Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band	)))))	WT Docket No. 07-293
	)	
Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band	)))	IB Docket No. 95-91 GEN Docket No. 90-357 RM No. 8610
	)	

REPLY COMMENTS OF XM RADIO INC.

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REPLY COMMENTS OF XM RADIO INC.

XM Radio Inc. ("XM") submits its reply to comments filed in response to the Federal Communications Commission's *Notice of Proposed Rulemaking* in the above-referenced docket, FCC 07-215 ("*Notice*").[1]

SUMMARY

The Comments filed in this docket demonstrate why this proceeding is so critical to more than 17.3 million consumers of satellite radio programming. First, the Comments underscore why permanent rules are needed for terrestrial repeaters in the Satellite Digital Audio Radio Service ("SDARS"). In the decade since XM received its authorization — and as the

1 *Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, WT Docket No. 07-293, Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, IB Docket 95-91, GEN Docket No. 90-357, RM No. 8610*, Notice of Proposed Rulemaking and Second Further Notice of Proposed Rulemaking, 22 FCC Rcd 22123 (2007) ("*Notice*").

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Commission hoped and expected when it created the SDARS service — XM has invested hundreds of millions of dollars to develop a nationwide repeater network, as a necessary complement to its satellite system. These repeaters are fundamental to meeting consumer expectations for reliable, uninterrupted audio program service with a service availability of greater than 99%. Sirius Satellite Radio Inc. ("Sirius") also has deployed its own repeaters based on the same technical necessity. Thus, the time is long past to complete action on SDARS repeater rules that the Commission first published for comment in 1997. XM and Sirius have fully supported the technical merits of their current proposals,[2] and those proposals should now be adopted.

In its comments, the WCS Coalition ("WCS Coalition" or "Coalition") continues its recent efforts to rewrite history and reinvent the WCS service. The Coalition asks the Commission to shoehorn mobile WiMax into a frequency band that the Commission expressly warned would be unsuitable for most mobile services (and especially broadband) due to the need to protect SDARS reception. The Coalition presents theoretical suggestions of how WCS spectrum owners might operate without harming SDARS service to consumers. However, on close inspection, those theories are based on flawed assumptions and are unsupportable in the real world.

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[2] Based on more recent testing and technical analysis, the current proposals of XM and Sirius differ from the proposed rules submitted by Sirius in 2006, Sirius Satellite Radio Inc., Petition for Rulemaking and Comments (filed Oct. 17, 2006), and supported by XM soon thereafter. Letter from Bruce D. Jacobs, Counsel for XM Radio Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission (filed Jan. 5, 2007). As the Commission notes, those proposals were based on a White Paper submitted by Sirius in March 2006. *Notice* at ¶ 12 n.34 *citing* Letter from Carl R. Frank, Counsel to Sirius Satellite Radio Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 05-256 and IB Docket No. 95-91, White Paper: Interference to the SDARS Service from WCS Transmitters (filed Mar. 29, 2006). We intend to supply new draft rules incorporating the proposals of XM and Sirius that are based our on more recent technical studies.

The WCS Coalition tries to appeal for sympathy by labeling its proposals as a "compromise," but the Commission should see through this rhetoric. The Coalition does not seek compromise; rather, it seeks reconsideration and reversal of rules firmly decided ten years ago. The Coalition completely disregards the fact that XM and Sirius have relied on those rules in making their multi-billion dollar investments in SDARS and bringing valuable services to the American consumer.

Similarly, the Commission should reject the WCS Coalition's recent argument that mobile WiMax is the "highest and best use" of WCS spectrum. Again, the Commission warned long ago that mobile broadband services were likely to be "infeasible" in this spectrum. Established, well-funded entities are in the process of developing mobile WiMax services in other bands better suited for that purpose. There is no need to harm satellite radio service to enhance the financial value of WCS spectrum that the Commission auctioned at bargain-basement prices — fully reflecting the limitations on its use — simply to reward speculators who have purchased that spectrum at low prices and now seek to enrich themselves at the expense of SDARS consumers.

In its initial Comments, XM presented test evidence of the serious harm that mobile WiMax operations would cause to reception from its satellites. In contrast, the WCS Coalition offers only flawed arguments and bare technical assertions to defend its proposals. In these Reply Comments, XM proves that the Coalition's theoretical assumptions do not meet real-world conditions with respect to such key parameters as path loss and noise floor. XM also demonstrates that the Coalition grossly understates the likelihood that mobile WiMax terminals will interfere with SDARS receivers and exposes the Coalition's positions that are inconsistent with the operational conclusions of the Coalition's members in the AWS-3 rulemaking. XM explains why the Coalition's primary answer to interference — more SDARS repeater coverage — misunderstands the way repeaters are used in SDARS networks, the coverage patterns of existing repeaters, and the enormous cost to consumers of additional repeater investment.

XM also demonstrated in its Comments that its repeaters do not cause harmful interference to WCS operations contemplated by the Commission's rules. Nevertheless, perhaps seeking leverage to effect its so-called "compromise," the WCS Coalition also argues for unnecessary restrictions on SDARS repeaters. Here too, the Coalition's technical arguments are fundamentally flawed. The Coalition mischaracterizes the XM repeater network in an attempt to make this point. The Coalition also ignores commercially available filters that typically would be used in WCS equipment. The Coalition fails to provide key parameters underlying its technical arguments, preventing a meaningful review of its conclusions. XM and Sirius have done their own testing,[3] and the results speak volumes regarding the lack of harmful interference SDARS would create to WCS operations contemplated by the current rules. The Commission should reject the Coalition's call for unnecessary power restrictions (especially on existing repeaters).

To put it simply, the WCS Coalition is asking the Commission to turn SDARS service into primarily a cell-based, terrestrial service, especially in major metropolitan markets, so that WCS licensees can offer a mobile broadband service inconsistent with the co-existence of a satellite service. The Coalition is seeking rules that would require SDARS operators to build

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3 As in XM's initial Comments, we have coordinated the preparation of our Technical Appendix with Sirius for the convenience of the Commission, while providing our own system-specific information and data, pursuant to an experimental grant of Special Temporary Authority. Sirius Satellite Radio Inc., File Nos. 0591-EX-ST-2007, 0085-EX-ST-2008 (call sign WD9XDT).

hundreds, if not thousands, of additional repeaters to provide the same service quality that they do today. This is no "compromise"; it is a reversal of a decade of history and associated investment.

In their Comments, XM and Sirius each made realistic proposals, based on real-world data, for rule modifications that would provide WCS spectrum owners with additional flexibility without unreasonably harming SDARS reception. XM and Sirius do not oppose carefully crafted rule changes (notwithstanding that even these changes will somewhat impair SDARS operations). But the Commission should reject the wholesale reinvention of the WCS band proposed by the WCS Coalition. As recently as one year ago, WCS spectrum owners assured the Commission that they were prepared to build out their networks without modification of the current WCS rules. Non-interfering fixed WCS operations have now been built and are operating. The Commission should have little sympathy for those WCS licensees who have allowed their spectrum to lay unused for a decade and now seek a fundamental change in the rules that SDARS operators have relied upon to bring service to the public.

XM asks that the Commission promptly bring this proceeding to a close. XM needs permanent SDARS repeater rules now, and the existing record fully supports the SDARS industry's positions. That said, if the Commission believes that any additional data is needed to address these subjects, it should quickly convene the parties and direct joint testing on an expedited basis. XM and Sirius have previously made clear that they are prepared to participate immediately in test design and data collection, including paying their fair share of the cost of a third-party tester.[4] Of primary concern is that this docket be completed promptly, based on sound technology rather than unfounded assumptions. Doing so will best serve the interests of millions of SDARS consumers and the public interest.

I. THE COALITION REWRITES HISTORY AND SPECTRUM POLICY IN ARGUING FOR MOBILE WIMAX IN THE WCS BAND.

The WCS Coalition's Comments are essentially a plea to be excused from key limitations of the fundamental service rules under which WCS licensees acquired their licenses, where such limitations exist to protect SDARS operators and their customers. The Coalition does not argue that WCS licensees cannot provide service with their spectrum under current rules. In fact, some WCS licensees are doing so today, including providing fixed broadband services, and more services are in the offing.[5] Indeed, just a year ago the Coalition obtained an extension of the WCS construction deadlines based in part on the representation that the ability of its members to operate did not depend on changes to the rules.[6] Now, somewhat disingenuously, the WCS Coalition tries to portray the Wireless Bureau's acquiescence in granting extensions of the WCS

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4 *See* XM Comments at 28 and n. 56; Sirius Comments at 24; Letter of James S. Blitz. Vice President, Regulatory Counsel, XM Radio Inc., and Patrick L. Donnelly, Executive Vice President, General Counsel & Secretary, Sirius Satellite Radio Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission (filed Feb. 28, 2008).

5 *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, Twelfth Report, 23 FCC Rcd 2241 ¶ 26 (Feb. 4, 2008) ("*CMRS Report*") ("AT&T is using its 2.3 GHz WCS spectrum licenses to offer fixed wireless broadband Internet access service in eight U.S. markets, including Juneau, AK."), *see also infra* Section I.B. (discussing other services being offered using WCS spectrum).

6 *See* Reply Comments of the WCS Coalition, WT Docket No. 06-102, at 12 (filed Jun. 23, 2006) ("[T]he WCS Coalition has not suggested that relief from the restrictive WCS spectral mask is necessary to permit deployments to move forward in accordance with their proposed extended construction schedule making the WCS spectral mask issue of no relevance here.") *see also* In re Request of AT&T Inc., BellSouth Corp., Comcast Corp., NextWave Broadband Inc., NTELOS, Inc., Sprint Nextel Corp., Verizon Labs Inc., and WaveTel NC License Corp. for Limited Extension of Deadline for Establishing Compliance With Section 27.14 Substantial Service Requirement, at 10 (filed Mar. 22, 2006) (noting that substantial progress has been made in the design of economically-viable equipment capable of supporting broadband networks in the 2.3 GHz band).

licenses based on prospects of developing new *fixed* WiMax equipment as an effort to "promote" *mobile* WiMax in the WCS band.[7] In granting these extensions, the Bureau in fact took pains to note the Coalition's representation that its members would meet the revised construction date whether or not the WCS rules were revised.

But now the WCS Coalition wants more. It even goes so far as to claim that the "highest and best use" of WCS spectrum is mobile WiMax,[8] and in this regard, the Coalition's basic complaint is that restrictive out-of-band emission ("OOBE") limits in the current rules (enacted to protect SDARS reception) make this new business plan more technically challenging and costly for WCS licensees.[9]

The WCS Coalition's arguments for overhauling key elements of the WCS rules rest on fundamental technical flaws. The Coalition grossly understates the harmful interference that mobile WiMax would cause SDARS reception and seeks to impose huge costs on SDARS operators (and ultimately their consumers) for new repeaters that would only partially mitigate this interference. These matters will be discussed in detail below.

But before doing so, we must address the Coalition's more general attempt to rewrite history and its corollary claim that its proposed rules reflect a "compromise." The Coalition appears to be suggesting that any resulting harms to SDARS somehow are fair and to be expected. Nothing could be further from the truth.

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7 *Compare* WCS Coalition Comments at 30 *with Consolidated Request of the WCS Coalition for Limited Waiver of Construction Deadline for 132 WCS Licenses*, Order, 21 FCC Rcd 14143, 14141 ¶ 12 (WTB 2006) (discussing potential for fixed wireless broadband based on trials conducted by licensees and evidence suggesting that new fixed wireless equipment would be available in the near future).

8 WCS Coalition Comments at 1.

9 *Id.* at 4-7.

A. The Commission Made a Final — Not "Initial" — Decision When it Warned WCS Licensees that Mobile WiMax Would Be "Infeasible"

First, the Coalition claims that the long-standing WCS rules somehow have been temporary and subject to change as WCS technology and business plans evolve.[10] This is simply wrong: the WCS rules were adopted as final operating rules, codified in Part 27 of the Commission's Rules, in part so that SDARS operators could rely on them in building their satellite audio programming business (as they have done at the cost of billions of dollars).[11]

The WCS Coalition cannot avoid the fact that when the Commission created the WCS rules in 1997, it expressly wrote those rules to protect SDARS operations. XM already has discussed the history of the WCS rules in its Comments, including the Commission's repeated warnings to WCS auction participants that use of WCS would be constrained by the need to protect SDARS reception.[12] The prices bidders paid for WCS spectrum reflected those warnings.

The Coalition tries to evade these clear statements of the Commission's intent by essentially arguing that the WCS rules were meant to be subject to ongoing reconsideration. Thus, for example, the Coalition claims that "the Commission *initially* cautioned WCS auction participants that the service would *initially* be subject to OOBE restrictions that could make provision of mobile services challenging."[13] Based on this characterization, the Coalition argues that the WCS rules are preliminary and subject to change and further "compromise." But there

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10 Indeed, WCS business plans have evolved dramatically over the years. The most recent publicly-announced change involves NextWave's plan to provide broadcast video using its mobile WiMax platform. *See, e.g.*, Kristen Beckman, *NextWave's latest effort: Mobile TV over WiMax*, RCR Wireless News (Mar. 10, 2008) ("The Company said its MXtv technology will be a standard feature in WiMax infrastructure products.").

11 XM Comments at 11-17.

12 *Id.* at 7-9.

13 WCS Comments at 5, n.10 (emphasis added).

was nothing "initial" about the WCS rules — they were just as final as any other rule in the Code of Federal Regulations, they have been in effect for over ten years, and WCS licensees have been on notice that those rules would serve to limit the services that they may offer and increase their costs. Most demonstrative of this point: the bidders recognized these restrictions when they valued the total WCS spectrum at only $14 million — a fraction of the winning bids for the SDARS licenses, with some WCS markets selling for as little as a single dollar.[14]

It is thus particularly disingenuous that the Coalition is seeking significant changes to the WCS rules in an attempt to squeeze — not just any mobile service — but mobile WiMax operations into WCS spectrum. The Coalition complains that the WCS rules "undermine the viability of the spectrum for mobile wireless broadband services"[15] — but this is hardly news. The Commission has made clear from the beginning of this service that the WCS spectrum is not feasible for such operations.[16] Even when the Commission amended the rules to permit certain low-duty portable WCS terminals, it emphasized:

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14 Ironically, in another context the WCS Coalition argues that pre-auction Commission warnings of operating constraints such as this are highly relevant. XM and Sirius have observed that their proposed technical rules are consistent with those adopted by the Commission for the Lower 700 MHz band. *See, e.g.,* XM Comments at 9. The Coalition's response is to argue that that proceeding is distinguishable "because the Commission specifically authorized high-powered operations prior to the auction, and warned potential bidders" that they were expected to take into account any resulting costs. WCS Coalition Comments at 33 n.69. Of course, the FCC did the same here when it repeatedly warned that it would be "infeasible" to provide mobile services in the WCS band. *See, e.g., Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service,* Report and Order, 12 FCC Rcd 10785, 10789 ¶ 25, 10801 ¶ 34, 10854 ¶ 138 (1997) ("*WCS Report and Order*"); *Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service,* Memorandum Opinion and Order, 12 FCC Rcd 3977, 3979 ¶ 5 (1997) ("*WCS MO&O*").

