment cost. We expect the second generation to reach 500 Mbps/sec. No other wireless technology can provide this combination of data speed and battery life at *any* cost. Bluetooth is far slower, at 1 Mbps/sec. Wi-Fi (802.11b) can reach 11 Mbps/sec, but that is still too slow for reliable video; and Wi-Fi takes far more battery drain than UWB. The "digital modulations" recently authorized in ET Docket No. 99-231 may eventually run several times faster than Wi-Fi,[7] but their power consumption will likewise remain too high for most handheld wireless devices.

---

[6] Sprint at 8-10; Qualcomm at 6.

[7] *Spread Spectrum Devices*, ET Docket No. 99-231, Second Report and Order, FCC 02-151 (released May 30, 2002).

The first consumer application for UWB is likely to be home video networking, interconnecting the cable or satellite dish access point, TV monitors around the home, and DVDs, VCRs, etc. Other wireless technologies lack the speed to accomplish this. Indeed, the same system can simultaneously accommodate a home computer network, with no loss in performance. The second class of products will provide wireless interconnection capability for portable devices such as laptops, Palm-type organizers, digital cameras and video recorders, MP3 players, etc. Those applications, too, are presently impossible without UWB, because other technologies with adequate data speed would drain the host device's battery too quickly.

Other near-term applications, including devices for identifying location, will directly benefit public safety users. For example, development of a fire and rescue personnel radiolocation system, which can track and locate individual personnel in hostile environments, will have a positive impact on the national welfare. And this application can to be adapted to other dispersed team operations, such as disaster relief teams and tactical police operations.

All of these applications will also give the U.S. economy a needed boost. American companies are the leading players in UWB, and have staked out a world-leading position. Indeed, the economic promise of this technology is underscored by its continuing ability to attract investment capital even in a market that is generally hostile to new hardware implementations.

UWB also promotes spectrum efficiency. Developing new frequencies is inherently expensive, and increasing conventional spectrum efficiency and re-use offer incremental gains at best. But UWB opens spectrum for tens of millions of new wireless devices for both consumer and public safety users, at low cost levels, with negligible effect on existing services, and without requiring an allocation of dedicated frequencies. Because it can share fully-occupied spectrum

without causing interference, UWB exploits spectrum capacity that would otherwise go unused. The Commission has recognized the public interest benefits of such efficiencies as it confronts severe spectrum shortages and increasing demands for additional spectrum for new and existing wireless services.

In short, UWB is in the public interest. It has earned the Commission's continuing support.

C. The Commission's Determination That UWB Will Not Interfere with Other Services Is Entitled to Great Deference.

The Petitioners' objections to UWB are premised on a presumed risk of interference into their respective services.[8] Conversely, no Petitioner would have a reasoned basis for contesting UWB if did not affect the Petitioner's service. One Petitioner expressly concedes the permissibility of Part 15 use (such as UWB) in a licensed band, provided it creates no harmful interference.[9]

Just last year, the D.C. Circuit upheld the Commission's right to add other users to a licensee's band, provided they do not cause interference. It specifically affirmed the Commission's determination that even an exclusive licensee cannot object to secondary use of its spectrum if no harmful interference results.[10]

No one disputes that UWB is legally unobjectionable if it does not cause interference. The Commission has determined that UWB operation under the rules is non-interfering, and

---

[8] The exception is Multispectral Solutions, Inc. See Section IV.G, below.

[9] Cingular at 3-4.

[10] *AT&T Wireless Services, Inc. v. FCC*, 270 F.3d 959, 964 (D.C. Cir. 2001).

therefore lawful. The Petitioners disagree. The dispute thus turns on the question of who decides the interference issue: the Petitioners or the Commission. Once asked, of course, the question all but answers itself.

A long line of unbroken precedent gives the Commission broad discretion in making its decisions. "If satisfied that the agency has taken a hard look at the issues with the use of reasons and standards, the court will uphold its findings . . . ."[11] The courts consistently emphasize that the agency need only (1) consider the record, (2) apply reasoned standards, and (3) explain its decision.[12] Once those criteria are met, the court will uphold even an agency decision the court itself would not have reached.[13] Certainly nothing in the Petitions can overcome the strong presumption of validity supporting the Commission's determination that UWB operation under the rules will not interfere with other services.[14]

---

[11] *Greater Boston Television Corp. v. FCC*, 444 F.2d 841, 853 (D.C. Cir. 1970).

[12] *Motor Vehicle Mfrs. Ass'n v. State Farm Mutual Auto Ins.*, 463 U.S. 29, 43 (1983) (agency must examine the relevant data and articulate a satisfactory explanation for its action including a "rational connection between the facts found and the choice made"), *quoting Burlington Truck Lines, Inc. v. United States*, 371 U.S. 156, 168 (1962).

[13] *FCC v. National Citizens Committee for Broadcasting*, 4336 U.S. 775, 803 (1978) (court not empowered to substitute its judgment for that of the agency); *Association of Public-Safety Comm. Officials-Int'l v. FCC*, 76 F.3d 395, 398 (D.C. Cir. 1996) (same).

[14] *AT&T Wireless Services, Inc. v. FCC*, 270 F.3d at 962 (deferring to Commission's finding of non-interference). *See also Telecommunications Research and Action Center v. FCC*, 800 F.2d 1181, 1184 (D.C. Cir. 1986) (Commission's judgment regarding how the public interest is best served is entitled to substantial judicial deference), *citing FCC v. WNCN Listeners Guild*, 450 U.S. 582, 596 (1981).

Moreover, an agency is entitled to further deference in the exercise of its particular technical expertise.[15] Just last year, the D.C. Circuit squarely held that the Commission, in adopting regulations to accommodate new technologies, "functions as a policymaker and, inevitably as a seer -- *roles in which it will be afforded the greatest deference by a reviewing court*."[16] The Commission's mandate in regulating a "dynamic, rapidly changing industry"[17] is especially strong:

> Regulatory practices and policies that will serve the "public interest" today may be quite different from those that were adequate to that purpose [in the past], or that may further the public interest in the future.[18]

The D.C. Circuit long ago gave notice it will particularly defer to the Commission's expertise in regulating new technologies:

> We confront on review an arcane, fast-moving field of technology . . . . In these circumstances *a reviewing court owes particular deference to the expert administrative agency's policy judgments and predictions* . . . .[19]

---

[15] *National Wildlife Federation v. EPA*, 286 F.3d 554, 560 (D.C. Cir. 2002) ("particular deference is given by the court to an agency with regard to scientific matters in its area of technical expertise").

[16] *Teledesic LLC v. FCC*, 275 F.3d 75, 84 (D.C. Cir. 2001), *quoting Telocator Network of America v. FCC*, 691 F.2d 525, 538 (D.C. Cir. 1982).

[17] *Washington Utilities & Transportation Comm'n v. FCC*, 513 F.2d 1142 (9th Cir.), *cert. denied*, 423 U.S. 836 (1975).

[18] *Id*.

[19] *Wold Communications, Inc. v. FCC*, 735 F.2d 1465, 1468 (D.C. Cir. 1984) (emphasis added). *Cf. National Cable & Telecommunications Ass'n, Inc. v. Gulf Power Co.*, 122 S. Ct. 782, 806 (2002) (where subject matter is technical, complex, and dynamic, agencies have authority to fill gaps where statutes are silent).

In short, the First Report and Order must stand if the Commission took the record into account, applied reasonable standards, and explained its decision. Each of these requirements is amply met.

III. PETITIONERS HAVE NOT RAISED ANY LEGAL ISSUES THAT WARRANT RECONSIDERATION.

The Petitioners variously allege violations of the Administrative Procedure Act (APA) and of the Commission's Rules. But none of the allegations stands up to applicable case law.

The PCS carriers raise two APA claims: that the Commission provided an inadequate analysis of interference from UWB into PCS; and that setting a UWB limit higher for indoor than for outdoor operation is irrational, because PCS signals are weaker indoors. The PCS carriers further allege the Commission violated its own rules by infringing on carriers' exclusive licenses in the PCS band.

A. Alleged violations of the Administrative Procedure Act

Alleged APA violations relate to the Commission's interference analysis and the differing limits for indoor and handheld UWB operation.

1. The Commission interference analysis is fully adequate.

Cingular argues it was arbitrary and capricious for the Commission to authorize UWB without an adequate interference analysis.[20] In a similar vein, Sprint complains that the Commission unlawfully ignored evidence in the record when it authorized UWB in the PCS bands.[21]

---

[20] Cingular at 10-14.

[21] Sprint at 3-4. *See also* Cingular at 12 (Commission's "rejection" of information on actual signal levels used in PCS systems).

In fact, however, these Petitioners do not challenge the adequacy of the Commission's analysis so much as the result.

The Commission's treatment of PCS interference studies spans twelve lengthy paragraphs.[22] The discussion systematically takes up and evaluates all of the major findings of all the submitted studies. Where the Commission disagrees with the PCS proponents, it explains why.