15 WCS Comments at 5.

16 In fact, when the Commission established the OOBE restrictions that would apply to WCS licensees to protect against interference to SDARS, the Commission concluded that the limits it originally proposed would be insufficient to protect SDARS receivers. *WCS Report and Order,* at 10854 ¶ 136. In this decision, the Commission adopted even more strict limits based on the record in the WCS proceeding and specifically encouraged potential WCS bidders and equipment manufacturers "to consult with one another prior to the commencement of the auction to determine what services and equipment can be economically provided on these frequencies." *Id.* at 10855 ¶ 138. The Commission noted that there were several means that could be employed to meet these restrictive limits,

> We wish to caution prospective WCS licensees, however, to consider carefully whether their anticipated uses and business plans can be successfully implemented under the additional technical and operational restrictions necessary to qualify for the less stringent out-of-band emission limit. In particular, wide area, full mobility systems and services such as those being provided or anticipated in the cellular and PCS bands are likely to be of questionable feasibility under either the alternative restrictions or the general out-of-band emission limits.[17]

Indeed, as the Commission reconsidered the WCS rules to this limited extent, it reserved the right to go back and make the limits on WCS even stronger, cautioning: "should the potential for WCS operations to interfere with DARS prove to be greater when the systems are implemented than our analysis indicates, we would of course revisit this issue and make appropriate adjustments."[18]

In light of all this history, the Coalition's arguments ring hollow insofar as they complain of costs WCS licensees would bear in providing mobile WiMax. The Commission expressly warned that this service would not be feasible in the WCS band and any party that might consider such operations would have to be prepared to face much higher costs and technical burdens than those offering mobile broadband in other spectrum.

It is equally relevant that while WCS licensees have been sitting on their spectrum or reselling it to spectrum speculators, XM and Sirius have been investing in designing a new technology, creating a new radio service, and developing a major business.[19] WCS licensees

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including "the use of linear amplifiers, filters distributed throughout the transmitter, and spectrum shaping signal processing." *Id*.

17 *WCS MO&O,* at 3979 ¶ 5.

18 *Id.* at 3992 ¶ 27 (citing 47 C.F.R. § 27.53(c) and noting that the rule permits the Commission at its own discretion to require greater attenuation than that specified in the rules).

19 Other incumbent users have similarly relied on existing rules. The Aerospace and Flight Test Radio Coordinating Council ("AFTRCC") commented that the Coalition's proposed OOBE limits would "increase dramatically" the risk of interference to flight test telemetry. Comments of Aerospace and Flight Test Radio Coordinating Council, WT Docket. No. 07-293, at 2-6 (filed Feb. 14, 2007) (noting that current OOBE limits, which

would have the Commission act as if on a blank slate, reinventing the WCS service to fit their members' new business models. But the time for reconsideration of the WCS rules is long past. XM bid and paid for its spectrum based on the flexibility the rules gave it to deploy SDARS and constructed a multi-billion dollar system in reliance on that flexibility — with complicated time and space diversity operating systems over two satellites, and with terrestrial repeaters to the extent necessary to meet consumer service quality expectations. The WCS Coalition is asking the Commission to rewrite those rules and seriously damage the fundamental technical and economic underpinnings of SDARS service solely to facilitate a mobile broadband business plan that the Commission ruled out of bounds a decade ago.[20] Sound regulatory policy would weigh in favor of licensees who built out multi-billion dollar systems, developed a customer base of 17.3 million, and can show with real data that the interference potential is severe, rather than reward spectrum speculation and efforts to change the rules based on deeply flawed technical assumptions.

B. The WCS Coalition Disregards the Many Other Bands that are Better-Suited for Mobile WiMax and Farther Along in WiMax Development

In addition to mistakenly suggesting that the WCS rules are "initial" and subject to change, the Coalition argues that mobile WiMax is the "current highest and best use" of WCS

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have worked "while WCS has been struggling (for years) to define a purpose and a technology, will not work at all if mobile applications are allowed to proliferate") ("AFTRCC Comments").

20 As XM noted in its Comments in this docket, the WCS auction prices reflected the strict technical limitations imposed on the spectrum. The entire 30 MHz of WCS spectrum was auctioned for under $14 million. *WCS Auction Closes,* Public Notice, 12 FCC Rcd 21653 (WTB 1997). In contrast, the AWS-1 auction raised more than $13.6 billion reflecting a far greater flexibility in operations feasible in the spectrum. *Auction of Advanced Wireless Services Licenses Closes*, Public Notice, 21 FCC Rcd 10521 (WTB 2006). The WCS Coalition now seeks essentially to relax the restrictions on WCS spectrum so that WCS licensees may offer the types of advanced services that will be offered in far more valuable spectrum. Clearly, should the Commission eliminate the restrictions placed on WCS spectrum to protect SDARS operations, WCS licensees will benefit from an enormous and unjust windfall – at the expense of satellite radio.

spectrum. This self-serving rhetoric is also wrong; the Commission has provided opportunities for mobile WiMax in many other spectrum bands that are much better suited for the purpose than is the WCS band and where the development of mobile broadband is much further along. There is thus even less reason to reinvent the WCS band and jeopardize billions of dollars of SDARS investment.

First of all, the WCS licensees could not reasonably suggest that their spectrum cannot be used to provide important and valuable services under the current rules. Equipment for fixed WCS service (including broadband fixed service) is available and has been deployed in the field. For example, AT&T is currently using its WCS licenses to offer fixed wireless broadband Internet access in eight markets in the United States — using WiMax.[21] In addition, Horizon Wi-Com has deployed a WiMax network in nine northeastern urban markets.[22] Comcast uses its WCS licenses to provide point-to-point wireless backhaul to connect Wi-Fi access points.[23] Stratos Offshore Services Company also provides broadband voice and data services under its WCS licenses to customers in the Gulf of Mexico.[24]

Second, and in any event, the WCS Coalition ignores the many other spectrum bands that can and do support mobile WiMax applications and other wireless broadband services — without rule changes and without causing widespread service disruption to millions of SDARS

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21 *CMRS Report*, at 2241 ¶ 26 (2008) (noting that AT&T is using its WCS spectrum to provide service in eight U.S. markets). IEEE 802.16e specifications provide technical standards for mobile WiMax services (as opposed to the older IEEE 802.16 specifications, which provided only for fixed WiMax services).

22 "WiMax Networks Go Live in Nine Northeast Cities," Information Week (Jun. 13, 2007), *at* http://www.informationweek.com/story/showArticle.jhtml?articleID=199903928; *see also, e.g.*, ULS File Numbers 0003045277 at Exhibit 1 (filed May 29, 2007). Horizon Wi-Com's WiMax network is IEEE 802.16e-compatible. *Id.*

23 *See, e.g.*, ULS File Numbers 0003107370 and 0003107379 at Exhibit A (both filed Jul. 12, 2007).

24 *See, e.g.*, ULS File Numbers 0003074022 (filed Jun. 18, 2007 and amended Aug. 23, 2007) and 0003074025 (filed Jun. 18, 2007 and amended Jun. 22, 2007 and Aug. 23, 2007) at Exhibit 1.

customers.[25] The cellular, PCS, AWS-1, 1670-1675 MHz, 700 MHz, 2.5 GHz Broadband Radio Service and Educational Broadband Service ("BRS/EBS"), and 3650-3700 MHz bands, among others, all may be used for fixed and mobile broadband services. The service rules eventually adopted for the AWS-2 and AWS-3 bands also are likely to support fixed and mobile wireless broadband based on the Commission's proposals. In total, these bands represent *more than 600 MHz of spectrum* that may be used for mobile wireless broadband services.

Even with respect to the deployment of WiMax-based services specifically, the WCS band is not the only band available for use. For example, spectrum in the 700 MHz band may be used to deploy WiMax services.[26] Some of that spectrum has been auctioned and is already available to accommodate such services, and the current auction will make an additional 62 MHz of spectrum available for deployment of such services.[27] The BRS/EBS bands (2.5 GHz) contain almost 188 MHz of spectrum that may be used for WiMax and other commercial broadband services — more than six times the amount of allocated WCS spectrum.[28] In fact, Clearwire already has deployed fixed WiMax services in the BRS/EBS bands (and has completed mobile WiMax trials), and Sprint Nextel has announced its intent to deploy mobile WiMax services in

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25 *See also* AFTRCC Comments at 5 (noting that WCS rule changes are not "necessary for the provision of WiMax services," and that "[o]ther bands . . . are all available for this purpose").

26 *See, e.g.,* Comments of Google Inc., WT Docket No. 06-150, at 7 (filed May 23, 2007), *see also CMRS Report* at ¶ 84 ("The total 84 megahertz of commercial spectrum in the 700 MHz band will generally be open to a broad range of flexible uses. This spectrum has many permissible uses: new licensees may use the spectrum for fixed, mobile (including mobile wireless commercial services), and broadcast services.").

27 *See Service Rules for the 698-746, 747-762 and 777-792 MHz Bands,* Second Report and Order, 22 FCC Rcd 15289 ¶ 5 (rel. Aug. 10, 2007); s*ee also CMRS Report* at ¶ 84.

28 The BRS bands include 73.5 MHz of commercial spectrum. The EBS bands include a total of 120.5 MHz of spectrum, and EBS licensees may lease up to 95% of their spectrum to commercial operators (for a total of 114.475 MHz of commercially available EBS spectrum).

those bands.[29] Moreover, WiMax BRS/EBS equipment is readily available, whereas no consumer equipment has yet been widely deployed for the 2.3 GHz band.

The WCS Coalition does not even attempt to discuss the availability and use of these alternative bands, which clearly demonstrate that widespread deployment of mobile WiMax does not depend upon the use of WCS spectrum or changes to the WCS rules. Nor does the Coalition provide any other justification to support its "highest and best use" rhetoric. The best it can do is observe that this spectrum will be used for mobile WiMax in other parts of the world, and consequently that certain equipment used overseas could be used for WiMax use here in the United States.[30]

But the Commission effectively addressed this argument when it authorized the SDARS and WCS services ten years ago. At that time, the Commission specifically acknowledged the fact that the 2320-2345 MHz band would be the home for SDARS service, unlike mobile

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29 *See, e.g.*, "Sprint Sets Stage for 2008 Xohm WiMAX Launch with Service, Device and Advertising Agency Agreements," Press Release (Jan. 1, 2008), *available at* http://newsreleases.sprint.com/phoenix.zhtml?c =127149&p=irol-newsArticle_newsroom&ID=1093296&highlight= (stating Sprint's planned 2008 commercial WiMax launch); "Can WiMax Save Sprint?" Business Week (Feb. 11, 2008) *at* http://www.businessweek.com/the_thread/techbeat/archives/2008/02/can_wimax_save.html?chan=search (reporting Sprint's planned launch of its Xohm WiMax service in April 2008 to the Washington, D.C., Chicago, and Baltimore markets); "Clearwire Successfully Completes First Phase Of Mobile WiMAX Field Trial," Press Release (May 21, 2007), *available at* http://investors.clearwire.com/phoenix.zhtml?c=198722&p=irol-newsArticle&ID=1004778&highlight=. Sprint also has announced that it is collaborating with Google to develop a new mobile portal for Sprint's WiMax service. "Sprint and Google to Collaborate on WiMAX Mobile Internet Services," Press Release (Jul. 26, 2007) *available at* http://www.xohm.com/news-072607.html. Sprint Nextel and Clearwire also reportedly are planning to revive their WiMax partnership. "Sprint, Clearwire Near WiMax Deal," TheStreet.com (Feb. 15, 2008) *at* http://www.thestreet.com/story/10403584/1/sprint-clearwire-near-wimax-deal.html. Intel also is reportedly planning to support the Sprint Nextel and Clearwire venture with a $2 billion investment. *Id.*; *see also* "Intel Seeks Salvation in WiMax," Fortune Magazine (Mar. 4, 2008) *available at* http://money.cnn.com/2008/03/04/technology/intel_analysts_day.fortune/?postversion=2008030412.

30 The WiMax Forum and Motorola make the same argument, but neither even attempt to address the technical harm that mobile WiMax would cause to SDARS. *See* Comments of WiMAX Forum, WT Docket No. 07-293, at 5-7 (filed Feb. 14, 2008) ("WiMAX Forum Comments"); Comments of Motorola, Inc., WT Docket No. 07-293, at 2-3 (filed Feb. 14, 2008) ("Motorola Comments"). While it is understandable why the Forum is a booster of "more WiMax," it has other bands where it can better place its efforts. Similarly, it is understandable that Motorola wants to sell more mobile equipment, but it too should focus on other bands here in the United States that are better suited for that purpose and do not endanger SDARS operations.

broadband services, which can be accommodated in many other bands in the United States.[31] In addition, when the Commission granted limited relaxation of the OOBE limits for low power mobile WCS terminals, it stated:

> We also recognize that the 2320-2345 MHz frequency band is the only spectrum specifically available for provision of Satellite DARS in the United States. Accordingly, if Satellite DARS in this spectrum is subject to excessive interference, the service will not be successful and the American public will not benefit from the service. In contrast, [Personal Access Communications Systems] can be provided in other spectrum currently available for use by services including cellular and PCS.[32]

Notwithstanding the clarity of the Commission's position, it was only many years later — in 2006 — that WCS licensees began talking about substituting mobile WiMax services for the fixed and low-power mobile services authorized under the WCS rules.[33] Yet the basic reasons for restricting such operations in the United States remain today. Unlike other nations, this country has set aside the 2320-2345 MHz band for SDARS, leading to multi-billion dollar investments by XM and Sirius to the benefit of more than 17.3 million current SDARS subscribers. In these circumstances, the Commission must take great care to ensure that SDARS service is not forced to confront new obstacles that may negatively impact service quality and consumer cost. The WCS Coalition, for all its rhetoric, cannot alter those facts.

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31 *CMRS Report*, at 23 FCC Rcd 2241 ¶ 77.

32 *WCS MO&O*, 12 FCC Rcd at 3992 ¶ 27.

33 It was not until June 2006, in the context of the WCS substantial service extension request proceeding, that the WCS Coalition first hinted that its members may seek to provide mobile services – and even then the Coalition stressed that the WiMax standard "supports a variety of non-mobile service offerings." Reply Comments of the WCS Coalition, WT Docket No. 06-102, at 13 (filed Jun. 23, 2006)

II. THE WCS COALITION'S "THEORETICAL" ANALYSIS GROSSLY UNDERESTIMATES INTERFERENCE FROM WCS MOBILE WIMAX INTO SDARS RECEIVERS UNDER ITS PROPOSED RULES

The wisdom of the Commission's long-standing restrictions on WCS operations is borne out in real-world testing. In its Comments in this proceeding, XM provided a detailed technical analysis demonstrating, through actual test data, the harm that mobile WiMax operations in fact would cause to SDARS service.[34] If WCS rules are relaxed as proposed by the Coalition, XM demonstrated that a mobile WiMax terminal would mute an SDARS satellite receiver when the WCS device transmitted from as far away as 16.3 meters.[35] Sirius has provided its own test data showing similar results for its receivers.[36] Such interference would be crippling to SDARS service in this country.[37]

In contrast to the real-world tests done by the SDARS operators, the WCS Coalition has offered the Commission only theoretical models based on flawed assumptions. The WCS Coalition admits that, to this point, the only studies it can offer are "preliminary field tests" yielding only a "preliminary analysis."[38] Even this characterization overstates the depth of the inquiry reflected in the Coalition's Comments.[39] XM therefore is placed at a disadvantage and

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34 *See* XM Comments at 30, Technical Appendix Exhibit C. This work built on previous analysis presented to the Commission showing that the WCS proposed OOBE limits would raise the satellite noise floor by 1 dB when the two devices operated within 860 meters of each other. See Letter from Patrick Donnelly, General Counsel, Sirius Satellite Radio Inc. and James Blitz, Regulatory Counsel, XM Radio Inc. to Marlene Dortch, Secretary, FCC, IB Docket No. 95-91 and GEN Docket No. 90-357 at Annex 1, 2 (filed Sept. 19, 2007).

35 This test was conducted using a 112 mW WCS transmitter. Technical Appendix, Exhibit C at 8.

36 *See* Sirius Comments at 23. Sirius's field testing indicates that a single WiMax mobile device operating at 250 mW would mute a satellite radio receiver at distances between 17.7 and 38 meters, depending upon the block in which the device operates.

37 *See* XM Comments at 13-14.

38 WCS Coalition Comments at 18, 31.

39 For example, the Coalition claims that in an area receiving SDARS service only by satellite, a 250 mW WCS transmitter induces muting in an SDARS receiver at distances of four to thirteen feet. WCS Comments at 18. This claim does not conform to XM test results and is completely unsupported. The Coalition fails to provide any

reserves the right to comment further based on any new material that the Coalition or WCS licensees may place in the record in their Reply Comments or subsequently in this proceeding. To state the obvious, the WCS Coalition has not even begun to meet its high burden of justification to revise long-standing restrictions that the Commission specifically placed in the rules to protect SDARS reception.

Meanwhile, XM has done its best to review and analyze the WCS Coalition's technical showing, hampered in key places by a lack of transparency as to the Coalition's assumptions and methodology. Notwithstanding these constraints, one can already identify major flaws in the Coalition's arguments that seek to minimize the actual harm mobile WiMax devices would cause in service to SDARS consumers.

A. The WCS Coalition Makes Errors in Key Technical Parameters

The minimal technical analyses provided by the WCS Coalition largely rests on one document: a theoretical "White Paper" prepared by NextWave Broadband Inc. ("NextWave"), a WCS licensee.[40] However, the NextWave Paper makes several assumptions that are either erroneous or misleading — each of which contribute to a significant underestimation of interference from mobile WiMax devices into SDARS receivers. Taken together, these incorrect assumptions fatally undermine the credibility of the Coalition's arguments.

XM and Sirius have conducted additional analyses in an attempt to understand the Coalition's arguments. As demonstrated in the attached Technical Appendix, the Coalition ignores real world engineering principles. The flaws in the NextWave Paper are confirmed by

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explanation of the relevant parameters behind this assertion, including the frequency block in which the WCS terminal operates, its duty cycle, test conditions, or the particular victim receiver.

40 *Id.*, Attachment B, Interference to SDARS Receivers from WCS Subscriber Terminals ("NextWave Paper" or "Paper").

the extensive field and bench test data produced by XM and Sirius, demonstrating that relaxing WCS OOBE limits as the Coalition has proposed will cause an unacceptable muting of SDARS receivers.

1. The WCS Coalition Exaggerates Relevant Path Loss

The NextWave Paper is flawed because it overstates path loss from mobile WiMax terminals into SDARS receivers by at least 10-15 dB.[41] As the Commission knows, path loss is one of the key components of assessing potential interference.[42] NextWave asserts that the expected path loss into SDARS receivers is 52 + 22 log (D).[43] However, this conclusion is inconsistent with well-established engineering principles drawn from other research, and with field tests conducted by XM attempting to replicate the NextWave Paper experiment. Based on its flawed results, NextWave drastically overestimates the actual attenuation of the signal from a WCS transmitter into an SDARS receiver and correspondingly understates the likelihood that WCS interference will mute the receiver.

Extensive recent testing of mobile-to-mobile path loss across short distances has determined such loss to be free space path loss + 3 dB.[44] NTIA and IEEE have conducted large

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41 Technical Appendix, Exhibit B at 8-9.

42 Path loss is the measure of the reduction in power density (attenuation) of an electromagnetic wave as it propagates through space — a major component in the analysis and design of the link budget of a radio-telecommunications system. Path loss may be caused by many effects, such as refraction, reflection, and absorption of a wireless signal due to environmental factors such as clutter, or the distance between the transmitter and receiver, as well as the height and location of antennas.

43 WCS Coalition Comments, Attachment B, at 12. The NextWave Paper states that the path loss can be expressed by: path loss (dB) = 52 + 22 log (D). XM engineers were unable to determine the theoretical basis on which this measurement is based, although they tested each of the widely used theoretical models.

44 Technical Appendix, Exhibit B at 2-4.

studies of this issue demonstrating this result.[45] Verizon and Motorola used this same approach to path loss calculation recently in their filings in the Commission's AWS-3 Rulemaking.[46]

It appears that NextWave purports to derive a claimed path loss based on a curve fit of data points.[47] Notably, however, the path loss figure used in the NextWave Paper is significantly higher than results consistent with the established "free space + 3 dB" path loss found in the third-party tests noted above. The Paper does not discuss this matter, nor does it explain why its results depart from those of other studies in the field.

XM attempted to understand the NextWave position by conducting field tests of path loss. As described in the attached Technical Appendix, XM engineers carefully documented the path loss between a WCS subscriber device operating in the D-Block and a standard XM radio receiver.[48] XM's results were fully consistent with those to be expected from the literature of other studies, as can be seen from curve fits that track XM's measured data to a curve of free space + 3 dB. Across the range of distances, the actual path loss is 52-73 dB for distances of three to 32 meters. At three meters the path loss is 10.1 dB less than that claimed by the NextWave Paper.

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45 Nicholas DeMinco, Propagation Loss Prediction Considerations for Close-In Distances and Low Antenna Height Applications, NTIA Report, TR-07-499 (Jul. 2007); T.J. Harrold et al., Propagation Studies for Mobile-to-Mobile Communications, Vehicular Technology Conference 2001, IEEE VTS 54th, vol. 3, 1251-55 (Oct. 2001).

46 Comments of Motorola, Inc., WT Docket No. 07-195, A-2 (filed Dec. 14, 2007) ("Motorola AWS-3 Comments"); V-Comm Telecommunications Engineering Presentation of Feb. 19, 2008, 5 *submitted with* Letter from Donald C. Brittingham, Director, Wireless / Spectrum Policy, Verizon Wireless, to Marlene H. Dortch, Secretary, Federal Communications Commission, Ex Parte Presentation, WT Docket No. 07-195 (filed Feb. 19, 2008).

47 The NextWave Paper does not provide sufficient information on test procedures to explain why its data is inconsistent with those in other path loss studies. It is possible to speculate as to test process errors, but the key point is that the Paper data results do not conform with those associated with the accepted definition of path loss.

48 Technical Appendix, Exhibit B at 8-9.

As a result, it is clear that the NextWave Paper materially understates the path loss impact of mobile WiMax terminals on SDARS reception. For example, as demonstrated by the XM test results, the path loss from a WCS interfering device into an SDARS receiver at 3 meters is approximately 52 dB — compared to a path loss of 62.5 dB for the same distance under the Paper's analysis.[49] Although sound reasons exist for preventing interference at closer than three meters, this distance is the absolute minimum needed to protect against interference from mobile WiMax terminals used in vehicles, or on sidewalks, adjacent to vehicles using SDARS receivers.[50]

2. The Coalition Underestimates the Relevant Noise Floor

Noise floor analysis is another key element of assessing the OOBE that an SDARS receiver may tolerate and still receive uninterrupted program service. NextWave agrees with XM and Sirius that a 1 dB rise in noise floor is the appropriate measurement, and the NextWave Paper incorporates this parameter.[51] However, the noise floor measurement provided at the outset is critical as well, as 1 dB represents a dramatic change in receiver tolerance levels.

In connection with their initial Comments, XM and Sirius each retained an independent third party to determine the appropriate noise floor for use in this analysis. That entity calculated

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49 *Id.*, Exhibit B at 3.

50 Notably, the WCS Coalition actually admits that the interference to a satellite radio receiver occurs with an 87 dB path loss. WCS Comments at 13. This would require nearly a 38 meter distance separation to avoid interference between the WCS transmitter and the victim satellite receiver.

51 NextWave Paper at 11.

the relevant noise floor as -113 dBm.[52] In contrast, the WCS Coalition relied on a noise floor of -111 dBm, 2 dB higher.[53]

XM engineers have revisited their field and modeling data to try to replicate the results of the NextWave Paper with respect to overload interference and the appropriate noise floor for SDARS receivers. The field tests by XM engineers confirmed a -113 dBm noise floor, the same as found by the independently conducted noise floor measurement submitted with its Comments. XM engineers, however, were unable to replicate the NextWave Paper's data concerning the WCS OOBE levels that constitute a 1 dB rise in the SDARS receiver noise floor. The incorrect NextWave noise floor measurement significantly exaggerates the level of interference SDARS receivers are able to tolerate.

3. The Coalition Minimizes the Probability of Interference Due To Unrealistic Assumptions Concerning Mobile WiMax Use

The WCS Coalition makes broad and erroneous claims that, in practice, mobile WiMax transmitters will operate in a manner that rarely interferes with SDARS, notwithstanding the technical interference characteristics of the WCS devices. Drawing on assumptions made in the NextWave Paper, the Coalition argues that: (i) the typical use characteristics of mobile WiMax service will not cause interference into SDARS receivers, and (ii) in any event, WCS transmitters rarely will be close enough in proximity to affect SDARS receivers.

To begin with, the WCS Coalition's arguments are not based on traffic studies or other real-world data, but on self-serving assumptions of the potential subscriber use of a hypothetical service. Actual usage, and hence actual interference to SDARS, is likely to be very different.

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52 *See* XM Comments, Technical Appendix, Exhibit C, Appendix 1. For ease of reference, this study is also provided in the attached Technical Appendix at Exhibit C, Appendix 1.

53 NextWave Paper at 11; WCS Comments at 13-14.

The Commission also should recognize that any changes to OOBE limits will apply 100 percent of the time, permitting increasingly harmful interference in an environment where mobile WiMax operations would be likely to grow unpredictably both in absolute numbers and in incidences of proximity to SDARS.

Even recognizing the difficulty of predicting actual mobile WiMax activity, it is possible to identify key flaws in the WCS Coalition's assumptions and to demonstrate how the Coalition understates the likely harm to SDARS subscribers.

a. Ignoring Conflicting Service Uses

First, the WCS Coalition suggests the characteristics of the services supported by mobile WiMax will only rarely harm SDARS reception. The Coalition claims that the NextWave Paper overestimates potential interference. Under real world conditions, the Coalition suggests, mobile WiMax users would transmit in bursts rather than in a continuous duty cycle (the parameter used in the NextWave Paper).[54] In addition, the Coalition argues that SDARS receivers' built-in buffering capacity would be sufficient to mask OOBE interference from a WCS transmitter such that the SDARS customer would not "suffer any interruption in his or her listening."[55]

XM strongly disagrees with these assumptions. Although broadband traffic is generally characterized by bursts rather than a continuous stream, some transmissions are more continuous than others. For example, it is very likely that mobile WiMax terminals will be used for voice telephony service, just as other cellular mobile services incorporate features reflecting the convergence of voice and data services. However, when a WCS mobile broadband user is transmitting voice, the traffic will be much more constant than the Coalition suggests and the

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54 NextWave Paper at 25.

55 WCS Coalition Comments at 20.

buffer capacity in a typical SDARS receiver will not mitigate this interference. That buffer capacity has been designed to deal with short term interruptions to be expected in a mobile satellite environment, such as passing for a very brief time under a highway overpass. Buffering is no solution to the continuous bursts that will occur in a VoIP transmission, where the terminal user predictably will talk for many seconds, if not minutes.[56]

In any event, mobile WiMax service should not be allowed to squander buffering capability that already is central to the SDARS network design and the technical challenges of providing the satellite-based service. XM uses buffering to mitigate all sources of satellite reception blockage, including random reception problems due to environmental or weather conditions. Consequently, the partial mitigation of WCS interference through buffering reduces the availability of buffering for the purposes for which it is designed, and thereby degrades overall SDARS network performance.

b. Ignoring Real-World Terminal Locations

The WCS Coalition also significantly underestimates the likelihood that WCS mobile devices would be close enough in proximity to a SDARS receiver to impact SDARS signal reception. This error stems from the NextWave Paper's overly-simplistic assumption that WCS user terminals would be distributed uniformly throughout a service area.[57] Specifically, the Paper argues that WCS operators would deploy a cellular system, and then simply assumes —

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[56] File upload from a mobile computer is another problem-use case. This would be a similar type of transmission to a VoIP telephone call and cannot be mitigated by SDARS buffer capacity.

[57] NextWave Paper at 17.

with no data — that mobile WiMax terminals rarely would be at the fringe of the cell where the most power would be required to transmit back to the WCS base station.[58]

These assumptions reduce the theoretical interference that might occur, but they are unfounded in the real world. The practical reality is that mobile WiMax terminals will not operate at random locations; rather, they will operate in exactly the same geographic locations as large numbers of SDARS receivers – in urban areas and particularly along major traffic arteries. Interference problems especially will arise along streets near the edges of WCS cells. Mobile WiMax terminals operating at those locations (in nearby vehicles on the same street or handheld on adjacent sidewalks) will cluster together with SDARS receivers at those locations in many cells. As the mobile WiMax terminal increases power to communicate with the more distant base station, the likelihood of muting to nearby SDARS receivers will increase further.

4. The Coalition Incorrectly Claims that Interference to SDARS Can Be Minimized By Technical Operations

The WCS Coalition suggests that polarization and angular discrimination would reduce the potential for interference into SDARS reception. The Coalition claims "it is highly likely that there will be a polarization mis-match" and "it is highly unlikely that subscriber equipment will be perfectly aligned."[59] However, this is incorrect, as it ignores the fact that SDARS receiver antennas are vertically polarized at 90º elevation angles for satellite reception and have a left-hand, circular-polarized reception for terrestrial signals. The predominant deployment for mobile broadband devices would use vertical polarization as well. Moreover, in any environment in which both WCS mobile devices and SDARS receivers operate in close

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58 *Id.*

59 WCS Coalition Comments at 20.

proximity, signal reflections from adjacent vehicles will cause random changes to polarization. Accordingly, it is unlikely that polarization and angular discrimination will mitigate interference from WCS transmitters into SDARS receivers.

The Coalition also suggests that interference to SDARS reception can be mitigated by power control on the mobile WiMax terminals.[60] While we believe power control is an essential requirement for WCS devices, a power control mechanism will not prevent WCS devices from operating at full power at the outer edges of the WCS coverage area, and will not materially reduce the coverage area in which SDARS receivers are subjected to interference. In order to get a signal to the base station, a WCS device will have to transmit at maximum power any time it is at the outer edge of the coverage area. It is an unavoidable consequence that these outer edges of WCS base station coverage areas will incorporate major roads and highways. In these locations, SDARS receivers in vehicles will undoubtedly be affected.