On one disputed issue, for example, the Commission disagreed with a party that PCS handsets need protection down to 6 dB below thermal noise. The explanation is very clear:

> Protecting the PCS receiver to a level 6 dB below the thermal threshold of the receiver is not reasonable because it represents the ideal performance of the receiver and is not representative of typical operating conditions. In practice, PCS receivers will normally receive signals well above the thermal threshold of the receiver. . . In addition, it is likely that intervening objects would provide significant attenuation to UWB emissions. Thus, we do not believe [the] calculations provide a reasonable representation of the interference potential of UWB to PCS operations.[23]

Similarly, the Commission disputed the generalization of test results obtained in a chamber that artificially isolated the handset from all external influences and reflections:

> We find that the testing in the anechoic chamber permitted the PCS receiver to function properly down to the thermal noise floor of the receiver. Once this equipment was placed outdoors in a simulated environment, the UWB emissions had no significant interference effect except at distances less than one meter. We find that it is extremely unlikely that UWB devices will be located this close to a PCS receiver, particularly given the operating restrictions we are applying to UWB devices.[24]

---

[22] First Report and Order at paras. 152-63.

[23] *Id*. at para. 154.

[24] *Id*. at para. 159.

And again, the Commission declined to accept conclusions drawn from laboratory measurements on the distances needed between UWB and PCS devices to prevent interference:

> [T]hese separation distances are based on worst case conditions as they do not assume that there is additional attenuation of the UWB emissions due to intervening objects, mismatched antenna polarizations, head loss, or other effects. They also assume that the UWB transmitter is operating at its maximum emission limit with the emission directed at the PCS receiver.[25]

These explanations (and the others in the First Report and Order) fully satisfy the APA. As noted, the D.C. Circuit has consistently held it to be enough that "the FCC has adequately articulated a *reasoned* analysis based on studies and comments submitted during the rulemaking process."[26] The court went on: "The fact that the Commission might not have addressed and rejected every conceivable approach . . . does not render its decision invalid."[27] Similarly, the court will affirm a Commission decision if it is "sufficiently clear to reasonably discern the Commission's rationale behind its ultimate balance of interests."[28]

---

[25] *Id*. at para. 161.

[26] *Ass'n of Public Safety Communications Officials-Intern'l v. FCC*, 76 F.3d 395, 400 (D.C. Cir. 1996) (italics in original).

[27] *Id*.

[28] *Atlantic Tele-Network, Inc. v. FCC*, 59 F.3d 1384, 1391 (D.C. Cir. 1995). *See also WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969) ("our busy agency staffs are not expected to dot 'i's' and cross 't's,'"), *cert. denied*, 409 U.S. 1027 (1972), *citing Braniff Airways, Inc. v. CAB*, 379 F.2d 453, 460 (1967).

Sprint cites *AT&T Wireless Services, Inc. v. FCC*[29] for the proposition that the Commission must explain the factual basis for interference standards.[30] But that is not in dispute. The point at issue is whether the Commission has explained its decision *adequately*. And even if it did not in *AT&T Wireless Services*, it certainly has here. The PCS carriers are free to disagree with the Commission's explanations. But they cannot deny that the explanations exist.

2. The indoor limit is not irrational.

The Commission established different limits for indoor and handheld UWB communications devices, with the expectation that handheld devices may be used outdoors. The indoor limit is 10 dB higher than the handheld limit at 1610-3100 MHz, and above 10.6 GHz.[31]

The PCS carriers assert that indoor PCS handsets receive less signal, and so need a *lower* UWB limit for interference protection. For that reason they claim the higher limit indoors is arbitrary and capricious, unsupported by the record, and irrational.[32]

But the differential between indoor and handheld UWB limits has nothing to do with PCS. The Commission determined that the indoor (higher) limit is adequate to protect PCS under all realistic conditions, including indoor PCS use.[33] The lower limit for handheld devices is intended to protect not PCS, but various Government systems whose frequencies range far

---

[29] 270 F.3d at 968.

[30] Sprint at 4.

[31] *Compare* 47 C.F.R. Sec. 15.517 *with* 47 C.F.R. Sec. 15.519.

[32] Sprint at 14-19; Cingular at 14-16.

[33] First Report and Order at para. 163.

above and below the PCS band.[34] The Commission applied the 10 dB penalty for handheld operation from 1610 through 3100 MHz, even though the PCS band (1850-1990 MHz) is less than 10 percent of that range.

Many other bands within 1610-3100 MHz, besides PCS, need no extra protection for outdoor operation, but the Commission prefers simple rules, where possible. Rather than chop up 1610-3100 MHz into individual sub-bands that do and do not need outdoor protection, the Commission applied the 10 dB cut to all frequencies over that range. Again, the PCS carriers may object to the result, but they cannot fault its rationality.

B. Alleged Violation of the Commission's Rules: Exclusivity of PCS Frequencies

Sprint and Cingular both assert a PCS licensee's "exclusive" right to its spectrum that bars UWB operation.[35] Cingular adds that the First Report and Order "amended" that long-standing policy without due process.[36] Both cite *Public Utility Commission of Texas*.[37] Cingular also cites Sections 22.905(a) and 22.911(a).[38]

There are several answers to the PCS carriers' claim of exclusivity, any one of which will suffice: (1) PCS license exclusivity runs only against other PCS licensees, not against Part 15; (2) The Commission has not authorized UWB in the PCS band, as the PCS carriers claim; and

---

[34] *See* First Report and Order at para. 199.

[35] Sprint at 4-8, Cingular 2-4, 9, 16-20.

[36] Cingular at 17-18.

[37] 13 FCC Rcd 3460, 3503 at para. 89 (1997).

[38] Cingular at 3 nn.7-8.

(3) Part 15 was authorized at levels higher than UWB at the time of the auction, so that PCS carriers were on notice when they made their bids.

1. PCS license exclusivity runs only against other PCS licensees, not against Part 15.

XtremeSpectrum agrees that PCS licensees have exclusive rights to their spectrum *as against other licensees*. That is the only relevant point in *Public Utility Commission of Texas*, and even that is *dictum.*[39] Similarly, Sections 22.905(a) and 22.911(a) of the Rules merely allocate each cellular spectrum block to one licensee in an area, and entitle that licensee to protection from other licensees.[40] There is no corresponding provision in the PCS rules.[41] And nothing in those rules blocks Part 15 operation in the licensed band.

A closely analogous case permitted non-interfering operation in a cellular band, over the objections of the exclusive licensee. In *AT&T Wireless Services, Inc. v. FCC*,[42] the licensee objected to the Commission's granting waivers to AirCell, Inc. for operation of an airborne cellular system on the licensee's frequencies. As here, the licensee pointed to Sections 22.905

---

[39] The case has nothing to do with PCS exclusivity. Rather, it challenges Commission preemption of state regulation as to the provision of competitive local telephone service. The only reference to PCS comes in a party's claim that the Commission should not preempt state build-out requirements because they are analogous to the build-out obligations imposed on PCS licensees. *Public Utility Comm'n of Texas*, 13 FCC Rcd 3460, 3503 at para. 88. The Commission distinguishes the PCS build-out requirement by explaining that only the PCS licensee can build a PCS system on that spectrum. *Id*. at para. 89.

[40] 47 C.F.R. Secs. 22.905(a), 22.911 (preamble).

[41] Instead, Cingular cites several PCS orders for the principle of "one license per spectrum block per service area." Cingular at 3 nn. 9-11. We agree the principle is correct, but it does not support Cingular's position here.

[42] 270 F.3d 959 (D.C. Cir. 2001).

and 22.911 as establishing exclusivity, notwithstanding a Commission finding of non-interference. But the court upheld the Commission:

> The Commission's interpretations of its rules regarding the rights of cellular licensees, including the right to channel block exclusivity and freedom from interference or signal capture within a given [service area] are entitled to substantial deference. The court therefore will accept that these rules proscribe only harmful interference within a given carrier's [service area] . . . . Absent harmful interference, AirCell's new system does not trammel upon petitioners' rights as licensees.[43]

This case establishes that a licensee's exclusivity does not bar non-interfering use by other parties. And if the Commission can lawfully allow a non-interfering second cellular carrier on a cellular licensee's frequencies, then *a fortiori* it can certainly allow a non-interfering low-power unlicensed use.

2. The Commission FCC has not *authorized UWB in PCS spectrum: UWB is out-of-band at PCS frequencies.*

The PCS carriers' claim that the Commission improperly allowed UWB operation on PCS frequencies is factually incorrect.

A UWB device's bandwidth is defined as the frequency range bounded by the points 10 dB below the highest radiated emission.[44] *The UWB bandwidth is required to lie entirely outside the PCS band* -- not just for communications systems, but for every category of UWB device.[45]

---

[43] *Id*., 270 F.3d at 962 (italics added).

[44] 47 C.F.R. Sec. 15.503(a).

[45] 47 C.F.R. Secs. 15.509(a) (low frequency imaging systems), 15.511(a) (mid-frequency imaging systems), 15.513(a) (high frequency imaging systems), 15.515(b) (vehicular radar systems), 15.517(b) (indoor communications systems), 15.519(b) (hand held communications systems).

As a consequence, any UWB emissions into PCS frequencies are necessarily out-of-band.[46] Like transmitters in many services, UWB is permitted out-of-band emissions limits in the PCS band, although at far lower levels than many others.[47]

In short, assertions that the rules permit UWB emissions at PCS frequencies are factually incorrect. The Commission prohibits intentional emissions, and permits only out-of-band emissions, which it regulates more stringently than those from most other transmitters.