B. The WCS Coalition's Arguments Are Inconsistent With Positions Taken in the AWS Rulemaking

Because of the substantial mobile-into-mobile interference issues discussed above, it is unrealistic to conclude that mobile WiMax operations can be made compatible with SDARS operations. As XM noted previously, parties commenting in the recent Advanced Wireless Service ("AWS") proceedings have raised strikingly similar issues with respect to adjacent channel interference.[61] Moreover, WCS Coalition members and other companies seeking to develop service offerings based on a mobile WiMax platform have taken positions in that proceeding that conflict dramatically with the Coalition's suggestion that SDARS can

60 *Id.* at 14-16.
61 XM Comments at 36-37.

accommodate a mobile WiMax service in the WCS band.[62] As XM has already pointed out, comments in the AWS-3 proceeding suggest that the WCS Coalition's proposals in this case for relaxed OOBE and power limits would not even mitigate interference among mobile WiMax service providers themselves, let alone facilitate coordination with adjacent channel users.[63]

In the attached Technical Appendix, XM outlines the similarities between the mobile-into-mobile adjacent channel interference concerns present in the AWS proceedings and those in the context of WCS and SDARS spectrum.[64] Notably, parties in the AWS-3 proceeding analyzed a similar band plan, with similar receivers, and concluded that unfettered mobile broadband deployment would cause interference to existing users of adjacent bands. Motorola conducted tests regarding the potential for AWS-3 services to interfere with adjacent AWS F Block users and concluded that "allowing mobile use in the [AWS-3] band may require power and out of band emissions restrictions on AWS-3 operations that are more restrictive than those applied to other mobile bands."[65] AT&T reached the same conclusion, noting that "Provision of uplink transmissions in the band would require stringent restrictions on operating power and [OOBE] and render deployment of a commercial mobile network impractical."[66]

The best assessment of the policy issue before the Commission was presented by the CTIA: "AWS-1 licensees have invested billions of dollars in spectrum, network deployment, and operations and maintenance to deliver high-quality next-generation mobile wireless services to consumers. The Commission therefore should adopt rules for the AWS-3 band that protect

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62 *See* Technical Appendix, Exhibit E at 6 (outlining positions of parties in the AWS-3 proceeding, WT Docket No. 07-195 with respect to OOBE and EIRP recommendations).

63 XM Comments at 38.

64 Technical Appendix, Exhibit E.

65 Comments of Motorola, Inc. WT Docket No. 07-195, 3 (filed Jan. 14, 2008).

66 Reply Comments of AT&T Inc., WT Docket No. 07-195, 1 (filed Jan. 14, 2008).

operations in adjacent bands from interference."[67] The case is even stronger here, where the Commission already provided for the protection of SDARS operations, and WCS licensees bought their spectrum knowing those restrictions.

Yet the WCS Coalition ignores the comments and technical showings made in the AWS-3 proceeding, including showings by WCS licensees, and proceeds to seek rule changes that raise directly analogous interference concerns. As discussed further in the Technical Appendix, the WCS Coalition's proposed mobile EIRP for the WCS band is <u>17 dB higher</u> than the maximum EIRP limit that would be required to protect SDARS under the methodology used by Motorola in the AWS-3 proceeding. Moreover, the Coalition's proposed OOBE limit is <u>26.5 dB less</u> than the limit proposed by Motorola as necessary to protect against interference to incumbent users.

III. AS A PRACTICAL MATTER, THE WCS COALITION IS ASKING TO MAKE SDARS A CELL-BASED TERRESTRIAL SERVICE IN METROPOLITAN AREAS TO ACCOMMODATE MOBILE WIMAX

The WCS Coalition not only grossly understates the harm mobile WiMax would cause to SDARS satellite-only reception, but compounds its error by suggesting that SDARS operators can use terrestrial repeaters to compensate for mobile WiMax interference. According to the Coalition, XM customers will not experience material interference because insofar as mobile WiMax mutes service from the satellites, repeaters can fill the breach.[68]

As an initial matter, this argument stands the purpose of satellite radio on its head. XM has carefully designed its satellite-based system (including operation at two orbital locations for space and time diversity) to minimize the number of repeaters needed to provide SDARS service

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67 Comments of the CTIA – The Wireless Association, WT Docket No. 07-195, 3 (filed Jan. 14, 2008).

68 WCS Comments at 18.

of acceptable quality to customers. Although repeaters are critical to XM's operations in many metropolitan areas, relying on the benefits of satellite service, XM has limited repeater deployment as much as possible. XM discussed these matters in detail in its Comments, and will not restate them here.[69]

Furthermore, the WCS Coalition's argument is factually flawed. The Coalition fails to acknowledge the repeater power level that would be required to overcome interference from a mobile WiMax terminal. The Coalition also drastically overstates the current coverage of SDARS repeaters or the consequences for overall system design. In reality, hundreds, if not thousands, of additional repeaters would be required to overcome mobile WiMax interference, at a cost of hundreds of millions of dollars. XM also would need to replace its signaling format as well as its entire installed base of repeaters and consumer receivers, causing a massive disruption to XM's business and great harm to all consumers of satellite radio services. Moreover, there is no feasible way to use repeaters across the country to eliminate mobile WiMax interference in crowded interstate highways, intersections, and any other place where significant numbers of people gather.

Essentially, the WCS Coalition wants the Commission to turn SDARS from a satellite-based service into a terrestrial service, especially in metropolitan areas. This absurd outcome would not only undermine the Commission's intention that SDARS is primarily a satellite service, but it would also impose huge capital outlays and expenses on SDARS operations and SDARS consumers – again only to accommodate a mobile WiMax service for which WCS spectrum was never intended.

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69 *See* XM Comments at 11-16.

A. The WCS Coalition Grossly Underestimates the SDARS Repeater Power Required to Overcome a Mobile WiMax Transmitter

The WCS Coalition's suggestion that terrestrial SDARS repeaters are the answer to mobile WiMax interference defies common sense. The Coalition asserts that: "no muting could be induced in the tested SDARS receivers when those receivers were served by SDARS terrestrial repeaters."[70] However, the Coalition provides no meaningful technical analysis to support this claim.

In contrast, as detailed in the attached Technical Appendix, XM has conducted real-world tests of the repeater serving level that would be required to overcome a 250 mW mobile WiMax transmitter located three meters away from an SDARS receiver. These tests conform to the expected power levels of mobile WiMax transmitters. Similarly, although comment in the AWS proceedings would suggest that a one-meter separation distance should be protected,[71] XM believes that three meters is an acceptable limit given the in-vehicle nature of most SDARS receivers and common traffic patterns where SDARS and mobile WiMax could be used in proximity (as discussed above).[72]

XM's test results are presented here in Exhibit C of the Technical Appendix.[73] XM determined that the repeater serving level would need to be -60 dBm, a power far in excess of its existing repeater footprint. Again, these test results stand in contrast to the WCS Coalition's failure to define the basis for its own assertions.

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70 WCS Comments at 18.

71 *See, e.g.*, AT&T AWS-3 Reply Comments at 4-5; Motorola AWS-3 Comments at 5-7, A-5; Verizon Wireless AWS-3 Comments at Attachment A.

72 *See* Technical Appendix, Exhibit B at 3. Indeed, the Commission has previously used a protection zone of 12 feet for SDARS receivers when it modified OOBE for low power, portable devices in the WCS band. *WCS MO&O*, at 3993 ¶ 31.

73 Technical Appendix, Exhibit C at 11.

B. The WCS Coalition Grossly Exaggerates the Service Area of XM Repeaters

The WCS Coalition also provides an inaccurate picture of the service patterns of current XM repeaters. According to the Coalition, "one need only look at the over 1,000 terrestrial repeaters XM and Sirius have deployed to see that most urban areas of any size, and their surrounding suburbs, are well served with terrestrial repeaters."[74]

This is simply wrong. As XM has discussed, it has no incentive to deploy repeaters where satellite coverage is adequate. We have a well-established technical model to evaluate where repeaters might be needed based on terrain and other related conditions. We have tested this model through actual measurements, including drive-testing, throughout markets where we operate. In short, we rely on our engineering to make investment decisions to ensure high quality consumer service at the lowest possible cost — that is, by relying on satellite service to the maximum extent possible.

The WCS Coalition also provides what it claims to be coverage maps of XM's repeaters for the Washington, D.C. and New York City metropolitan areas. The Coalition argues that its maps demonstrate widespread, high power repeater service in these areas.[75] However, once again, the Coalition's facts are incorrect and its analysis deeply flawed, grossly overstating actual repeater coverage. First, the Coalition appears to be mapping repeaters that were initially authorized but were never built.[76] As XM has indicated in this proceeding and in other

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74 WCS Comments at 17.

75 *Id.*

76 The fact that XM has fewer repeaters in service than are covered in its initial authorization is a matter of record before the Commission, in a proceeding in which the WCS Coalition itself has participated. In XM's October 2006 Request for Special Temporary Authority, XM noted that: "The repeater network that XM is requesting to operate with the technical parameters in Exhibits A.1 and A.2 represents over 300 fewer repeaters than the FCC authorized XM to operate in its existing STAs, including 85 fewer high power repeaters, and over 250

Commission proceedings, it fortunately has been able to provide service with many fewer repeaters than originally anticipated.[77] It also appears that the Coalition did not use reasonable terrain assumptions in developing repeater profiles. For example, for unknown reasons, the Coalition labeled its coverage maps of the New York City repeater networks "Sub-90%"[78] suggesting that the Coalition is treating Manhattan as if it were a suburban area for coverage purposes, notwithstanding all of the obvious transmission challenges in that most urban of settings.[79]

In any event, the reality of the XM repeater network is far different from that hypothesized by the Coalition. In the attached Appendix, XM provides repeater coverage maps here for the same two cities chosen by the Coalition,[80] using the same methodology that we use in our day-to-day business to evaluate the need for repeaters and their adequacy in meeting fill-in service requirements where satellite signals are not available. We also have provided maps based on actual drive tests of XM service in those same cities. Those drive tests have proven the

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fewer medium power repeaters (operating in the 2 - 10 kW range). From an overall system standpoint, the total power being radiated and particularly the radiation of high power signals in urban markets results in a network that should be less objectionable to other parties than the network approved by the Commission in XM's previous STAs." Letter from James S. Blitz, Vice President, Regulatory Counsel, XM Radio Inc, to John Guisti, Acting Chief, International Bureau, Federal Communications Commission, Request For Special Temporary Authority to Operate Satellite Digital Audio Radio Service Terrestrial Repeaters, SAT-STA-20061013-00119 (filed Oct. 13, 2006).

77 XM Comments at 14.

78 We believe the WCS Coalition used CellPlan software to construct these maps. In this software, coverage can be predicted using several different parameters, depending on the type of terrain on which the coverage is being predicted. The label "Sub-90%" on the purported coverage map of New York appears to denote the use of a suburban modeling parameter, rather than the more appropriate "urban" parameter.

79 Indeed, the WCS Coalition used this methodology on all of the maps in Attachments D, E, and F except for the map purporting to show combined XM and Sirius repeater coverage in Washington, D.C. The only explanation of the parameters used in creating the maps is an ambiguous footnote in the WCS Comments which does not define the relevant "terrain and morphology adjustments." *See* WCS Comments at 17 n.31.

80 Technical Appendix, Exhibit A, Appendix A.

accuracy of our repeater coverage model and given us the confidence to rely on that model for multi-million dollar investment decisions.

These coverage maps demonstrate several important points about the XM repeater network. First, as important as our repeaters are to providing a seamless SDARS service, those repeaters in no way substitute for satellite service. In Exhibit A of the Technical Appendix, XM shows that in the Washington, D.C., and New York City markets, the bulk of the market area is not covered by repeaters.[81] In each case, a vehicle moving through major routes in these cities would often receive service from satellites; at other times repeaters would fill a satellite service gap. The same is true in other market areas that XM serves.

Second, the power level of these repeaters on the ground is much lower than the WCS Coalition suggests. In each case, XM has indicated the area in which its repeaters deliver greater than -60 dBM service, the level chosen because that is the service level needed to provide three meters of protection to SDARS receivers. The WCS Coalition suggests that such zones somehow would be very large. As can be seen, however, actual tests along major city routes demonstrate that XM repeaters exceed that level only in very small areas generally directly at the repeater location.

In short, the WCS Coalition is basing its analysis on repeater network power and coverage characteristics that do not exist.

C. XM Cannot Feasibly Build Hundreds, or Even Thousands, of Additional Repeaters to Accommodate Mobile WiMax Interference

It may be that the WCS Coalition expects XM to build more repeaters to meet the service contours in its maps. If so, that would be an impractical and exceedingly costly task.

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81 *Id.*, Exhibit A, Figures 1 and 2.

First of all, hundreds, if not thousands, of additional repeaters would be required in metropolitan areas across the country, at a cost of many millions of dollars. This would not even solve the problem of interference from WCS mobile WiMax in smaller markets where service is entirely received from satellite today. XM noted in its initial comments that with its satellite system, only one repeater was needed to fill coverage in the Indianapolis market today.[82] If repeater power is restricted to 2 kW EIRP, XM would need 39 additional repeaters to provide the same coverage (-88 dBm) of that market it provides with existing repeaters. However, XM would need to deploy far more repeaters in that market to meet the -60 dBm repeater service level.

Even leaving aside the prohibitive cost of constructing and operating all of these additional repeaters, this solution is not even technically practical given XM's system design. The XM terrestrial waveform uses a wide bandwidth, high-capacity signaling scheme for the single-frequency XM terrestrial repeater network. To overcome the ISI (inter-symbol interference) inherent in this single frequency network, the XM signaling scheme uses an OFDM (Orthogonal Frequency Division Multiplexed) signaling format with guard intervals and symbol durations that are suitable for receiving the terrestrial signals with the amplitude/delay profiles that are presented in the currently deployed XM system. The waveform was not designed for and will not work with the onerous amplitude/delay profiles that would exist in a system of multiple repeaters deployed to produce the ubiquitous -60 dBm serving level. A modification to accommodate this change would also require a massive recall of consumer equipment, which was designed to operate with the existing system.

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82 *See* XM Comments at 26.

The bottom line starkly underscores the absurdity of the Coalition's position. To accommodate the WCS Coalition's wishes, XM would have to change the signaling format in its network to use different OFDM guard intervals and/or symbol times. But to do so would require a complete replacement of our entire installed base of repeaters and XM consumer receivers, leaving millions of customers stranded without service, and completely disrupting XM's business. In summary, the Coalition asks the impossible, based on a basic misunderstanding of the XM's satellite system and repeater network. The Commission warned that mobile operations would not be feasible in the WCS band for a reason and that reason is even stronger today after billions of dollars of SDARS investment, to serve millions of consumers.

Finally, the WCS Coalition's proposal also fails to give any weight to the fact that millions of SDARS receivers are in use or already installed in OEM equipped vehicles that are available for future subscriptions, with millions more in production. In 2007 alone, 3.5 million automobiles were produced with XM receivers pre-installed.[83]

The Coalition suggests that satellite radio receivers are overly-sensitive to the transmissions they propose and that the Commission should consider the ability of both SDARS licensees and WCS licensees to incorporate filtering technologies to mitigate adjacent channel interference.[84] However, XM's receivers already incorporate filtering mechanisms that are more

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83 It is a matter of record before the Commission that XM participates in a partnership with automobile manufacturers in connection with the installation and delivery of satellite radio services into new vehicles. Letter from Richard Lee, Executive Director of Satellite Radio Services, General Motors Corporation, Edward B. Cohen, Vice President, Government and Industry Relations, Honda North America, Jon Bucci, Corporate Manager, Advanced Technology Department, Toyota Motor Sales USA, Inc., to Kevin J. Martin, Chairman, Federal Communications Commission (filed Dec. 15, 2006) (supporting XM Radio Request for Special Temporary Authority and noting that "The quality of service delivered to these customers is important to our companies therefore making the quality of coverage of XM's terrestrial repeater network significantly important to GM, Honda, and Toyota, and to the automobile industry in general.").

84 WCS Coalition Comments at 11 n.24.

than adequate and are designed to perform at very high specifications. Receiver improvements are implemented in new designs as technology is developed and the production cycle allows but legacy equipment has a long life-span and will remain in use for years. Any suggestion that additional requirements be placed on SDARS receivers to accommodate a new mobile service in the WCS band truly would shift the burden of costs to the wrong parties. The Commission has made clear all along that any WCS licensees proposing to use the WCS bands for mobile services would bear the costs of doing so.[85]

Another important aspect of receiver design that the WCS Coalition fails to consider is that SDARS user terminals are receive-only devices that do not incorporate any feedback capability. Because of this, XM has no way of knowing whether customers are experiencing interference unless they report it or if XM engineers go into the field and take signal measurements. If mobile WiMax operations in the WCS bands cause interference to satellite radio services, it could take months for customers to complain of service lapses or for SDARS licensees to notice the interference on their own. Moreover, subscribers may drop XM's service altogether because of outage problems and may not provide this feedback to the company. These problems underscore the importance of restricting OOBE to levels that will not affect SDARS receivers, regardless of whether — in theory — use of permitted devices may cause interference only a relatively small percentage of the time. At this point, XM's system cannot be redesigned to incorporate a mechanism allowing SDARS receivers to report interference.

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85 *See WCS Report and Order* at 10855 ¶ 138 ("[W]e encourage potential WCS bidders and equipment manufacturers to consult with one another prior to the commencement of the auction to determine what services and equipment can be economically provided on these frequencies.").

These examples illustrate that the WCS Coalition effectively would have SDARS licensees redesign their satellite receivers and replace millions of units currently in use and in production in order to accommodate their proposed mobile operations. Such a result would require a massive effort on the part of SDARS licensees (not to mention automobile manufacturers and retailers) to modify or replace customer equipment. Again, millions of SDARS customers should not be subject to the ever-changing business plans of WCS licensees. The WCS proposals would impose costs on the wrong parties and would not be in the public interest.

IV. SDARS REPEATERS DO NOT INTERFERE WITH WCS OPERATIONS PERMITTED BY THE COMMISSION'S RULES

The WCS Coalition also erroneously claims that SDARS terrestrial repeaters operate at power levels that interfere with WCS services. The Coalition argues for a 2 kW power limit, including on existing repeaters, that would force XM to build hundreds of additional repeaters, at lower elevations, to provide the same level of service quality to consumers in repeater coverage areas as is offered today. This position is somewhat peculiar because it would vastly increase the number of SDARS repeaters and impose new challenges for WCS services that would have to accommodate those repeaters. The Coalition's proposal is unnecessary and nothing in its or any other party's Comments justifies this result.

A. The Coalition's Arguments Depend on Inaccurate Descriptions of SDARS Repeaters and Disregard Standard Filter Technology

The WCS Coalition alleges that SDARS licensees have deployed a vast number of terrestrial repeaters at high power and that current repeater configurations will cause overload interference in WCS base stations if a ground level power flux density limit of 110 dBμV/m is adopted. The Coalition argues instead for a 2 kW limit on repeaters. To support its argument the Coalition uses its flawed understanding of the XM repeater network already discussed above. The Coalition attempts to show the impact of SDARS repeaters on WCS base stations in New York and Washington, D.C. at this ground-based limit. It suggests that at 30 meters above ground, the interference would be much greater because the usual clutter present at ground level does not attenuate interfering signals as effectively.[86]

The Coalition provides no data describing the performance of WCS base stations, base station receivers, or handheld terminals, and XM once again is faced with the task of responding to theory and assertions rather than science. However, some major flaws appear on the face of the Coalition argument.

XM already discussed above some of the fundamental errors in the WCS Coalition's description of the XM repeater network. Most significantly, the WCS Coalition assumed there are more terrestrial repeaters in operation than is currently or has ever been the case. The Coalition also claimed that -40 dBm would overload a WCS base station,[87] disregarding the availability of band pass filters that would provide an additional 10 to 20 dB more protection to mitigate this interference than was used in their analysis.[88] Because of these assumptions, the coverage maps the WCS Coalition supplied of New York City and Washington, D.C., are grossly incorrect.[89] As shown in the attached technical Exhibit, the WCS Coalition's coverage maps do not depict where WCS base stations with receive antennas located 30 meters above ground

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86 WCS Comments at 19.

87 *Id.* at Attachment F.

88 Technical Appendix, Exhibit A, Appendix D at 27.

89 WCS Coalition Comments, Attachment E.

would experience overload from SDARS repeaters. At this height above ground, there is essentially no interference from XM repeater OOBE that would affect WCS base stations.[90]

In their test, XM engineers have corrected several of the erroneous assumptions that appear to have been used in the WCS Coalition's analysis and have explained in detail each of the parameters used to reconstruct the test so that the results can be replicated.[91] XM corrected the repeater configurations used by the WCS Coalition, which appears to have overestimated the number of repeaters actually in use by relying on data as to the sites *permitted*, rather than sites *in use*.[92] That showing alone makes a significant change in the analysis, as shown in Exhibit B, Appendix A. It reduces the area with a received signal of greater than -45 dBm dramatically. XM engineers also note that the WCS Coalition's base station filter rejection figure should be corrected, as receive filters are readily available for this band that provide at least 50 dB of rejection, and filter vendors have noted that filters providing 60 dB of rejection can be developed cost-effectively.

XM's modeled data provide a stark contrast to the maps supplied by the WCS Coalition. XM's coverage maps show the same geographic areas, but with far smaller areas where power exceeds -45 dBm. XM's measured data confirm these results. As previously discussed, these measurements were taken on-site and have to be highly accurate because they are used for planning and construction of repeaters. The maps produced as a result of this testing show very few instances of terrestrial repeater power at -45 dBm or above.

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90 Technical Appendix, Exhibit A, Appendix B.

91 *Id.*, Exhibit B, Appendix D at 26-27. Several of the WCS Coalition's assumptions were outlined in a footnote in its Comments rather than in the Attachments. The assumptions here were outlined in footnote 41. WCS Coalition Comments at 22 n.41.

92 *See supra* note 76 (noting that XM's use of fewer repeaters than authorized is a matter of record before the Commission).

The WCS Coalition also misstates the potential of OOBE from SDARS terrestrial repeaters to affect WCS base stations. It argues that the Commission should adopt a common OOBE restriction for WCS fixed base stations and SDARS repeaters requiring attenuation by a factor of 75 + 10 log (P) dB.[93] Its technical showing, however, greatly overstates potential OOBE interference from SDARS repeaters into WCS base stations.[94] Equipment designed to current specifications and deployed at existing XM repeater sites incorporates antenna gain and results in much more stringent attenuation measures for emissions into the WCS band than the WCS Coalition proposes. Based on the specifications XM provides to equipment manufacturers, current XM equipment attenuates the OOB signal by a factor of approximately 90 + 10 log (P).[95]

Notably, the WCS Coalition couches its proposal as a concession. The Coalition attempts to show that WCS base stations would suffer interference if its proposal is adopted by providing a map depicting interference zones that would cover Washington, D.C., and New York City if SDARS terrestrial repeaters were granted OOBE relief as well. However, given the fact that SDARS terrestrial repeaters already comply with a much more stringent OOBE limit based on equipment design, the Coalition's showings — and its concession — have little meaning. WCS base stations will not suffer from SDARS OOBE.

Finally, it is appropriate to reiterate here that the WCS Coalition's technical assessment of potential interference caused by SDARS repeaters focuses almost entirely on mobile WiMax services in the WCS spectrum. It is those services, not fixed service from base stations, that are the real issue for the Coalition here. But as we have discussed, even if SDARS repeaters

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93 WCS Coalition Comments at 21.

94 *Id.* at Attachments C and D

95 Technical Appendix, Exhibit A, Appendix B.

arguably interfere with mobile WiMax, they are interfering with a use that is inconsistent with the WCS band's intended purpose, and a use that on the mobile terminal side will significantly damage SDARS reception. To the extent that the Coalition claims that fixed WiMax services or any other permissible uses would be affected by current SDARS terrestrial repeater operations, it has not made that case.

B. The WCS Coalition Provides No Convincing Argument As To Why Existing Repeaters Should Not Be Grandfathered

The WCS Coalition argues not only that the Commission should limit all SDARS repeater power to 2 kW average EIRP,[96] but also that SDARS licensees should be allowed only a one year period from release of the Commission's Report and Order in this proceeding to conform existing repeaters to the new rules.[97] As discussed above, this process would entail a massive conversion of the existing repeater network into a low-power, cell-based terrestrial network — a network redesign and the construction of thousands of additional repeaters. The Coalition supports this proposal with flawed, incomplete data. In fact, as shown above, existing XM and Sirius repeater networks will cause very little interference into WCS base stations, at very few locations, and that small amount of interference can be mitigated by readily-available filters.

In contrast, replacing existing repeaters and reconfiguring existing repeater networks will impose an enormous burden on SDARS licensees — both in terms of equipment and construction costs, and in terms of disruption of service to customers. If the Commission does not grandfather existing repeaters, the Commission should adopt a workable time frame for

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96 WCS Coalition Comments at 22-25.

97 *Id.* at 42.

SDARS licensees to reconfigure their networks to comply with the new rules. In its assessment of that time frame, XM urges the Commission to consider the 12-to-18 month construction and approval processes required for each site.[98]

If the Commission grandfathers the existing SDARS repeater networks, XM would support a requirement to attenuate OOBE from SDARS repeaters at the levels at which they currently operate. As noted in the Technical Appendix, our equipment specifications require attenuation at 90 + 10 log (P).[99] As discussed above, this emission mask is far more stringent than that proposed by the WCS Coalition,[100] and should afford more than adequate protection for WCS base stations and fixed user terminals.

V. THE COMMISSION SHOULD ADOPT THE RULES PROPOSED BY XM AND SIRIUS

The technical analyses presented in this docket strongly supports the proposals of XM and Sirius. As XM and Sirius illustrated in their Comments and supporting technical showings, a ground-based power flux density ("PFD") limit of 110 dBμV/m for SDARS terrestrial repeaters will strike the best balance between WCS and SDARS interests. While this limit will not provide protection for mobile WiMax services in the WCS band, WCS licensees were well aware that such services would be infeasible in that band even before the spectrum was auctioned. The ground-based PFD limit will, however, protect many other types of operations in the WCS bands.

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98 XM Comments at 26-27.

99 Technical Appendix, Exhibit B at 11.

100 The WCS Coalition proposed that WCS and SDARS fixed transmitters attenuate emissions into the other services band by a factor of 75 + 10 log (P) dB. WCS Coalition Comments at 21.

Additionally, the data XM and Sirius presented in the record support some relaxation of the WCS rules, but the relaxation should be narrowly tailored depending upon the band and application. For WCS mobile and portable devices, the Commission should adopt an EIRP limit of 10 dBm in the A and B Blocks and 0 dBm in the C and D Blocks. OOBE from WCS mobile and portable devices should be attenuated to 102.7 + 10 log (P), measured in a 1 MHz bandwidth. For fixed WCS operations operating at less than 2 watts EIRP, and for WCS base stations, the Commission should adopt a ground-based PFD limit of 100 dBμV/m in the A and B blocks and 90 dBμV/m in the C and D blocks. OOBE should be attenuated to 75 + 10 log (P) (-45 dBm power) measured in a 1 MHz bandwidth. These modifications to current rules will provide WCS licensees with additional flexibility in their fixed and base station operations and, at the same time, afford SDARS with adequate protection.

The results of extensive testing conducted by XM and Sirius demonstrate that mobile WiMax operations in the WCS bands will interfere with satellite radio reception by consumers and that the WCS Coalition's proposals to relax the rules applicable to WCS spectrum are unworkable. XM and Sirius have also demonstrated that there are critical flaws in the theoretical assumptions and the errors in the data supplied by the WCS Coalition in support of its proposals.

VI. CONCLUSION

The Commission should reject the WCS Coalition's attempt to rewrite history. Over ten years ago the Commission established rules for WCS written carefully to protect SDARS reception, now enjoyed by over 17.3 million consumers. The WCS spectrum was auctioned subject to those restrictions. XM and Sirius have invested billions of dollars to bring new audio programming to consumers across the country, all in reliance on the restrictions on WCS use clearly stated in the rules.

XM demonstrated in its initial comments that the terrestrial repeaters it has deployed play a critical role in meeting consumer needs for reliable service — just as the Commission intended when it recognized the need for repeaters as an element of SDARS networks. XM also demonstrated that its repeaters do not interfere with WCS services, including fixed broadband, permitted by the current rules. Although the WCS Coalition tries to point to such interference, its claims are entirely without technical merit.

The Coalition similarly fails to provide any technical basis for a wholesale change in the rules to allow mobile WiMax in the WCS band. XM and Sirius have provided ample evidence, based on extensive modeled and measured data, showing that mobile WiMax operations in the WCS bands pose a severe threat to SDARS. The record demonstrates that the WCS Coalition's proposals are infeasible in this band and that they are based on erroneous assumptions and flawed technical analysis. Moreover, the rules the Coalition proposes, if adopted, would lead to an absurd result — transforming the satellite radio service into a cell-based terrestrial radio service to accommodate mobile service in the WCS band, which the Commission has repeatedly discouraged. For these reasons, the Commission should adopt the proposals made by XM and Sirius in this docket, which will provide WCS licensees with additional flexibility in their fixed and base station operations but also protect the satellite radio service enjoyed by millions of subscribers.

Respectfully submitted,

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Its Counsel

March 17, 2008

TECHNICAL APPENDIX

CERTIFICATION: **Certification of Craig P. Wadin, Senior Vice President, RF Systems, XM Radio Inc.**

EXHIBIT A: **Repeater Coverage Maps for New York City and Washington, D.C. Markets**

Appendix A: XM Repeater Coverage Maps for New York and Washington, D.C.

Appendix B: XM Repeater Out of Band Emissions Impact on WCS Base Stations

Appendix C: XM Repeater Coverage Maps for New York and Washington, D.C. Markets for Ground-Based Levels >-44 dBm and >-35 dBm

Appendix D: XM Repeater Coverage Maps for New York City and Washington, D.C. Markets Showing WCS Base Station Receive Levels >-40 dBm

EXHIBIT B: **WCS Portable/Mobile/SDARS Interference Modeling**
Path Loss
Overload/OOBE Trade Space

EXHIBIT C: **Experimental Measurements of Overload Interference from WCS Transmitters to DARS Receivers and the SDARS Noise Floor**

Appendix 1: Noise Floor Measurement

EXHIBIT D: **Power Measurements**

EXHIBIT E: **Comparison of the AWS-3 Proceeding (WT Docket No. 07-195) to the WCS/SDARS Proceeding (WT Docket No. 07-293)**

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I, Craig P. Wadin, am the Senior Vice President, RF Systems at XM Satellite Radio Inc. I joined XM in 1999 and have been involved in digital technology for approximately 34 years. Prior to joining XM, I was employed at Motorola Inc. I hold 37 U.S. patents in the field of Digital Communication

I hereby declare under penalty of perjury that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing Comments of XM Radio Inc. and any attachments, that I am familiar with Part 25 and Part 27 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in the Comments of XM Radio Inc. and any attachments, and that it is complete and accurate to the best of my knowledge and belief.

____

Craig P. Wadin
Senior Vice President, RF Systems
XM Satellite Radio Inc.

Dated: March 17, 2008

Exhibit A

Repeater Coverage Maps for New York City and Washington, D.C. Markets

Introduction

The WCS Coalition's comments in this proceeding[1] included an analysis of Sirius and XM repeater coverage for the New York and Washington markets. This analysis was used in an attempt to illustrate a variety of points regarding transmitter powers and out of band emissions (OOBE) as summarized in Table 1, below.