3. PCS carriers had notice at the time of the auction that Part 15 operation was permitted in PCS bands.

The PCS carriers claim they bid on and invested in their licenses in reliance on having exclusive use of their frequencies, as against UWB.[48] Yet the PCS broadband auctions began five years *after* the present-day Part 15 regime was put in place.[49] Those rules permit *intentional* unlicensed emissions in the PCS band at the Part 15 general limits.[50] The PCS carriers knew that when they placed their bids. If emissions at those levels were a potential source of interference, the PCS carriers presumably adjusted their valuation of the spectrum accordingly.

---

[46] Sprint concedes this point. Sprint at 2, 26-27.

[47] *See* the attached Technical Statement at iii-iv.

[48] Sprint at 4; Cingular at 16.

[49] *Revision of Part 15 of the Rules*, 4 FCC Rcd 3493 (1989). The auctions began in 1994. *See* http://wireless.fcc.gov/auctions/04/

[50] 47 C.F.R. Sec. 15.209(a).

UWB devices are permitted emissions in the PCS band that are at least 12 dB *lower* than the Part 15 general limits.[51] In other words, the PCS carriers placed their bids knowing they were potentially exposed to Part 15 signals much higher than UWB.

Not so, say the PCS carriers. First, they say, the prior Part 15 authorization in the PCS band was difficult to use, and in fact went largely unused.[52] This needs no answer. The PCS carriers valued the spectrum subject to the possibility of someone finding a way to make Part 15 practical, at those frequencies.

Second, the PCS carriers argue the prior Part 15 rules prohibited broadband and damped-wave emissions, which UWB uses.[53] But this is why the Commission requires UWB to operate at 12 dB below the general limits in the PCS band: "in an abundance of caution," to allow for the possibility that UWB may be more interfering than other Part 15 operation.[54] And indeed, the PCS carriers have not tried to show that UWB actually causes more interference than other modulations operating 12 dB higher.[55]

Finally, Sprint argues that this reasoning would permit the Commission to let anyone use the PCS band simply by redesignating the service as Part 15.[56] We disagree. Part 15 operation

---

[51] *See* First Report and Order at para. 183, Table 8.

[52] Cingular at 19.

[53] Cingular at 18; Sprint at 5 (noting UWB was prohibited at the time of the auction).

[54] First Report and Order at para. 163.

[55] The PCS carriers do say that 12 dB reduction below the general limits is not enough to protect their operations. We respond to these technical arguments in Part IV.A, below.

[56] Sprint at 6 n.16.

must be non-interfering.[57] We have no doubt that the PCS carriers could stop a high-powered service whose intentional emissions caused actual harmful interference in their band, no matter what that service is called.

* * * *

In short, the PCS carriers' claim that their exclusive licenses bars UWB finds support in neither the facts nor the law. The Commission has reasonably determined that UWB does not interfere with PCS, and that determination is entitled to great deference. See Part II.C, above. There is no precedent for barring a non-interfering, unlicensed use; to the contrary, *AT&T Wireless Services, Inc. v. FCC* is recent precedent for allowing it. The PCS carriers had ample notice of potential Part 15 operation in their bands before they placed heir bids; and in any event, UWB places only out-of-band emissions on PCS frequencies, at lower permitted levels than countless other intentional and unintentional emitters. UWB operation in the PCS band is entirely permissible.

IV. TECHNICAL ISSUES

Several petitioners raise claims of potential interference to their respective services. None of these have merit, and for the same reason: Each argues from hypothetical conditions that cannot arise in practice. Whatever their theoretical value, these claims have no bearing on real-world operation. We explain below as to each individual service.

Moreover, all of the interference claims presented here were addressed and resolved in prior stages of the proceeding. The petitioners add no new facts or analysis, but merely recycle arguments from their prior filings.

---

[57] *See* 47 C.F.R. Sec. 15.5(b).

The positions below are supported by the attached Technical Statement.

A. PCS Issues

The PCS carriers challenge the limits for UWB devices in the PCS band, at 12 dB below the Part 15 general limits.[58] They claim UWB emissions at this level will cause unacceptable numbers of dropped calls.[59]

Specifically, the PCS carriers insist the Commission should have accepted their industry threshold of -105 dBm for received power levels. Because it did not, they say, UWB will cause loss of PCS network capacity and coverage.[60] Cingular adds that a PCS handset would receive harmful interference from a UWB device that causes a 1 dB rise in the receiver thermal noise floor.[61] Qualcomm claims that any UWB emissions greater than 6 dB below the thermal noise floor can interfere with to a PCS handset.[62]

The Commission has examined appropriate interference thresholds for PCS in detail.[63] The Commission does not question the PCS carriers' assessment of their handsets under ideal

---

[58] Qualcomm at 5, 12-13.

[59] Cingular at 5. Cingular claims a UWB device at 3 meters will cause dropped calls at a 1.2-4.8% rate; and at 2 meters, at a 2.0-7.9% rate. Cingular at 6-7.

[60] Sprint at 10-14; Qualcomm at 4, 7-9 (PCS handsets work at levels below -100 dBm). According to Cingular, a UWB device one foot from the handset will cause dropped calls in a handset at -99 to -103 dBm for an unloaded system, and -85 to -89 dBm for a loaded system. Cingular at 6.

[61] Cingular at 5.

[62] Qualcomm at 4-5.

[63] *See Potential Interference to PCS from UWB Transmitter Based on Analyses from Qualcomm Incorporated* (filed Feb. 14, 2002) (OET Staff Report); *see also* First Report and Order at paras. 152-163.

conditions. But it concludes that UWB devices will not present a significant risk of harmful interference to PCS, "*particularly when evaluated under actual operating conditions instead of in a laboratory environment*."[64]

Accordingly, the Commission set UWB emissions limits that take into account real-world limitations on PCS operation. These include, for example, such effects as multipath fading (*i.e.* reflections), interference from PCS base stations in neighboring cells, interference from non-PCS sources, sub-optimal antenna alignment, and potential signal attenuation due to the user's head and hands. The PCS carriers dispute this approach, but they offer no evidence as to why it is wrong. Setting aside unsupported assertions, the Petitions contain nothing to show that UWB under the adopted rules will interfere with PCS under actual operating conditions.

Sprint believes the Commission could have afforded greater protection to PCS without impairing UWB performance, because PCS frequencies are out-of-band to UWB communications devices.[65] The premise is true, but the conclusion is not. The physics of UWB systems generally yields a shallow curve of emissions against frequency. Under the present rules, UWB communications systems must significantly attenuate their emissions below 3100 MHz. Although XtremeSpectrum devices do not carry data at those frequencies, implementing a further cuts below 3100 MHz would, in some cases, impair performance in other parts of the spectrum.

---

[64] First Report and Order at para. 163 (italics added).

[65] Sprint at 26-27.

For a detailed treatment of these issues, see the Technical Statement at i-iv. On the alleged irrationality of higher UWB limits for systems indoors, where PCS signals are fainter, see Part III.A.2, above.

B. DARS Issues

The DARS petitioners insist the Commission erred in setting the UWB limits in the DARS band at 10 dB (indoors) and 20 dB (handheld) below the general limits. They claim the appropriate figure should be much lower, at 35 dB below the general limits[66] -- approximately the same as in the GPS band.

The Technical Statement points out several specific errors in this argument. For example, the DARS industry criticized the Commission for assuming UWB antennas are not left-hand circularly polarized, as DARS antennas are; yet a circularly polarized antenna that operates correctly over the entire UWB spectrum would be difficult or impossible to design, and would offer no advantages over linear polarization.[67] The DARS industry also criticizes the Commission's use of a 360º receiver noise temperature -- a number provided by the DARS providers themselves earlier in the proceeding.[68] Moreover, the numbers they offer now would make sense only if the receiver were in orbit, or if it used a pencil-beam antenna, unlike the nondirectional DARS antennas actually installed.[69] The DARS industry also overlooks permitted

---

[66] XM and Sirius at 5.

[67] Technical Statement at 1v n.32.

[68] Technical Statement at iv-v.

[69] Technical Statement at v.

emissions from the neighboring 2400 MHz ISM band that are much higher than UWB is allowed.[70]

We find a troubling inconsistency between two claims by the DARS petitioners: (1) the DARS signal outdoors is so weak as to require extraordinary protection from UWB; and (2) the DARS signal functions well indoors, despite about 9 dB of building loss. Both of these cannot be true. But we suspect that indoor DARS reception requires either a nearby terrestrial repeater or an outdoor antenna. The DARS providers' own numbers make it unlikely that an indoor antenna can achieve reliable reception from the satellite. And, while they try to play down the role of repeaters by emphasizing that 99% of their service area will have no repeater coverage, in fact the 1% that does have coverage accounts for a large fraction of the population.

We show in the Technical Statement that separation between an indoor UWB and an outdoor DARS antenna, or a handheld UWB and a mobile DARS antenna, would be 3 meters or less before interference is experienced.[71]

C. GPS Issues

Sprint asserts the rules give inadequate protection for indoor operation of GPS.[72] We note that the level adopted by the Commission, 34 dB below the general limits, is the lowest value requested by the U.S. GPS Industry Council.[73] The Commission also provided an

---

[70] Technical Statement at vi.