To correct a number of significant errors and omissions in the WCS Coalition's analysis, XM has provided its own engineering analysis of the same markets along with specific details on the models and analysis used. XM's study is based on engineering models whose accuracy has been confirmed by measured data in extensive field tests. XM relies on these models to determine where repeaters are necessary to ensure continuous service to our customers, and where it can rely on service from its satellites and avoid the significant expense of repeater deployment and operation.

Table 1 WCS Coalition Filing Coverage Predictions: Summary of Points in Response

WCS	Signal Area Shown	WCS Coalition Argues:	Using Corrected Data, XM Demonstrates:
Attach. C	XM repeater	WCS Coalition predicted an expansive repeater coverage area for NYC and Washington DC which they suggest should allow relaxed WCS terminal power and OOBE rules within these markets	Appendix A • Basic coverage area is corrected to show actual repeater coverage, predicted using actual drive test measurement based data. • Experimental data showing that strong repeater signals are needed to mitigate WCS interference. • Corrected coverage area to demonstrate that the areas of potential interference mitigation are much smaller than the WCS Coalition estimates.
Attach. D	Sirius and XM combined OOBE	WCS Coalition predicted coverage area showing areas where 1 dB base station receiver noise floor rise would be experienced, implying that this interference mechanism is significant.	Appendix B • XM repeater specifications for OOBE are significantly more stringent than for WCS base stations. • When correctly calculated, there is essentially zero potential interference from XM repeater out of band emissions to WCS base station receivers.
Attach. E	Sirius and XM combined > -44 dBm	WCS Coalition predicted coverage area showing areas where -44 dBm ground level would be exceeded at 2 meter AGL height	Appendix C • When correctly modeled, there are very few areas where this limit is exceeded, as confirmed by measured data example. • The limit used provides significantly more protection than needed by a WCS terminal. XM current repeater ground based limit is 110 dBuV/m and the corresponding area is insignificant.

[1] Comments of the WCS Coalition, WT Docket No. 07-293 (filed Feb. 14, 2008) ("WCS Coalition Comments").

Attach. F	XM repeater signal >-40 dBm at 30 m rx height	WCS Coalition predicted coverage area showing areas WCS base station overload would be experienced, implying that this interference mechanism is significant.	Appendix D • When correctly modeled, there are very few areas where this limit is exceeded. • Receiver filter profile used does not represent available filter technology.

List of Figures

Appendix A

XM Repeater Coverage Maps for New York and Washington, D.C.

Prediction Information

Market Boundary for Statistics Aggregation[2]

Urbanized areas, New York—Newark, NY—NJ—CT and Washington, DC—VA—MD

Model Parameters

The model parameters used are shown in Table 2:

Table 2 Model Parameters Used for Repeater Coverage Prediction

Item	**Value**	**WCS Coalition nearest equivalent**[3]
Model type	EDX Signal Pro®[4]	"Cell plan"
Terrain resolution	30 meters	Not specified
Clutter	11 categories, 30 meter resolution, based on 2006 satellite imagery	Not specified
Coverage criteria	-95 dBm (edge of coverage boundary) -75 dBm (intermediate serving level boundary) -60 dBm level required to tolerate a WiMax 250 mW mobile at 3 m (See Exhibit [C])	-95 dBm boundary
Location probability	50%	90%
Fade margin	n/a	7 dB
Receiver height	2 m Above Ground Level (AGL)	2 m AGL

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[2] Although not explicitly stated, the geographic area used for statistics generation in the WCS Coalition's Comments at Appendix C, appears to be an "Urbanized Area" according to U.S. Census data available at (http://www.census.gov/geo/www/ua/ua_2k.html). The actual geographic boundaries used by XM for the statistics calculation were obtained from http://www.census.gov/geo/www/ua/ua_bdfile.html

[3] The WCS Coalition's filing did not disclose sufficient information to directly duplicate or confirm the modeling assumptions used. The information here is from footnote 31 of the WCS Coalition Comments. WCS Coalition Comments at 17, n.31.

[4] http://www.edx.com/

Site Table

The WCS Coalition's analysis used the repeater configurations on file with the FCC as of Fall 2007.[5] The predictions in this appendix represent XM's actual operating network with the sites specified in Table 3.

Table 3 XM Prediction Site List and Parameters

Site ID	Sector ID	Site Lat (Deg N)	Site Long (Deg W)	Antenna Type (Til-Tek Model)	Ant Beamwidth (Deg AZ)	Ant Orientation (Deg AZ)	ANT Downtilt (Deg)	Ant Height (Ft AGL)	Average EIRP (Watts)
NYC001D	Tx1	40-42-28	074-00-20	TA-2350-DAB-T6	Omni	0	0	314	1247
NYC002A	Tx1	40-44-23	073-59-03	TA-2350-DAB-T6	Omni	0	0	201	1247
NYC003B	Tx1	40-45-11	073-59-12	TA-2304-2-DAB(60)	60	30	-13	407	3980
NYC004A	Tx1	40-48-00	074-28-50	TA-2350-DAB-T6	Omni	0	0	187	1247
NYC005A	Tx1	40-57-39	073-55-22	TA-2350-DAB-T6	Omni	0	0	240	1247
NYC006B	Tx1	40-43-50	074-03-49	TA-2350-DAB-T6	Omni	0	0	189	1247
NYC008B	Tx1	40-39-34	073-42-13	TA-2350-DAB	Omni	0	0	88	1335
NYC009A	Tx1	40-45-46	073-49-10	TA-2350-DAB	Omni	0	0	195	1247
NYC010A	Tx1	40-13-45	074-05-25	TA-2304-2-DAB-H(120)	120	175	0	300	34596
NYC012B	Tx1	40-46-34	074-02-01	TA-2304-2-DAB(60)	60	35	0	112	4831
NYC013C	Tx1	40-52-58	073-54-41	TA-2350-DAB	Omni	0	0	203	1247
NYC014A	Tx1	40-53-32	073-51-09	TA-2350-DAB-T6	Omni	0	0	159	1247
NYC015A	Tx1	40-56-45	073-53-09	TA-2350-DAB	Omni	0	0	156	1233
NYC017C	Tx1	40-28-46	074-28-28	TA-2350-DAB-T6	Omni	0	0	317	625
NYC019F	Tx1	40-56-04	074-07-07	TA-2335-DAB-H	Omni	30	0	100	2140
	Tx3	40-56-04	074-07-07	TA-2335-DAB-H	Omni	270	0	100	2140
NYC020B	Tx1	40-50-46	074-36-35	TA-2304-2-DAB-H(120)	120	0	0	240	6124
	Tx2	40-50-46	074-36-35	TA-2335-DAB-H	Omni	120	-6	240	770
	Tx3	40-50-46	074-36-35	TA-2335-DAB-H	Omni	240	0	240	7710
NYC026A	Tx1	40-40-03	073-57-34	TA-2350-DAB-T6	Omni	0	0	429	1247
NYC027A	Tx1	40-23-44	074-10-27	TA-2304-2-DAB-H(120)	120	190	0	198	16070
NYC028C	Tx1	40-51-41	074-25-01	TA-2304-2-DAB-H(45)	45	300	0	97	4988

[5] WCS Coalition Comments at 17 n.31. Because the WCS Coalition filing did not provide a specific list of sites used for the prediction, XM has examined the plots provided and made a best effort at interpreting which sites were actually used.

Site ID	Sector ID	Site Lat (Deg N)	Site Long (Deg W)	Antenna Type (Til-Tek Model)	Ant Beamwidth (Deg AZ)	Ant Orientation (Deg AZ)	ANT Downtilt (Deg)	Ant Height (Ft AGL)	Average EIRP (Watts)
NYC031D	Tx1	40-44-18	074-10-09	TA-2335-DAB-H	Omni	0	0	425	1878
	Tx2	40-44-18	074-10-09	TA-2335-DAB-H	Omni	120	0	425	1878
NYC034C	Tx1	40-47-17	074-15-17	TA-2350-DAB-T6	Omni	0	0	203	274
NYC035A	Tx1	40-51-18	073-55-38	TA-2304-2-DAB(120)	120	210	-4	200	2490
NYC036A	Tx1	40-52-17	074-11-44	TA-2350-DAB	Omni	0	0	181	1099
NYC038B	Tx1	40-53-17	074-03-14	TA-2350-DAB-T6	Omni	0	0	285	1247
NYC042D	Tx1	40-36-44	073-58-08	TA-2350-DAB	Omni	0	0	83	1247
NYC046A	Tx1	40-34-24	074-13-10	TA-2335-DAB-H	Omni	135	0	80	15600
	Tx2	40-34-24	074-13-10	TA-2335-DAB-H	Omni	225	0	80	15600
NYC048D	Tx1	40-43-02	074-00-26	TA-2350-DAB-T6	Omni	0	0	294	1247
NYC051A	Tx1	40-44-49	073-58-36	TA-2350-DAB-T6	Omni	0	0	261	1247
NYC052C	Tx1	40-45-54	073-59-04	TA-2350-DAB-T6	Omni	0	0	264	1247
NYC053E	Tx1	40-43-33	073-59-20	TA-2350-DAB	Omni	0	0	180	1247
NYC054F	Tx1	40-45-37	073-58-35	TA-2350-DAB-T6	Omni	0	0	490	1247
NYC055A	Tx1	40-48-12	073-56-30	TA-2350-DAB	Omni	0	0	143	1203
NYC058D	Tx1	40-44-58	073-59-39	TA-2350-DAB	Omni	0	0	248	1500
NYC059F	Tx1	40-46-52	073-57-10	TA-2350-DAB-T6	Omni	0	0	181	1247
NYC062A	Tx1	40-43-00	073-59-46	TA-2350-DAB	Omni	0	0	98	624
NYC068A	Tx1	40-49-54	074-07-22	TA-2350-DAB	Omni	0	0	77	624
NYC070G	Tx1	40-58-11	073-42-48	TA-2350-DAB	Omni	0	0	86	1254
NYC074B	Tx1	40-42-45	073-56-26	TA-2350-DAB	Omni	0	0	155	1247
NYC097I	Tx1	40-38-33	073-55-30	TA-2350-DAB	Omni	0	0	93	1568
NYC098A	Tx1	40-54-43	073-46-56	TA-2350-DAB	Omni	0	0	195	1247
NYC100A	Tx1	40-57-42	074-04-24	TA-2350-DAB	Omni	0	0	183	1247
NYC103B	Tx1	40-39-59	074-12-53	TA-2350-DAB-T6	Omni	0	0	159	1247
NYC104C	Tx1	40-37-35	074-26-23	TA-2350-DAB-T6	Omni	0	0	127	1247
NYC112F	Tx1	40-45-23	073-54-50	TA-2350-DAB	Omni	0	0	80	1400
NYC123B	Tx1	41-01-51	073-45-41	TA-2304-2-DAB(160)	160	15	0	142	1574
NYC128C	Tx1	40-41-08	074-18-13	TA-2350-DAB	Omni	0	0	110	1247
NYC131C	Tx1	40-59-25	074-01-48	TA-2304-2-DAB(120)	120	0	0	150	3557
NYC132H	Tx1	41-04-13	073-47-22	TA-2304-2-DAB(120)	120	0	-4	187	2392

Site ID	Sector ID	Site Lat (Deg N)	Site Long (Deg W)	Antenna Type (Til-Tek Model)	Ant Beamwidth (Deg AZ)	Ant Orientation (Deg AZ)	ANT Downtilt (Deg)	Ant Height (Ft AGL)	Average EIRP (Watts)
NYC134C	Tx1	40-59-38	073-40-37	TA-2350-DAB	Omni	0	0	163	1568
NYC136C	Tx1	40-55-06	073-54-05	TA-2350-DAB	Omni	0	0	104	1320
NYC138A	Tx1	40-50-47	073-50-05	TA-2350-DAB	Omni	0	0	200	991
NYC141A	Tx1	40-39-12	074-00-25	TA-2304-2-DAB(120)	120	30	0	153	1466
	Tx2	40-39-12	074-00-25	TA-2304-2-DAB(120)	120	150	0	153	1466
NYC142A	Tx1	40-36-30	074-00-18	TA-2350-DAB	Omni	0	0	79	1570
NYC143B	Tx1	40-36-06	073-56-33	TA-2350-DAB	Omni	0	0	109	1570
NYC145D	Tx1	40-42-44	073-50-02	TA-2350-DAB	Omni	0	0	285	1570
NYC146D	Tx1	40-42-58	073-46-20	TA-2350-DAB	Omni	0	0	94	1247
NYC148B	Tx1	40-44-15	073-47-00	TA-2350-DAB	Omni	0	0	277	1400
NYC161A	Tx1	40-49-35	074-13-37	TA-2350-DAB-T6	Omni	0	0	109	625
NYC163C	Tx1	40-54-17	073-58-09	TA-2304-2-DAB(120)	120	30	-4	150	1247
NYC168A	Tx1	40-37-33	074-01-36	TA-2350-DAB	Omni	0	0	94	1570
NYC169A	Tx1	40-38-15	073-58-21	TA-2350-DAB	Omni	0	0	220	1570
NYC170C	Tx1	40-34-51	073-57-22	TA-2350-DAB	Omni	0	0	88	1400
NYC172A	Tx1	40-40-24	073-55-33	TA-2304-2-DAB(120)	120	100	0	113	2490
NYC174A	Tx1	40-41-29	073-51-05	TA-2350-DAB	Omni	0	0	93	312
NYC181A	Tx1	40-46-42	073-46-49	TA-2350-DAB	Omni	0	0	243	1247
NYC190A	Tx1	40-56-05	073-59-46	TA-2350-DAB	Omni	0	0	108	991
NYC192C	Tx1	40-37-36	074-04-28	TA-2335-DAB-H	Omni	150	0	130	963
	Tx2	40-37-36	074-04-28	TA-2335-DAB-H	Omni	315	0	130	963
NYC193B	Tx1	40-37-47	074-18-12	TA-2350-DAB	Omni	0	0	85	1247
NYC195B	Tx1	40-43-48	074-13-19	TA-2350-DAB	Omni	0	0	123	1492
NYC196A	Tx1	40-34-47	074-06-29	TA-2350-DAB	Omni	0	0	105	1400
NYC200A	Tx1	40-57-07	073-49-04	TA-2304-2-DAB(160)	160	0	0	81	1442
NYC205A	Tx1	40-52-46	073-53-10	TA-2304-2-DAB(120)	120	0	-2	490	2850
NYC206B	Tx1	40-55-30	073-50-12	TA-2350-DAB	Omni	0	0	80	630
NYC209A	Tx1	40-53-59	074-10-12	TA-2350-DAB	Omni	0	0	150	991
NYC210A	Tx1	40-52-05	074-00-03	TA-2350-DAB	Omni	0	0	180	1247
NYC212A	Tx1	40-39-39	074-22-42	TA-2350-DAB-T6	Omni	0	0	101	1247
NYC214B	Tx1	40-38-18	074-10-14	TA-2335-DAB-H	Omni	135	0	163	1862