[71] Technical Statement at vii.

[72] Sprint at 21-24.

[73] Letter from Raul R. Rodriguez, Counsel to the U.S. GPS Industry Council, to Magalie R. Salas, Secretary, FCC (filed Jul. 16, 2001), Attachment at 4 (§XX.af(a)).

additional 10 dB protection against spectral lines. Nothing in the record (or in Sprint's petition) justifies lower values.

Moreover, the values in the Rules approach the lower limits for practical measurement. The Commission cannot practically specify a much smaller number, because there would be no way to ascertain whether a device complied.

The PCS providers are not concerned about GPS operation in general, but about E911 applications.[74] They argue (correctly) that protecting GPS is not necessarily enough to protect E911, because E911 uses the PCS link to augment processing of a weak GPS signal. Thus, interference to the PCS link will also impair E911.[75] As we showed above, however, the PCS-band limits are more than adequate to protect the PCS link from UWB under actual operating conditions. Indeed, the Commission chose those limits in part to protect E911 operation.[76] Indoor E911 is a difficult application that may not always work; but if it fails in a given situation, UWB will not be the reason.

D. Fixed Satellite Issues

The Satellite Industry Association (SIA) alleges the Commission's rules are insufficient to protect Fixed Satellite System (FSS) receive dishes at 3.7-4.2 GHz. According to SIA, the Commission developed limits based on indoor UWB devices, taking building attenuation into account, but then applied those limits to UWB devices outdoors as well, where building

---

[74] Sprint at 20-26; Cingular at 20-21.

[75] Cingular at 20-21; Sprint at 24-26.

[76] First Report and Order at para. 192.

attenuation does not apply.[77] Further, SIA claims the emissions limits are based on separation distances reported by NTIA that range from 630 meters to tens of kilometers, and are unrealistically large.[78]

The First Report and Order responded to SIA's points,[79] and SIA presents no evidence or arguments that warrant reopening the issue. NTIA studied FSS interference from UWB emitters at elevations of 2 and 30 meters. Contrary to SIA's assertion, the Commission only mentions building attenuation, and does not rely on it. Moreover, the Commission's Rules require an earth station antenna to be angled upward at least 5 degrees.[80] XtremeSpectrum has noted this raises the antenna axis, where sensitivity is greatest, well above a 2-meter-high UWB emitter. That isolates the emitter from the FSS receiver by at least another 10 dB.[81]

Thus, the Commission correctly determined that only the 30 meter elevation is a potential source of interference into FSS.[82] However, because the UWB rules prohibit outdoor infrastructure,[83] a UWB device 30 meters up is necessarily located inside a building. As the

---

[77] Satellite Industry Association at 3-4.

[78] Satellite Industry Association at 4-5, *citing Assessment of Compatibility Between Ultrawideband Devices and Selected Federal Systems*, NTIA Special Publication 01-43 (January 2001).

[79] *See* First Report and Order at paras. 139-40.

[80] 47 C.F.R. Sec. 25.205 (transmit stations). A receive-only dish can operate at any elevation, but must be above 5 degrees to qualify for interference protection from terrestrial stations.

[81] *See* XtremeSpectrum, Inc., *Presentation to IRAC of Detailed Technical Analysis of Systems Studied in NTIA Reports* at 22-25 (filed Nov. 14, 2001).

[82] First Report and Order at para. 139.

[83] 47 C.F.R. Secs. 15.517(a)(3), 15.519(a)(2).

Commission notes, "The FSS antenna would not point at a building since the building would block signals from the satellite."[84]

SIA disagreement with these results apparently stems from its application of a protection criterion different from that used by the Commission. The same discrepancy leads to SIA's claim of unrealistic separation distances. But SIA's brief pleading offered no technical grounds for questioning the Commission's calculations.

For a more detailed treatment, see the Technical Statement at vii-viii.

E. Aviation Issues

ARINC and Air Transport Association urge that UWB communications devices be limited to frequencies above 5.5 GHz in order to protect various aviation systems between 2.31 and 5.25 GHz.[85] Between 3.1 and 5.5 GHz, they ask that emissions be limited to the values presently applicable to 1.99-3.1 GHz.[86] ARINC and Air Transport Association also ask that UWB-equipped devices be prominently labeled, "WARNING: NOT FOR USE ON AIRCRAFT."[87]

---

84 First Report and Order at para. 140.

85 ARINC and Air Transport Ass'n at 4-5.

86 ARINC and Air Transport Ass'n at 4-5.

87 ARINC and Air Transport Ass'n at 6.

All of the aviation systems of concern to ARINC and Air Transport Association were either thoroughly analyzed in the proceeding,[88] or else lie below 3.1 GHz, and so already have the protection requested. The petition does not present any technical basis for reconsideration.

XtremeSpectrum opposes the proposed labeling requirement. The Commission's Rules already prohibit UWB operation on board aircraft.[89] And handheld devices, the only type that passengers could conceivably operate on board an aircraft, are already subject to stringent emissions limits. Moreover, a labeling requirement would raise both design and manufacturing problems for consumer device manufacturers; and a required label in English would limit distribution. In any event, as a realistic matter, we very much doubt that labeling would significantly affect compliance.

F. "Aggregation" Issues

Some petitioners continue to insist the Commission adjust emissions levels to account for cumulative UWB interference.[90]

The supposed aggregation of UWB emissions is the long-standing urban myth of this proceeding. Many parties casually assume harmful aggregation occurs, although XtremeSpectrum has repeatedly shown that it does not, for two reasons.[91]

---

[88] Many of these systems were addressed in *Assessment of Compatibility Between Ultrawideband Devices and Selected Federal Systems*, NTIA Special Publication 01-43 (January 2001).

[89] 47 C.F.R. Sec. 15.521(a).

[90] *E.g.*, Sprint at 27-29; XM and Sirius at 22-23.

[91] *See also* First Report and Order at para. 234.

First, any interference scenario involving multiple UWB emitters is strongly dominated by the nearest emitter. All others combined make only a trivial contribution. Although UWB emissions add in principle, they fall off so quickly with distance there is little signal to add. Compare, for example, ten UWB emitters at 10 meters from a victim receiver, to one emitter at 3 meters. *The combined effect of the ten more distant emitters is less than 1% of the effect produced by the single nearest emitter*.[92]

Any different result requires hopelessly unrealistic numbers of UWB emitters. One study filed by Sprint assumed a UWB density of one device per 10 square meters.[93] This is 100,000 devices per square km -- equivalent to 10 devices for every man, woman, and child in metropolitan New York City, all operating simultaneously![94]

The second objection to aggregation notes that many UWB devices cannot transmit at once in a small area. Because UWB devices share a common radio channel, those within range

---

[92] This assumes same-room propagation losses at $1/R^2$ for the emitter 3 meters away, and $1/R^4$ for emitters 10 meters away. *See* Letter from Mitchell Lazarus to William F. Caton, Acting Secretary, FCC (filed Feb. 6, 2002), Attachment at iii; Letter from Mitchell Lazarus Magalie Salas, Secretary, FCC (filed Jan. 3, 2002) at 7-8.

[93] Jay Padgett, *A Model for Calculating the Effect of UWB Interference on a CDMA PCS System*, at Attachment 1, page 10, filed as an attachment to Letter from Charles W. McKee, Sprint PCS to Magalie Roman Salas, FCC (filed Sept. 12, 2000).

[94] Details: The 2000 Census put the population of New York City at 8,008,278. The area is 320 square miles, or 828 square kilometers. This yields an average population density of 9672 people per square kilometer, less than 1/10 the UWB density in the PCS studies.

of each another must take turns.[95] Even a dense deployment of devices still could not yield a dense deployment of *operating* devices.

In short, aggregation cannot be a significant factor. The interference from a single UWB emitter provides an excellent approximation to that from a large population. See the Technical Statement at ix for additional details.

G. Response to Multispectral Solutions, Inc.

Multispectral Solutions, Inc. (MSSI) says that UWB systems with a high pulse repetition frequency (PRF) are more interfering than those with a low PRF.[96] It specifically criticizes high-PRF bi-phase modulated systems as "not [] adequately tested" for interference effects.[97] And it asks the Commission to amend the definition of UWB transmitter to exclude "devices which achieve wide instantaneous bandwidths because of the use of high data rates; i.e., in which the bandwidth is modulation dependent."[98]

As the Technical Statement discusses in detail, MSSI is simply wrong on every point.[99] The output of a properly-designed, high-PRF system is indistinguishable from low-level

---

[95] Letter from Mitchell Lazarus to Magalie Salas, Secretary, FCC (filed July 26, 2001), Attachment at 3; *Comments of XtremeSpectrum, Inc. on Issues of Interference into Global Positioning System Receivers* at 21-22 (filed Apr. 25, Parte

[96] Multispectral Solutions at 10-11.

[97] Multispectral Solutions at 13.

[98] Multispectral Solutions at 13.

[99] Technical Statement at ix-x.

wideband noise, which is benign into a wide range of receiver architectures. The bi-phase modulation that MSSI objects to is the bi-phase technique used by XtremeSpectrum.