Site ID	Sector ID	Site Lat (Deg N)	Site Long (Deg W)	Antenna Type (Til-Tek Model)	Ant Beamwidth (Deg AZ)	Ant Orientation (Deg AZ)	ANT Downtilt (Deg)	Ant Height (Ft AGL)	Average EIRP (Watts)
	Tx2	40-38-18	074-10-14	TA-2304-2-DAB(45)	45	275	0	163	2377
NYC218B	Tx1	40-49-32	073-53-21	TA-2350-DAB	Omni	0	0	95	1247
NYC221D	Tx1	40-41-09	074-00-04	TA-2304-2-DAB(90)	90	120	-5	94	1416
NYC222C	Tx1	40-46-01	073-54-19	TA-2350-DAB	Omni	0	0	80	1247
NYC223B	Tx1	40-45-31	073-52-44	TA-2350-DAB-T6	Omni	0	0	61	1570
NYC225B	Tx1	40-42-04	073-53-46	TA-2350-DAB	Omni	0	0	72	1247
NYC227A	Tx1	40-43-19	073-48-18	TA-2350-DAB	Omni	0	0	96	1570
NYC228C	Tx1	40-43-18	073-43-50	TA-2350-DAB	Omni	0	0	80	350
NYC259A	Tx1	40-58-52	073-44-35	TA-2350-DAB	Omni	0	0	78	1247
NYC261B	Tx1	40-47-22	073-58-31	TA-2304-2-DAB(90)	90	0	0	243	794
	Tx2	40-47-22	073-58-31	TA-2304-2-DAB(120)	120	90	0	243	630
	Tx3	40-47-22	073-58-31	TA-2304-2-DAB(120)	120	210	0	243	630
NYC611B	Tx1	40-24-12	074-02-38	TA-2304-2-DAB(120)	120	160	0	247	3170
NYC614B	Tx1	40-13-04	074-45-00	TA-2350-DAB-T6	Omni	0	0	175	1247
NYC630A	Tx1	41-01-09	073-55-41	TA-2350-DAB	Omni	0	0	127	991
NYC683A	Tx1	40-47-37	074-11-52	TA-2350-DAB	Omni	0	0	127	1062
NYC762A	Tx1	40-45-49	073-57-31	TA-2350-DAB-T6	Omni	0	0	283	1191
WDC101A	Tx1	38-54-18	077-03-15	TA-2350-DAB	Omni	0	0	175	1100
WDC102E	Tx1	38-52-54	077-00-59	TA-2350-DAB-H	Omni	0	0	104	1400
WDC103D	Tx1	38-54-25	077-00-25	TA-2350-DAB	Omni	0	0	96	1185
WDC105I	Tx1	38-57-01	077-04-47	TA-2335-DAB-H	Omni	20	-5	207	2392
	Tx2	38-57-01	077-04-47	TA-2335-DAB-H	Omni	260	0	207	21318
WDC106F	Tx1	38-55-56	077-02-13	TA-2350-DAB	Omni	0	0	125	1448
WDC201A	Tx1	38-53-27	077-04-56	TA-2350-DAB	Omni	0	0	164	1292
WDC202A	Tx1	38-51-46	077-03-04	TA-2350-DAB	Omni	0	0	197	1276
WDC203B	Tx1	38-53-01	077-07-05	TA-2335-DAB-H	Omni	210	-6	220	1000
	Tx3	38-53-01	077-07-05	TA-2335-DAB-H	Omni	310	-6	220	1000
WDC204A	Tx1	38-55-16	077-13-42	TA-2350-DAB-T6	Omni	0	0	242	1588
WDC207C	Tx1	38-57-33	077-25-28	TA-2350-DAB-T6	Omni	0	0	169	1002
WDC215B	Tx1	38-47-16	077-19-46	TA-2335-DAB-H	Omni	130	-4	410	3396
	Tx2	38-47-16	077-19-46	TA-2335-DAB-H	Omni	240	-3	410	30272

Site ID	Sector ID	Site Lat (Deg N)	Site Long (Deg W)	Antenna Type (Til-Tek Model)	Ant Beamwidth (Deg AZ)	Ant Orientation (Deg AZ)	ANT Downtilt (Deg)	Ant Height (Ft AGL)	Average EIRP (Watts)
WDC218B	Tx1	38-40-59	077-14-11	TA-2335-DAB-H	Omni	0	0	175	256
	Tx2	38-40-59	077-14-11	TA-2335-DAB-H	Omni	120	0	175	1146
	Tx3	38-40-59	077-14-11	TA-2335-DAB-H	Omni	240	0	175	1146
WDC220C	Tx1	38-44-57	077-29-13	TA-2350-DAB-T6	Omni	0	0	152	1400
WDC221A	Tx1	38-51-57	077-21-55	TA-2335-DAB-H	Omni	0	0	140	1664
	Tx2	38-51-57	077-21-55	TA-2335-DAB-H	Omni	250	0	140	1664
WDC222A	Tx1	38-39-24	077-17-14	TA-2304-2-DAB(60)	60	125	0	200	2518
WDC223A	Tx1	38-56-58	077-21-18	TA-2350-DAB-T6	Omni	0	0	195	1050
WDC227E	Tx1	38-44-44	077-05-57	TA-2335-DAB-H	Omni	180	0	352	2992
	Tx2	38-44-44	077-05-57	TA-2335-DAB-H	Omni	290	-3	352	176
WDC230A	Tx1	38-52-28	077-13-24	TA-2304-2-DAB(90)	90	225	-5	603	3120
WDC231C	Tx1	38-50-40	077-06-59	TA-2350-DAB-T6	Omni	0	0	313	1100
WDC232E	Tx2	38-47-35	077-10-35	TA-2335-DAB-H	Omni	260	-2	193	4074
	Tx3	38-47-35	077-10-35	TA-2335-DAB-H	Omni	160	0	193	4074
WDC301A	Tx1	39-02-28	076-59-36	TA-2350-DAB	Omni	0	0	245	1074
WDC303A	Tx1	39-06-57	077-04-28	TA-2304-2-DAB(90)	90	330	0	135	2046
WDC304A	Tx1	39-05-02	077-08-54	TA-2304-2-DAB(90)	90	330	0	222	3557
WDC307A	Tx1	39-06-54	077-11-58	TA-2304-2-DAB(90)	90	0	0	295	3990
WDC312D	Tx1	38-58-58	077-05-35	TA-2350-DAB	Omni	0	0	192	1206
WDC313B	Tx1	38-48-21	076-58-41	TA-2304-2-DAB(45)	45	50	-2	169	1991
	Tx2	38-48-21	076-58-41	TA-2304-2-DAB(90)	90	195	-6	169	868
WDC314B	Tx1	38-55-46	076-55-27	TA-2350-DAB	Omni	0	0	180	941
WDC316A	Tx1	38-51-37	076-56-57	TA-2304-2-DAB(120)	120	160	0	224	1954
WDC319A	Tx1	38-53-19	076-54-18	TA-2350-DAB-T6	Omni	0	0	106	1416
WDC322D	Tx1	39-00-17	076-58-32	TA-2350-DAB-T6	Omni	0	0	272	1552
WDC325A	Tx1	38-57-17	077-00-17	TA-2335-DAB-H	Omni	50	-6	297	921
	Tx2	38-57-17	077-00-17	TA-2335-DAB-H	Omni	310	-6	297	1107
WDC327A	Tx1	39-01-40	077-08-26	TA-2350-DAB-T6	Omni	0	0	187	1247
WDC329A	Tx1	39-08-50	076-50-51	TA-2350-DAB-T6	Omni	0	0	105	1588
WDC337B	Tx1	39-02-26	077-03-18	TA-2350-DAB-T6	Omni	0	0	329	600
WDC401B	Tx1	39-17-14	076-36-53	TA-2350-DAB	Omni	0	0	420	894

Site ID	Sector ID	Site Lat (Deg N)	Site Long (Deg W)	Antenna Type (Til-Tek Model)	Ant Beamwidth (Deg AZ)	Ant Orientation (Deg AZ)	ANT Downtilt (Deg)	Ant Height (Ft AGL)	Average EIRP (Watts)
WDC402D	Tx1	39-19-54	076-39-28	TA-2335-DAB-H	Omni	0	0	320	1150
	Tx2	39-19-54	076-39-28	TA-2335-DAB-H	Omni	120	-4	110	390
	Tx3	39-19-54	076-39-28	TA-2335-DAB-H	Omni	240	0	320	1150
WDC405A	Tx1	39-24-03	076-35-55	TA-2304-2-DAB(160)	160	0	0	280	1074
WDC407E	Tx1	39-19-58	076-41-55	TA-2335-DAB-H	Omni	270	0	162	3170
WDC408A	Tx1	39-13-44	076-39-46	TA-2335-DAB-H	Omni	180	0	166	2826
WDC409A	Tx1	39-12-08	076-37-49	TA-2335-DAB-H	Omni	180	0	130	3320
WDC410C	Tx1	39-19-26	076-32-55	TA-2304-2-DAB(120)	120	90	0	410	2576
WDC414B	Tx1	39-22-39	076-43-20	TA-2304-2-DAB(120)	120	330	0	194	2192
WDC418A	Tx1	39-12-44	076-51-40	TA-2350-DAB	Omni	0	0	183	1290
WDC430A	Tx1	39-09-54	076-36-18	TA-2335-DAB-H	Omni	130	+3	189	2042
WDC434A	Tx1	39-10-41	076-52-32	TA-2350-DAB-T6	Omni	0	0	163	1002
WDC500B	Tx1	38-48-54	077-03-09	TA-2350-DAB	Omni	0	0	113	314
WDC501B	Tx1	38-47-28	077-03-51	TA-2335-DAB-H	Omni	180	0	178	4376
WDC502A	Tx1	38-59-32	076-52-54	TA-2350-DAB	Omni	0	0	221	1234
WDC504B	Tx1	39-01-24	077-06-17	TA-2350-DAB-T6	Omni	0	0	292	1384
WDC507C	Tx1	38-53-09	076-59-52	TA-2350-DAB	Omni	0	0	84	1150
WDC510B	Tx1	38-57-31	076-52-08	TA-2350-DAB-T6	Omni	0	0	135	1234
WDC513A	Tx1	38-52-47	077-10-17	TA-2335-DAB-H	Omni	200	0	270	3900
WDC515A	Tx1	39-16-01	076-47-37	TA-2350-DAB-T6	Omni	0	0	112	1400
WDC517A	Tx1	38-56-15	077-10-41	TA-2350-DAB-T6	Omni	0	0	144	1552
WDC519A	Tx1	38-53-45	077-08-07	TA-2335-DAB-H	Omni	210	-6	254	1482
	Tx2	38-53-45	077-08-07	TA-2335-DAB-H	Omni	310	-6	254	1482

Market Statistics

The WCS Coalition's Comments were unclear as to how the tables of statistics shown in Attachment C were generated. The total area statistics put forward by the WCS Coalition align most closely with those for a market definition of "Urbanized Area." The methodology XM used to calculate the relevant statistics was as follows:

1. Demographic data layers from the 2000 Census were used to provide a boundary layer of population and household data.
2. Using the radio planning coverage predictions, the values of total population and households covered were calculated for three basic serving level conditions within XM's defined market boundary:
    a. At a signal level >-95 dBm, for the nominal case to allow for comparison of the base case with the WCS Coalition filing. The XM repeater signal service threshold is approximately -93 dBm.
    b. At a signal level >-75 dBm, an intermediate serving level boundary.
    c. At a signal level >-60 dBm. This is the average level above which a WCS 250 mW handset would actually be able to operate within 3 meters of an SDARS radio.[6]
3. The population and household counts were aggregated for those areas falling either partially or totally within the signal level boundary using a standard Geographic Information System (GIS) query available in EDX Signal Pro®.

The calculated values are shown in Table 4 for New York and Table 5 for Washington. As demonstrated on these tables, XM's coverage of these markets is far less substantial than the WCS Coalition claims.

[6] *See* Exhibit C (showing repeater signal serving levels required to overcome WCS interference).

Table 4 NYC Market Statistics

NYC Active sites	Area (Square miles)	% of Area Covered	Population	Households
Total Market Area	3412.2	100%	16,326,682	6,266,156
> -95 dBm	1,720.4	50%	12,128,315	4,788,975
> -75 dBm	386.4	11%	2,333,498	1,024,222
> -60 dBm	25.8	0.8%	87,200	39,792

Table 5 Washington Market Statistics

WDC Active sites	Area (Square miles)	% of Area Covered	Population	Households
Total Market Area	1,570.2	100%	5,150,176	2,125,276
> -95 dBm	1,268.38	80.8%	4,581,288	1,904,785
> -75 dBm	259.0	16.5%	1,033,812	451,379
> -60 dBm	26	1.6%	87,457	42,603