In fact, XtremeSpectrum chose bi-phase modulation in part because it is more power efficient and less interfering than other methods. Bi-phase modulation encodes the 0s and 1s in a data stream with inverted and non-inverted pulses. Once the input stream has been "whitened" to eliminate any repeating patterns, the output signal is highly noise-like. High-PRF bi-phase modulation also results in a very low peak-to-average ratio, typically less than 10 dB (lower than typical radio-frequency interference), which further helps to minimize interference. Other modulation methods -- for example, encoding 0s and 1s by the presence or absence of a pulse, or shifting the timing of pulses -- are well-known to be less efficient and more likely to produce non-noise spectral features that can cause interference, and also tend to show a much higher peak-to-average ratio.

Under some readings, MSSI's proposed UWB definition may exclude XtremeSpectrum's bi-phase modulation, one of the safest proposed. MSSI's position finds no reasoned support in the record of this proceeding, in results from the academic and industry research communities, or even in MSSI's own Petition for Reconsideration. The request merits no attention.

CONCLUSION

The Petitioners have failed to carry their burden of showing they are entitled to reconsideration. Petitioners may disagree with some of the outcomes, but that does not warrant changing the rules. As a legal matter, the Commission has done everything required of it: The Commission considered the entire record, apply reasoned standards, and amply explained its decision. The courts have never required more. As a factual matter, the Commission has plainly

established that its UWB rules will not cause actual harmful interference to any service, including PCS.

By denying the Petitions, the Commission will remove the last cloud of uncertainty from UWB communications systems, and free this exciting technology to develop its promise and serve the pubic interest.

Respectfully submitted,

Mitchell Lazarus
FLETCHER, HEALD & HILDRETH, P.L.C.
1300 North 17th Street, 11th Floor
Arlington, VA 22209
703-812-0440
Counsel for XtremeSpectrum, Inc.

July 31, 2002

Technical Statement

Opposition To Petitions For Reconsideration
XtremeSpectrum, Inc.
July 31, 2002

A. PCS Issues

The basis for the indoor UWB limit of –53.3 dBm/MHz is clearly explained in the FCC staff analysis[1]. The FCC's analysis (and that of others, such as XSI[2]) shows that the 12 dB of protection is more than adequate to protect PCS operation in all situations. This conclusion does not rely on any assumption about additional protection due building penetration losses between UWB and PCS devices.

The limits for indoor UWB systems are based on what the FCC has determined are adequate levels of protection for PCS handsets, whether indoors or out. That limits for "handheld" systems (potentially outdoors) are even lower does not imply the PCS needs more protection outdoors, only that they enjoy more protection than they need because of the actions of the FCC to provide conservative protection for other outdoor systems.

Sprint's claim that the FCC could have provided adequate protection in the PCS band without impacting the functionality of UWB devices is unfounded. In fact, arbitrarily low limits for out of band emissions will impact the performance, functionality and economic feasibility of UWB devices. There is significant precedent for out-of-band (OOB) emission levels (in fact UWB emission limits are at or below the OOB limits for all Class B devices).

The PCS companies feel that the FCC should have used a much lower power level for the "minimum" level at which PCS handsets can operate. The FCC Office of Engineering and Technology (in staff comments filed Feb 14, 2002 pages 5-6) [3]demonstrated that –96 dBm is a reasonable minimum level. In response, the different PCS companies claim various numbers for the "correct" minimum level:

- Qualcomm indicates[4] that FCC should have used a level of –100 dBm, or in some instances as low as –105 or –106 dBm.
- Cingular states[5] that PCS systems operate at levels at or below thermal noise floor of –105 dBm. Cingular also references[6] previous Sprint filings claiming PCS operation at signal levels as low as –118 dBm.

---

[1] FCC Office of Engineering and Technology, "Potential Interference to PCS from UWB Transmitter Based on Analyses from Qualcomm Incorporated", 14 FEB 2002 ("Staff Report").
[2] Comments of XtremeSpectrum, Inc. on UWB/PCS Interference Issues, ET 98-153, 25 APR 2001
[3] See [1] at 5, 6.
[4] Qualcomm Incorporated's Petition for Reconsideration, 17 JUN 2002, at 4
[5] Cingular Wireless LLC, Petition for Reconsideration, 17 JUN 2002, at 13
[6] *Id*. at 6.

- Sprint presents[7] a theoretical analysis and concludes that a PCS handset could operate with signals levels as low as –118 dBm, assuming ideal conditions, a thermal noise floor of –105 dBm and a NF of 8 dB.

Despite their different opinions as to what constitutes the minimum signal level that can actually be used in a real system, each of the three PCS companies agrees that the levels used by the FCC are not correct. In addition, they all claim that the FCC failed even to provide a "reasoned justification" of why they settled on the –96 dBm number instead of the lower –105 dBm number, or others, that the PCS companies preferred.

In fact, the FCC gives a reasoned justification in its comments dated February 14, 2002[8]. The FCC staff analysis contains a clear and appropriate explanation of the basis for the minimum signals levels determined by the FCC, and also shows that they carefully considered all of the information submitted by the PCS companies and other parties in the public record. None of the more recent claims made in the petitions for reconsideration undermine the FCC's justification for the adequacy of the current regulations.

In its analysis[9] the FCC explains that even if PCS operation in an anechoic chamber is possible at levels as low as –105 dBm, real world conditions require signal margin to combat the effects of multipath fading, RFI, interference from other cells, sub-optimal antenna alignment, and potential signal attenuation due to the users hands, head, etc.[10]

The FCC determination is completely supported by other data submitted by Sprint that documents the degree of multipath fading that can be experienced in real world systems[11]. This data shows that received signal fading causes signal fluctuations of up to 30 dB in the first plot (Figure 11[12]), and even under *extremely optimistic* assumptions of 3 equal strength Rayleigh components, sophisticated rake processing still results in multiple fluctuations of 8-10 dB in signal level at the rake combiner output (figure 12[13]).

Qualcomm, in order to support the claim that –105 dBm is a reasonable value to use for a minimum operations signal level, presents a plot of a PCS call showing sustained operation at signal levels fluctuating between –100 and –105 dBm[14]. Although the description of the test gives no indication of the test conditions, it is clear that this test includes no allowance for real world conditions such as fading, RFI, etc. mentioned specifically by the FCC.

In fact, the test results in Figure 1[15] clearly show that at these low power levels (-100 dBm or lower), even minor fluctuations in received signal power of only a dB or so can

[7] Sprint Petition for Reconsideration, 17 JUN 2002, at Attachment 1, p.4.
[8] Staff Report.
[9] *Id*. at 4-5.
[10] Also see R & O ¶158, ¶159, ¶162
[11] Sprint Petition for Reconsideration, 17 JUN 2002, at Attachment 1, pp.19-20.
[12] *Id*. at 19.
[13] *Id*. at 20.
[14] Qualcomm Incorporated's Petition for Reconsideration, 17 JUN 2002, at 8.
[15] *Id*.

cause spikes in the frame error rate that exceed the level for "acceptable errors" of 2%. The FCC analysis explained that a signal level of –105 dBm was an unreasonable operating level for just this reason: there is not sufficient margin left to allow for signal fluctuation due to fading caused by real-world factors such as multipath propagation or shadowing.

It is clear that the Qualcomm test represented a signal with no fading because the signal does not show the characteristic Rayleigh fades documented by Sprint[16]. These plots prove that real world conditions require fading margin and that operation at –100 dBm or –105 dBm (much less –118 dBm) could not be sustained in the presence of multipath (Rayleigh) fading as the FCC has clearly explained.

Qualcomm claims[17] that the FCC staff analysis wrongly rejected its claim that any UWB emissions greater than 6 dB below the noise floor of a PCS receiver would cause harmful interference. Although these statements are made in Qualcomm's filed petition, the accompanying text provides no support or justification. In fact, in its comments, Qualcomm essentially concedes that noise floor analysis is not relevant (as the FCC explained in its analysis) and instead presents a discussion of signal-to-noise ratio. Even this discussion is flawed, however, because it assumes that signal levels of –100 dBm represent acceptable operational conditions. We have already seen that this assumption has been rejected by the FCC based on analysis presented by the FCC and others.

These claims also assume that the PCS system operates in an otherwise noise-free environment. UWB emitters and even other intentional emitters are only minor sources of noise. Unintentional radiators (digital circuitry, computers) and incidental radiators (motors, ignition systems) form a background level that the receiver is immersed in. Very little has been done in recent years to conduct a concerted study of the background noise at UHF and microwave frequencies, although there is a great desire to learn how the increasingly fast digital circuitry and wireless systems are affecting background noise[18]. There are a number of models, some dating back to the early 70's[19], of man-made noise. A 1990 update to ITU-R P.372 predicts higher noise levels in business areas, with 3 dB above kTB being calculated for 2 GHz. Models based on a number of separate measurement programs, like Skomal[20], estimate excess noise in the business district due to ignition sources to be 8 dB above kTB at 2 GHz. Measurements in the UK and Greece performed between 1.5 – 2.0 GHz have produced values in the 7 to 10 dB range above ktB with peak impulse field strengths of 37 dBµV/m and average impulse powers ranging from -83 dBm to -93 dBm in a 1 MHz bandwidth[21,22,23,24]. These levels are background

[16] Sprint Petition for Reconsideration, 17 JUN 2002, at Attachment 1, pp.19-20.
[17] Qualcomm Incorporated's Petition for Reconsideration, 17 JUN 2002, at 4
[18] See for example Anil Shulka "Radiocommunications Agency – Feasibility Study into the Measurement of Man-made Noise", DERA, Malvern, UK, March 2001
[19] Man-made noise, ITU-R P.372-7
[20] E. N. Skomal & A. A. Smith, Jr, *Measuring the Radio Frequency Environment*, Chapter 2, Van Nostrand Reinhold, NY
[21] H.Masoum and J. Gardiner, "Simulation of man-made noise in 100 MHz to 3 GHz band" Mobile Radio and Personal Communications, 1991., Sixth International Conference on, 1991 pp. 255 -260

levels experienced throughout the urban area, but there are also individual sources that can be found in close proximity to a PCS user. Measurements made of electric drills show excess noise over 8 dB at a range of 2 meters[25] and peak field strengths across the PCS band of 60 – 70 dBμV/m at 1 meter[26]. Certainly, with values like these, if PCS signals were at the levels claimed, they would fail to ever operate.

B. DARS Issues

The SDARS joint petition[27] requests a field strength limit of 8.6 μV/m limit on UWB signals in a 1 MHz bandwidth when in co-polarized free space conditions. In fact, they question why the Commission did not adopt the 5.8 μV/m adopted in Part 27. They claim the Commission made its calculations with erroneous values and assumptions.

The numbers the Commission used[28] seem to have been the values provided by XM Radio in its earlier comments[29], where they desired to limit UWB field strength to 18 μV/m. The SDARS joint petition includes a technical appendix where the "errors" in the Commission's calculations are "corrected".

The first of these errors is claimed to be the 3 dB polarization mismatch. The SDARS receive antennas are designed to be left-hand circularly polarized[30,31], and while the polarization of a UWB antenna may be "unknown", it is almost certainly not circular[32].

The second error that is claimed is that the FCC incorrectly stated the noise temperature of the SDARS receiver as 360°K. As noted above, the numbers used by the Commission

---

[22] P.Constantinou, et al, "Man made noise measurements", IEEE Vehic. Tech. Conf., pp. 475 - 476, St. Louis, MAY 1991.

[23] D. Apostolakis and P. Constantinou, "Man made noise measurements and modelling", IEEE Int'l Conf. on Universal Personal Comm. (ICUPC'93), pp. 585 - 589, Ottawa, OCT, 1993

[24] M. Button, "Measurement of the Impulsive Noise Environment for Satellite-Mobile Radio Systems at 1.5 GHz", IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 51, NO. 3, MAY 2002, pp.551-560

[25] H.Masoum and J. Gardiner, "A receiver system for the measurement and characterisation of man-made noise in the frequency range 1.5 GHz to 2.5 GHz", Radio Receivers and Associated Systems, 1989, Fifth International Conference on, 1990 pp. 15 -19

[26] NTIA Report 01-383 "The Temporal and Spectral Characteristics of Ultrawideband Signals," January 2001, Appendix D, Figure D.F.2.

[27] Sirius Satellite Radio Inc. and XM Radio Inc. Joint Petition for Partial Reconsideration, 17 JUN 2002

[28] R&O at ¶169.

[29] Technical Appendix to Comments of XM Radio Inc., 12 SEP 2000.

[30] *Id.*

[31] M. Daginnus, *et al*, "SDARS – Antennas: Environmental Influences, Measurement, Vehicle Application Investigations and Field Experiences", SAE World Conference 2002, Detroit, MI, March 2002.

[32] While there are advantages to circular polarized systems in spaceborne, or even airborne applications, these are usually not of interest in terrestrial applications. Even if they were, it is unclear that it is possible to construct a circularly polarized UWB antenna that maintains its polarization characteristics across the bandwidth of the signal while faithfully reproducing the short time response needed in UWB systems. To eliminate the 3 dB polarization loss means that the SDARS filers have assumed that not only is the UWB antenna circularly polarized, but also that it is left-hand circularly polarized.

are identical to those provided by XM Radio in its earlier filing[33]. The Commission used the –110 dBm provided by XM Radio that matches the 1.2 dB noise figure and the 2 MHz bandwidth provided in the same document.[34] This is equivalent to a noise temperature of 70° K. The 158°K noise temperature mentioned in the SDARS joint petition is a better match to the Sirius receiver[35]. This is equivalent to a noise figure of 1.85 dB.

The joint petition errs in attempting to use these noise temperatures directly, with no regard for the environment surrounding the antenna. When they point out the noise temperature is 158°K "when an SDARS receiver is located in an environment suitable for satellite reception…" they must either mean when the receiver is located above the earth, or when it uses a pencil beam antenna that has response only in the direction of the satellite.
Since the DARS antenna has a broad response angle, much of which strikes the earth, the effective noise temperatures are more likely to approach 290° higher than those stated. Even given a –40° day at a barren mountaintop location, the correction to the Commission's calculations is not 3.6 dB, but should be *minus* 0.5 dB for the noise temperature provided.

The SDARS joint petition also faults the Commission for assuming that the "UWB emissions would be somewhat below the maximum level permitted under the rules"[36]. This is actually a reasonable assumption, since any compliant UWB device will have out-of-band emission skirts that will roll off below 3.1 GHz to meet the more restrictive emission limit transitions at 1.99 GHz and 1.6 GHz. The DARS band is a full 800 MHz below the UWB passband at 3.1 and so significant spectral roll-off is a reasonable assumption.

The SDARS joint petition attempts to minimize the potential effect of other, non-UWB, sources of interference to their receivers. For example, they point out that Part 27 mobile stations must reduce their out-of-band (OOB) emissions in the SDARS band to –80 dBm. However, they fail to point out that fixed, land, and radiolocation land stations in the same service are allowed to have OOB emissions in the SDARS band at –50 dBm[37], 1.3 dB more than is allowed for indoor UWB communications devices. In mentioning the agreement with Mexico, the joint petition lists the limit of –154 dBW/m^2/4kHz as being the limit for terrestrial systems at the U.S.-Mexican border. This number is in fact the limit that U.S. stations must meet. The requirements for Mexican stations (depending on frequency) are –150 and –145.5 dBW/m^2/4kHz for terrestrial stations, and –130.5 dBW/m^2/4kHz for satellite stations. This is 23.5 dB higher than the values stated in the

[33] Technical Appendix to Comments of XM Radio Inc., 12 SEP 2000.
[34] The actual number should be –109.8 dBm using these figures, which we assume XM Radio rounded up to –110 dBm.
[35] Comments of Sirius Satellite Radio, Inc., 12 SEP 2000, page 16.
[36] R&O at ¶169.
[37] *See* 47 CFR 27.53 (a) (1). These stations are required to reduce their emissions in the 2320-2345 MHz band by not less than 80 + log (p) dB where p is the transmitter power. Assuming a fixed station with a 1 watt transmitter (+30 dBm), this equates to –50 dBm.

joint petition[38], while the power in a 4 kHz bandwidth is 24 dB less than that in a uniform 1 MHz bandwidth. So we see that the Part 27 mobile stations are a more significant source of potential interference than the DARS filing seems to imply.

Other radio services are also much more likely to lead to interference to the DARS systems than the low level UWB OOB emissions at –53 dBm/MHz or lower. For example, the Amateur Radio Service has allocations on either side of SDARS[39] and has no specific limits for reduction of spurious emissions from these bands. In addition, SDARS is adjacent to the 2400 MHz ISM band where spread spectrum radios, cordless phones, WiFi, Bluetooth, HomeRF, and wireless video systems are used. These devices are regulated by part 15 but only require OOB emissions to meet the general 500 µV/m limits of §15.209[40]. The primary users of the ISM band (such as microwave lighting and microwave ovens) are allowed OOB emissions of 25 µV/m at 300 meters- equivalent to 2500 µV/m at 3 meters-- which is huge relative to any potential UWB emissions.

Measurements made on microwave ovens by the NTIA[41] show levels in the SDARS band of -80 to -55 dBm 3 meters from the ovens in the same room, -100 to -86 dBm in adjacent apartments, and levels of -90 to -77 at the exterior of the apartment complex. For comparison, the expected power in an isotropic antenna, 3 meters from an indoor UWB transmitter, is –101.6 dBm, assuming free space propagation—significantly lower all of these other interference sources. In conclusion, it is clear that the SDARS does not operate in a band subject only to UWB interference. SDARS suppliers would like to burden UWB with limits well below those of other users of the spectrum who are more likely to cause interference.

SDARS also suffers from the same problems of man-made noise as PCS, but with levels that are expected to be 1 – 2 dB lower. Considering that the majority of man-made noise in this part of the spectrum is assumed to be from ignition sources, the proximity of the ignition system to the SDARS antenna in a mobile application may create even more of a problem.

We cannot understand how if the SDARS signal is so weak it can suffer the additional loss of 9 dB or more in penetrating a building to provide indoor service without an external antenna – unless this scenario is one where terrestrial repeaters are involved. While the SDARS suppliers note that 99% of their service area will not be covered by repeaters, they give no indication of what percentage of their audience will be served by repeaters. It is reasonable to assume that homes desiring SDARS service will have outdoor antennas unless there are repeaters. As in most of this proceeding, the issue is not one of the noise floor, but of the available signal-to-noise ratio. The 9 dB building loss will put the indoor UWB transmitter about on par with the handheld UWB transmitter

[38] Agreement Between the Government of the United States Of America and the Government of the United Mexican States Concerning the Use of the 2310-2360 MHz Band, Appendix I.
[39] The Amateur Radio Service is assigned to 2300 – 2310 MHz and 2390 – 2450 MHz. Spurious and harmonic energy is to be reduced to best engineering practice, without a specific value being noted.
[40] Field disturbance devices regulated under §15.245 could reach OOB levels as high as 1580 µV/m.
[41] NTIA Technical Memorandum 92-154. For tests specific to microwave ovens also see also NTIA 94-303-1 which shows the range of mean EIRP between 2300 and 2400 MHz to be from 61 to 94 dBpW.

levels with regards to interference potential. The SDARS signal is expected to be between –90 and –95 dBm at the receiver antenna[42]. With an I/N of –6 dB, the separation between an indoor UWB and an outdoor antenna, or a hand held UWB and a mobile SDARS receiver should be 3 meters or less before interference is experienced[43].

C. GPS Issues

The PCS companies claim that the FCC staff analysis wrongly concluded that 12 dB attenuation below the Part 15 general limits is more than sufficient to provide protection to E911 applications. The PCS companies also state that the R&O conflicts with the FCC's E911 mandates. They argue that protecting the GPS portion of E911 Phase II systems makes no sense if similar protections are not extended to the PCS portion of the systems, because the GPS information is transmitted over the PCS band.

Proper operation of PCS-assisted E911 technology does require the proper operation of the PCS element of the system, but the R&O clearly provides this protection as explained by the FCC in its analysis. The R&O is entirely consistent with the E911 mandate.

D. Fixed Satellite Issues

The Satellite Industry Association (SIA) states[44] that FSS systems at 4 GHz are not protected from handheld UWB devices and will be exposed to harmful interference, jeopardizing billions of dollars of investment in these systems. The SIA states that the FCC improperly relied on building attenuation to protect FSS earth stations from UWB emissions, while ignoring the effects on outdoor operations, noting the entries in Tables 6 and 7 of the R&O. In addition, the SIA states that the FCC's outdoor emission limits for handheld devices are premised on separation distances that are well beyond the separations that one can expect in actual practice.

The FCC clearly explained why the R&O provides adequate protection for FSS receivers. The FCC's explanation in the R&O explains the basis for both indoor and handheld (outdoor) UWB devices in paragraphs 139 and 140 of the R&O.

For the case of the UWB devices at 30 meters height (i.e. in a building), the FCC explains that the satellite blockage of the building would be the dominant effect, so the UWB devices in tall buildings will not be an interference risk to FSS.

---

[42] M. Daginnus, *et al*, "SDARS – Antennas: Environmental Influences, Measurement, Vehicle Application Investigations and Field Experiences", figure 4.1, SAE World Conference 2002, Detroit, MI, March 2002.

[43] A modified version of the NTIA spreadsheets presented in NTIA Special Publication 01-43 was used to calculate the signal losses between UWB sources of –51.3 dBm/MHz and –61.3 dBm/MHz to an SDARS receiver with a 1.85 dB noise figure. The propagation mode used was free space and no antenna polarization loss was included. The UWB transmitter and SDARS receiver were set to a height of 1.5 meters and a mathematical model of the SDARS antenna pattern presented in reference [29] was included. A signal level of –95 dBm was assumed to be impinging on the SDARS antenna. Encounters of less than 1 meter were required to exceed the S/I except when the indoor UWB transmitter was placed outdoors, at which point the S/I was exceeded at 3 meters.

[44] Petition for Reconsideration of Satellite Industry Association, 17 JUN 2002

For UWB devices at 2 meters height (i.e. ground level), the FCC addresses both the case of an indoor and outdoor receiver. For the indoor case, the FCC does acknowledge that there will be additional loss due to through-wall propagation (12 dB at 4 GHz[45]). However, for neither the indoor nor outdoor case does FSS protection *rely* on this 12 dB building loss. In particular, the FCC determined that the appropriate protection basis for the FSS system is a worst-case interference-to-noise ratio (I/N) of 0 dB[46]. This protection basis is clearly satisfied for both the indoor and outdoor UWB devices emitting at the levels specified in the R&O, since it results in a 10 dB increase in the maximum EIRP levels for the FSS given in Tables 6 and 7 of the R&O.

Thus, the numbers cited by the SIA as required limits for outdoor UWB devices[47] do not indicate that the R&O provides inadequate protection from outdoor UWB devices, since they are based on a different protection criterion than used by the FCC. For this same reason, SIA's claim that outdoor protection of FSS is based on unrealistic separation distances is also incorrect. The limits of the R&O provide the appropriate level of protection at the same distances as those indicated in the original NTIA interference analysis[48] (see NTIA SP 01-43, dated January 2001)

In addition to the FCC analysis showing adequate protection for FSS, an earlier technical analysis submitted by XSI[49] provides even further proof that the emission limits of the R&O are more than adequate to protect FSS from outdoor UWB devices. In this analysis, XSI clearly demonstrate that the use of realistic off-axis antenna patterns for the FSS analysis results in 10 dB or more of *additional isolation* relative to the FCC analysis between the FSS and any ground level UWB emitters.

E. Aviation Issues

The pleading from Aeronautical Radio Inc. and the Air Transport Association of America Inc.[50] states that until more real-world experience is gained, the FCC should limit indoor, portable and handheld consumer devices to operations above 5.5 GHz (except for coordinated terrestrial imaging systems) in order to protect critical aviation operations between 2 GHz and 5.5 GHz. Furthermore, they state that limits between 3100 and 5500 MHz should be lowered to at least -51.5 dBm for indoor use and -61.3 dBm for handheld devices. Concerned that it might be difficult to enforce the prohibition on UWB operations aboard aircraft, they also feel that the FCC should require labels and statements in user manuals for all UWB consumer devices, stating "WARNING: NOT FOR USE ON AIRCRAFT."

---

[45] R & O, Table 7.
[46] R & O. See ¶139 and ¶134.
[47] *Id.* Table 6.
[48] See NTIA Special Publication 01-43, "Assessment Of Compatibility Between Ultrawideband Devices And Selected Federal Systems", January 2001, pp. 4-39 – 4-56.
[49] XtremeSpectrum Comments, November 14, 2001, "Detailed Technical Analysis of Systems Studied in NTIA Reports", pages 22-25
[50] Petition for Reconsideration of, 17 JUN 2002

All of the aviation systems mentioned by the ATA were either already analyzed by the NTIA[51] and other reports or are outside of the authorized UWB bands and have adequate protection from the R&O mask. The ATA and ARINC provide no additional data or analyses to justify the limits they claim are necessary, and no justification as to why the FCC's analyses and explanations in the R&O and other documents are insufficient. The FCC's R&O already prohibits the operation of UWB on aircraft.

F. "Aggregation" Issues

A number of petitioners complained that the effects of aggregation of multiple UWB devices had not been considered in formulating the Order. The aggregation of UWB signals to the point of raising the noise floor of the planet has taken on all the characteristics of an urban myth[52]. XSI has commented frequently[53] in the last three years on the fact that although signals do add, in real world applications there is little to no wide area aggregation of signals. Even in a possibly dense office environment there are limits, as each personal network of devices must share the "channel" with other nearby networks. So UWB communications devices have a fundamental limit that precludes large number so operating devices in the same location. Interference due to large aggregations of UWB devices will simply not occur.

G. Response to Multispectral Solutions, Inc.

In its Petition for Reconsideration[54], MSSI makes misleading statements that need to be corrected. Multispectral Solutions, Inc. (MSSI) claims that UWB systems with a high pulse repetition frequency (PRF) are more interfering than those with a low PRF.[55] It specifically criticizes high-PRF biphase modulated systems as "not [] adequately tested" for interference effects.[56] Based on its misconceptions, it asks the Commission to amend the definition of UWB transmitter to exclude "devices which achieve wide instantaneous bandwidths because of the use of high data rates; i.e., in which the bandwidth is modulation dependent."[57] In fact, the record shows that the very bi-phase modulation that MSSI is petitioning to be excluded is the only one with a theoretical proof that the

---

[51] NTIA Special Publication 01-43, "Assessment Of Compatibility Between Ultrawideband Devices And Selected Federal Systems", January 2001,

[52] "Noise level of radiated emissions from multiple ultra wideband (UWB) transmitters", submitted by Canada to the ITU-R Working Parties 1A, 8A and 8B, October, 2001, submitted as Appendix B of the Intelligent Transportation Society of America *ex parte* filing of 28 NOV 2001

[53] J. McCorkle and M. Rofheart, Short Analysis on the Effects of a Large Number of UWB Systems, TR-98-1, Fall 1998, attached as part of XSI's 8 DEC 1998 comment on the UWB NOI, XtremeSpectrum, Inc., Technical Statement on NTIA Report, 12 MAR 2001 Reply to ET docket 98-153, section 5; Technical Statement on Reports Addressing Potential GPS Interference from UWB Transmitters, 25 APR 2001, Reply to ET docket 98-153, section 5; and most recently Presentation to IRAC of Detailed Technical Analysis of Systems Studied in NTIA Reports, 14 NOV 2001, ex parte filing to ET docket 98-153.

[54] Multispectral Solutions, Inc (MSSI), Petition for Reconsideration, 14 JUL 2002

[55] Multispectral Solutions at 10-11.

[56] Multispectral Solutions at 13.

[57] Multispectral Solutions at 13.

spectral lines can be made zero[58]. Further, bi-phase modulation is more power efficient[59] and is *less* interfering than other methods such as on off keying or pulse position modulation. The FCC should reject the changes suggested by MSSI.

The MSSI petition makes the following statement:

> "Thus, it makes little sense for the FCC to restrict the operation of low PRF devices, e.g. vehicular radars, in the same region of the spectra (e.g., 3.1 to 10.6 GHz) that it is considering for the use of high-speed communications devices which have been shown to have a significantly higher potential for interference. MSSI, NTIA and others have recommended to the Commission that limits be placed on the PRF within certain regions of the spectrum. Indeed, the use of UWB devices – irrespective of their functionality – having PRFs less than 100 Kpps has been demonstrated by the NTIA to pose significantly less of an interference problem than do communications devices, and should be permitted within the 3.1 to 10.6 GHz region."

This statement is a gross generalization and a significant distortion of the NTIA interference analysis and test results. The record clearly shows that systems with a high pulse repetition frequency (PRF) are less interfering than those with a low PRF, not more.

In the case of peak power interactions with digitally modulated systems, MSSI's statement is a clearly in conflict with the actual NTIA results. In their analysis, the vast majority of the systems were significantly more sensitive to interference from low PRF systems, and the required separation distances were as much as 10 times greater for low PRF systems that for higher PRF systems[60].

In the case of GPS receivers, it is true that for some cases the NTIA found that interference for GPS receivers occurred at lower power levels for some higher PRF UWB signals than for 100 kHz PRF signals[61]. This underlying cause for this finding, however, is well known, documented in the proceedings, and is not fundamentally a PRF issue at all. Instead the specific interference mechanism is the sensitivity of C/A code GPS receivers to certain spectral lines. The source of these CW tones (from UWB of any form or other conventional sources) does not matter to the GPS receiver. In fact, the R&O specifically addressed this issue with a spectral line test for these critical GPS-band lines.

Furthermore, the recent FCC proceedings and R&O have stimulated significant research activities on different forms of UWB in both industry and academia. A number of recent IEEE papers have presented results and conclusions regarding the interference effects of high PRF UWB systems. Consider, for example:

---

[58] John G. Proakis, Digital Communications, McGraw Hill, 1995 Page 207: no spectral lines for symmetric constellation (BPSK)

[59] John G. Proakis, Digital Communications, McGraw Hill, 1995. Pages: 257-284, comparison of power efficiency for antipodal (BPSK) and orthogonal (PPM) modulation

[60] *Id.* Table 2.

[61] NTIA Special Publication 01-45, "Assessment of Compatibility Between Ultrawideband (UWB) Systems and Global Positioning System (GPS) Receivers", February 2001, Tables 1-4.

- A recent paper from researchers at Intel Corporation[62] show that coded UWB signals with higher PRFs result in lower interference than similar UWB signals with the same data rate and average power, but which did not use the direct sequence coding that resulted in the high PRF.

- Another paper by researchers at Telecom Italia Lab[63] analyzes the interference effects of UWB systems with relatively low PRFs (i.e. where the PRF is approximately the same as the data rate of the victim receiver). They conclude that the interference from such systems is not well modeled by Gaussian-distributed random noise, but in fact has a much more harmful effect on the victim and caused much more significant reductions in bit-error-rates.

These papers agree with classical analysis and the simple result that for a given average power, a system with low PRF (e.g. < 100 KHz) (or low duty cycle) will have a much more non-Gaussian, impulsive time-domain waveform and corresponding interference effect on the front-end of both a narrowband or wideband victim receiver. For high PRF systems (e.g. > 100 MHz), however, the interference from a compliant system (i.e. with minimal spectral line content) will be essentially indistinguishable from wideband random noise. Such interference is relatively benign, fits standard Gaussian models, and will be less dependent on the receiver architecture than will the effects of impulsive interference.

All of these results, both from the FCC proceedings and from the industry and academic research community, contradict the claims of MSSI in its petition. Petitions by MSSI is a to have the FCC specifically exclude bi-phase modulated coded UWB signals are not only unfounded but are contrary to the public interest in encouraging implementations with high power efficiency. Therefore, the FCC should reject the changes suggested by MSSI.

[62] Jeffrey R. Foerster, "The Performance of a Direct-sequence Spread Ultrawideband System in the Presence of Multipath, Narrowband Interference, and Multiuser Interference," Proceeding of the UWBST 2002, May 2002

[63] Guiseppi Durisi and Giovanni Romano, "On the Validity of Gaussian Approximation to Characterize the Multiuser Capacity of UWB TH-PPM", Proceedings of UWBST 2002, May 2002.

CERTIFICATE OF SERVICE

I, Joan P. George, a secretary for the law firm of Fletcher, Heald & Hildreth, P.L.C., hereby certify that a true copy of the foregoing "Opposition to Petitions for Reconsideration" was sent this 31st day of July, 2002 via first class, United States mail, postage prepaid to the attached Service List, except by hand delivery and e-mail as indicated.

/s/
Joan P. George

***Denotes By Hand Delivery and E-mail**

SERVICE LIST

* Chairman Michael Powell
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Commissioner Kathleen Q. Abernathy
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Commissioner Michael J. Copps
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Commissioner Kevin J. Martin
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Peter A. Tenhula
Office of Chairman Powell
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Bryan Tramont
Office of Commissioner Abernathy
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Paul Margie, Office of Commissioner Copps
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Sam Feder, Office of Commissioner Martin
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Edmond J. Thomas, Chief, OET
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Julius P. Knapp, Deputy Chief, OET
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Bruce A. Franca, Deputy Chief, OET
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Michael J. Marcus
Associate Chief (Technology), OET
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Lisa A. Gaisford, Chief of Staff, OET
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Geraldine A. Matise, Deputy Chief
Policy and Rules Division
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Ira R. Keltz, Deputy Chief
Policy and Rules Division
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Karen E. Rackley, Chief
Technical Rules Branch
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* John A. Reed
Technical Rules Branch
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

* Ron Chase
Technical Rules Branch
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

J.R. Carbonell
Carol L. Tacker
David G. Richards
Cingular Wireless LLC
5565 Glenridge Conector
Suite 1700
Atlanta, GA 30342

Luisa L. Lancetti
Vice President, PCS Regulatory Affairs
Sprint Corporation
401 9th Street, N.W., Suite 400
Washington, D.C. 20004

Charles W. McKee, General Attorney
Scott Freiermuth, Attorney
Sprint Corporation
6450 Sprint Parkway
Mail Stop: KSOPHN0212-2A553
Overland Park, KS 66251

Dr. Samir S. Soliman
Vice President - Technology
QUALCOMM Incorporated
5775 Morehouse Drive
San Diego, CA 92121-1714

Dean R. Brenner
Crispin & Brenner, P.L.L.C.
1156 15th Street, N.W.
Suite 1105
Washington, D.C. 20005
Attorney for QUALCOMM Incorporated

Nicholas Allard
David M. Leive
Olivier P. Strauch
Latham & Watkins
555 11th Street, NW
Washington, D.C. 20004
Counsel for Sirius Satellite Radio, Inc.

Bruce D. Jacobs
David S. Konczal
Shaw Pittman LLP
2300 N Street NW
Washington, D.C. 20037
Counsel for XM Radio, Inc.

Multispectral Solutions, Inc.
20300 Century Boulevard
Germantown, MD 20874

Richard DalBello
Executive Director
Satellite Industry Association
255 Reinekers Lane
Suite 600
Alexandria, VA 22314

John C. Smith
General Counsel
Aeronautical Radio, Inc.
2551 Riva Road
Fifth Floor
MS 5-300
Annapolis, MD 21401

David A. Berg
Assistant General Counsel
Air Transport Association of America, Inc.
1301 Pennsylvania Avenue, N.W.
Suite 1100
Washington, D.C. 20004

Edward A. Yorkgitis, Jr.
Kelley Drye & Warren LLP
1200 Nineteenth Street, N.W.
Suite 500
Washington, D.C. 20036
Counsel for Aeronautical Radio, Inc. and
Air Transport Association of America, Inc.

Ari Q. Firzgerald
David L. Martin
Hogan & Hartson, L.L.P.
555 13th Street, NW
Washington, D.C. 20004
Counsel to Siemens VDO Automotive AG

Alliance Law Group LLC
8614 Westwood Center Drive, Suite 450
Tysons Corner, VA 22182
Counsel for Kohler Co.

Paul Withington
Vice-President
Cummings Research Park
7057 Old Madison Pike
Huntsville, AL 35806
Counsel for Time Domain Corporation

Lori S. Traweek
Senior-Vice President
Operations and Engineering
American Gas Association
400 N. Capitol Street, N.W.
Washington, D.C. 20001

Robert Cave
President
American Public Gas Association
11094-D Lee Highway, Suite 102
Fairfax, VA 22030-5014