Figure 1 New York City Repeater Coverage Map

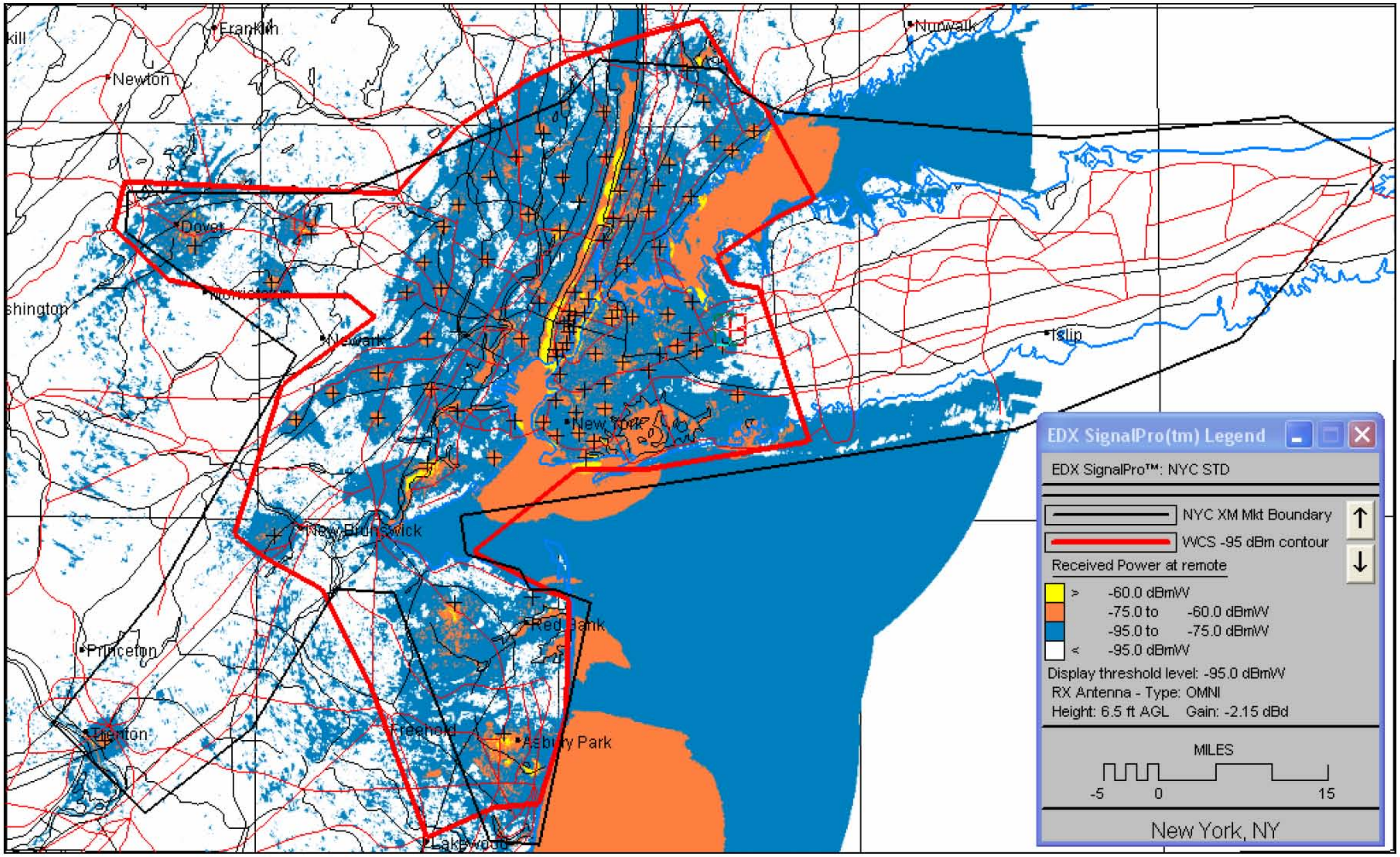
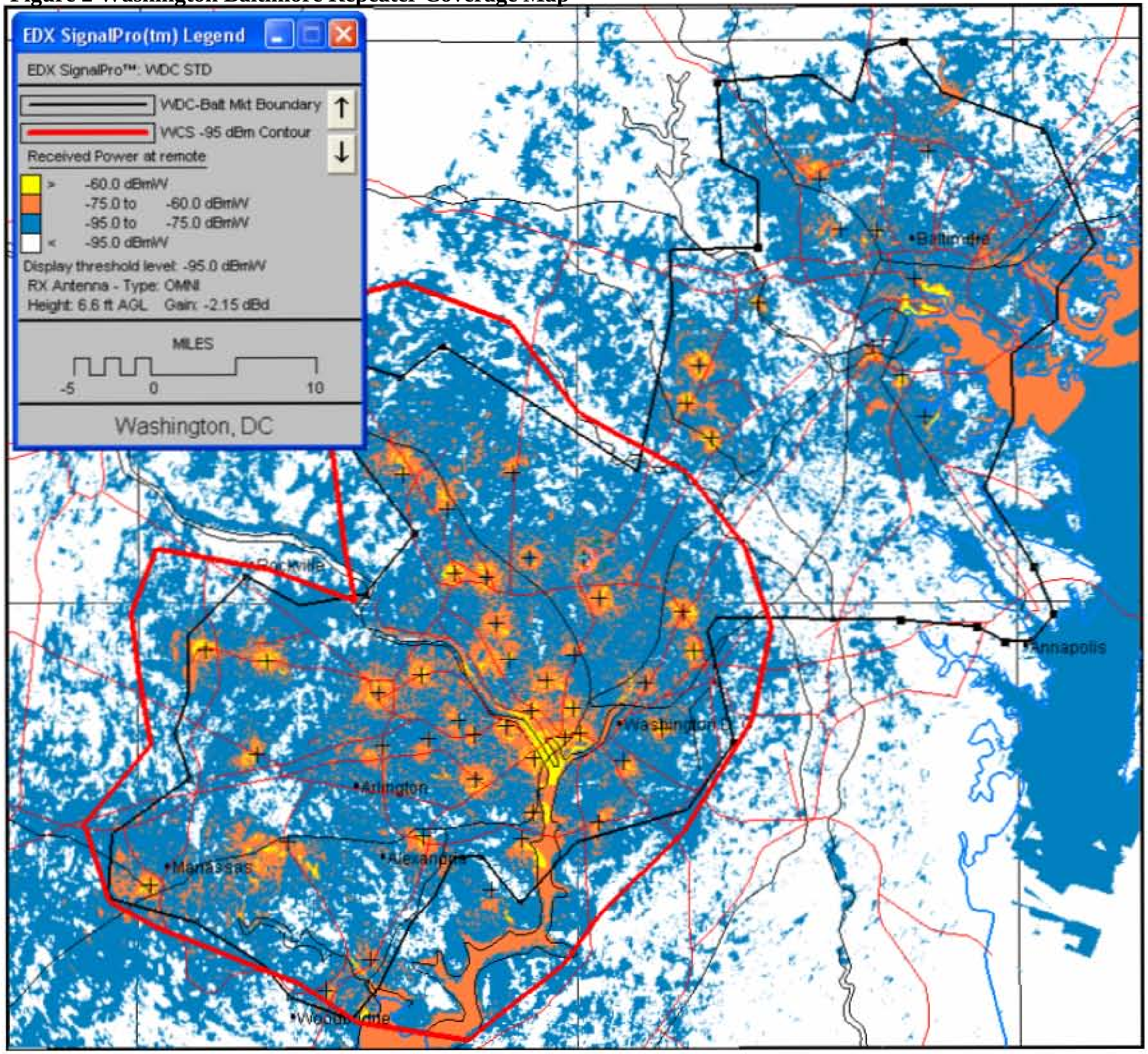


Figure 2 Washington Baltimore Repeater Coverage Map



Appendix B

XM Repeater Out of Band Emissions Impact on WCS Base Stations

SDARS Repeater Out of Band Emission Limits

All of XM's current operating and planned repeaters in the markets in question meet an out of band emissions (OOBE) limit defined as follows:

The out of band emissions in a 1 MHz bandwidth outside of the range 2332.5 to 2345 MHz shall be attenuated by 75+10 log (P) dB with respect to the Effective Isotropic Radiated Power (EIRP) (P), in watts.

In providing specifications for equipment manufacturers, an allowance of 2 dB is made for cable loss and 17 dB for sectorized antenna gain. This results in a transmitter output referenced specification (TPO) of -60 dBm in a 1 MHz bandwidth. This would be equivalent to **90+10 log (P)** attenuation where "P" is now the transmitter output power in watts. This transmitter referenced value (i.e. 90+10 log (P)) can be compared to the WCS Coalition proposal of **75+10 log (P)**[7] which XM has agreed to allow for WCS base stations.

WCS OOBE Impairment Criteria[8]

The exact analysis used by the WCS Coalition to arrive at OOBE impairment criteria is somewhat unclear and therefore XM provides the following details of its analysis of what it believes the Coalition probably did:

A 1 dB rise in the receiver noise floor is the stated impairment criterion.[9] The relevant noise floor is calculated as follows:

The base receiver noise floor is stated as -114 dBm/MHz. This is assumed to be the nominal thermal noise floor, namely -174 + 10 log (10^6).

The WCS Coalition then applies a 4 dB receiver noise figure (which, inconsistently, does not seem to be applied in the overload calculation[10] which uses the same impairment criterion), producing an input referenced noise power of -110 dBm/MHz.

The 1 dB rise criterion is than applied by subtracting 6 dB from this value to give -116 dBm/MHz.

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[7] WCS Coalition Comments at 21.
[8] *Id.* at 22 n.41; *see also id.* at Attachment D.
[9] *Id.* at Attachment D.
[10] *Id.* at 28, 29 n. 60.

The receiver antenna is stated to have a gain of 17 dBi, no downtilt with respect to the line of sight from the SDARS repeater (which is unreasonable given the service objective of mobile service), and zero cable loss.

The received signal level impairment criteria would then be -116-17= -133 dBm/MHz referenced to the antenna "input." This is consistent with the stated WCS Coalition value.

SDARS Repeater Exclusion Zone Calculation

As previously indicated, XM repeaters (including the ones used in the WCS Coalition prediction) meet an OOBE limit of 90+10 log (P) (1MHz BW), TPO, or, equivalently for the nominal sectorized case, -45 dBm (1MHz BW), EIRP. Thus, a path loss of >88 dB (-133+45) is sufficient to reduce the emissions below the stated impairment level.

Using a simple free space model, this corresponds to a zone of less than 300 meters around an SDARS repeater. By contrast, the WCS Coalition claimed this zone should be 1,400 meters.

In addition, even small amounts of WCS base station receive antenna downtilt for this gain of antenna will introduce significant additional attenuation of the line of sight OOBE signal from the SDARS repeater. For example, 5 degrees of downtilt for a 17 dBi gain sector antenna will introduce more than 20 dB of additional attenuation (see Figure 3). Assuming only 6 dB of additional attenuation due to receive antenna downtilt results in a required path loss of 82 dB and an exclusion zone of 130 m. All but 2 of XM's Washington DC-market sites and all but 25 of the NYC-market sites are above the 30 meters in height stated as the nominal WCS base station receiving antenna height.

No attempt has been made to plot these extremely small exclusion zones, due to the fact that XM has already demonstrated that this interference mechanism is essentially of no relevance to the discussions in these proceedings.

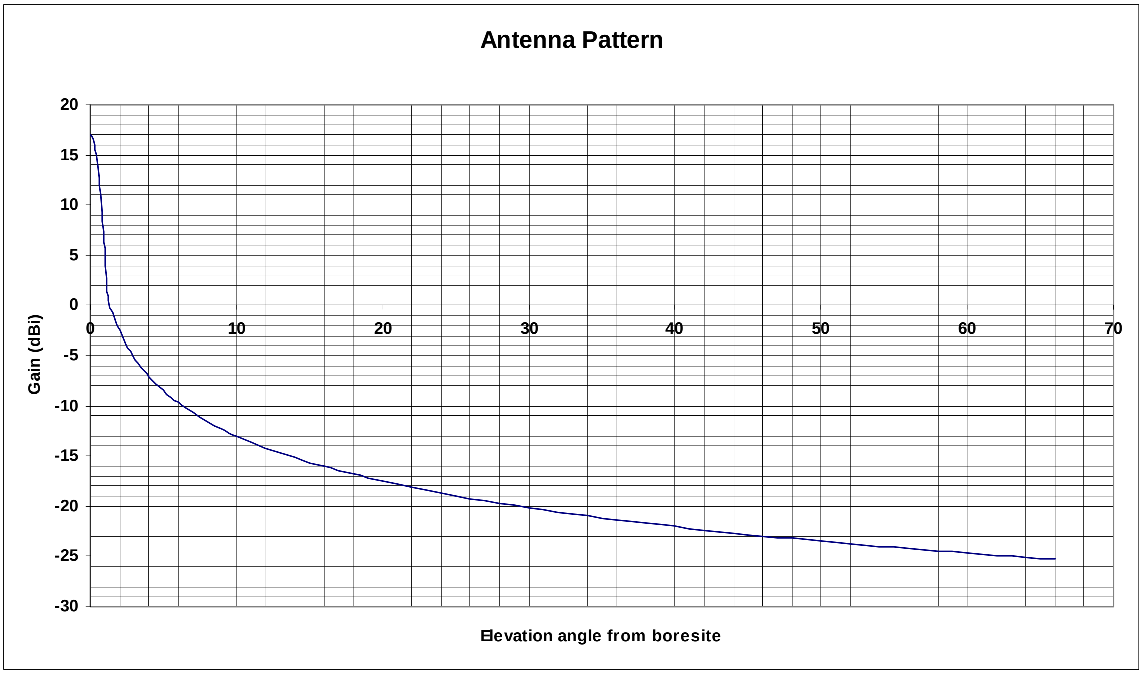


Figure 3 From ITU F1336, 90 degree 17 dBi gain

Appendix C

XM Repeater Coverage Maps for New York and Washington, D.C. Markets For Ground-Based Levels >-44 dBm and >-35 dBm

Introduction

Sirius and XM have proposed that all SDARS repeaters would meet a ground based limit of 110 dBμV/m (-35 dBm equivalent isotropic received power), which would be sufficient protection for mobile WCS terminals based on XM's current understanding of the likely characteristics of such devices.[11] The WCS Coalition filing used the original Sirius proposal of 100 dBμV/m, made before sufficient information on the characteristics of likely WCS mobile terminals was known. To allow an appropriate comparison, both values are examined here.

Ground Based Signal Level Prediction Information

Model Parameters

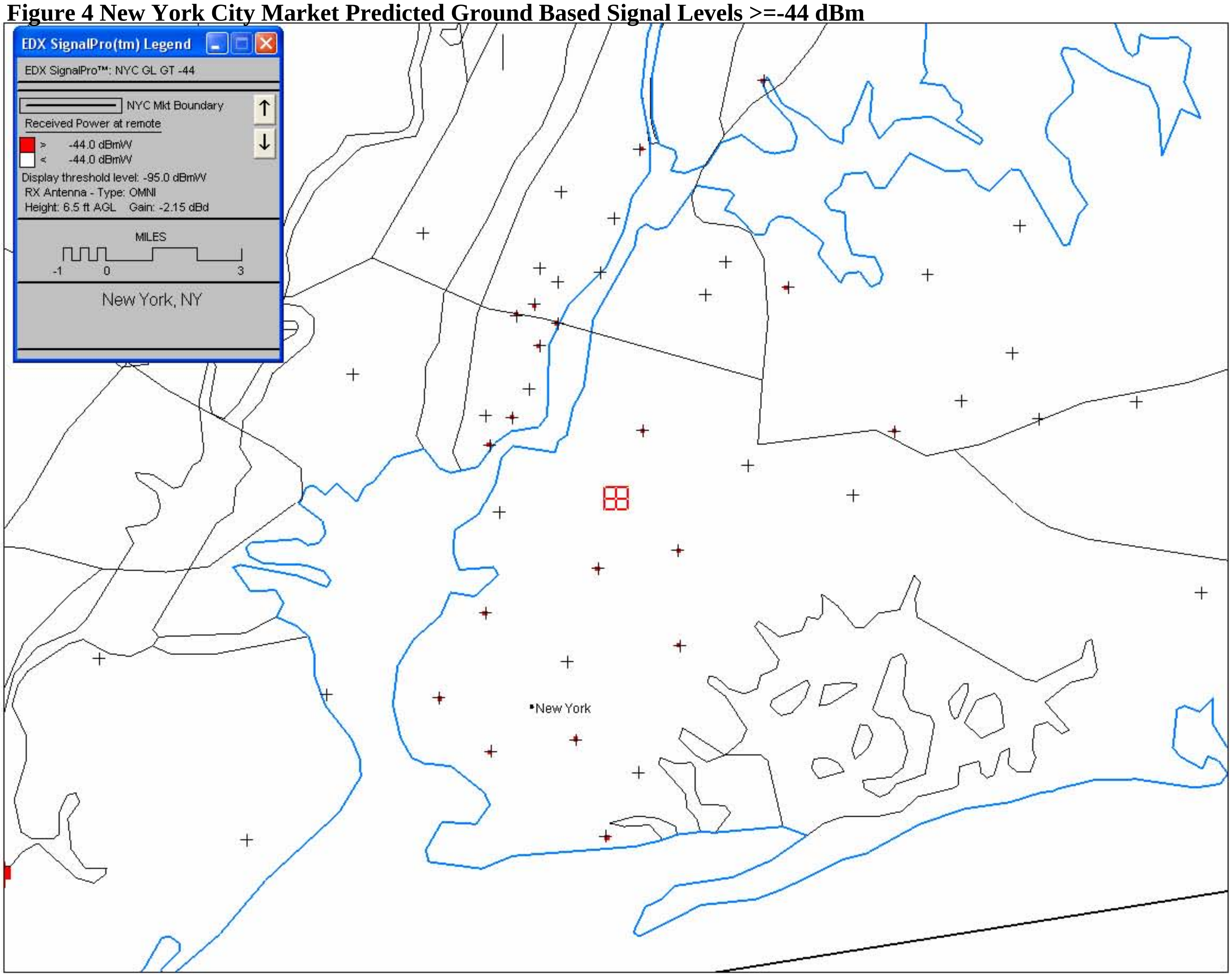
The model parameters used are shown in Table 2:

Table 6 Model Parameters Used for Prediction

Item	Value	WCA Filing Nearest Equivalent
Model type	EDX Signal Pro®	"DVB-H"
Terrain resolution	30 meters	Not specified
Clutter	11 categories, 30 meter resolution, based on 2006 satellite imagery	Not specified
Coverage criteria	Received signal >=-44 dBm Received signal >=-35 dBm	
Receiver height	2 m AGL	
Location probability	50%	90%
Fading margin	n/a dB	7 dB

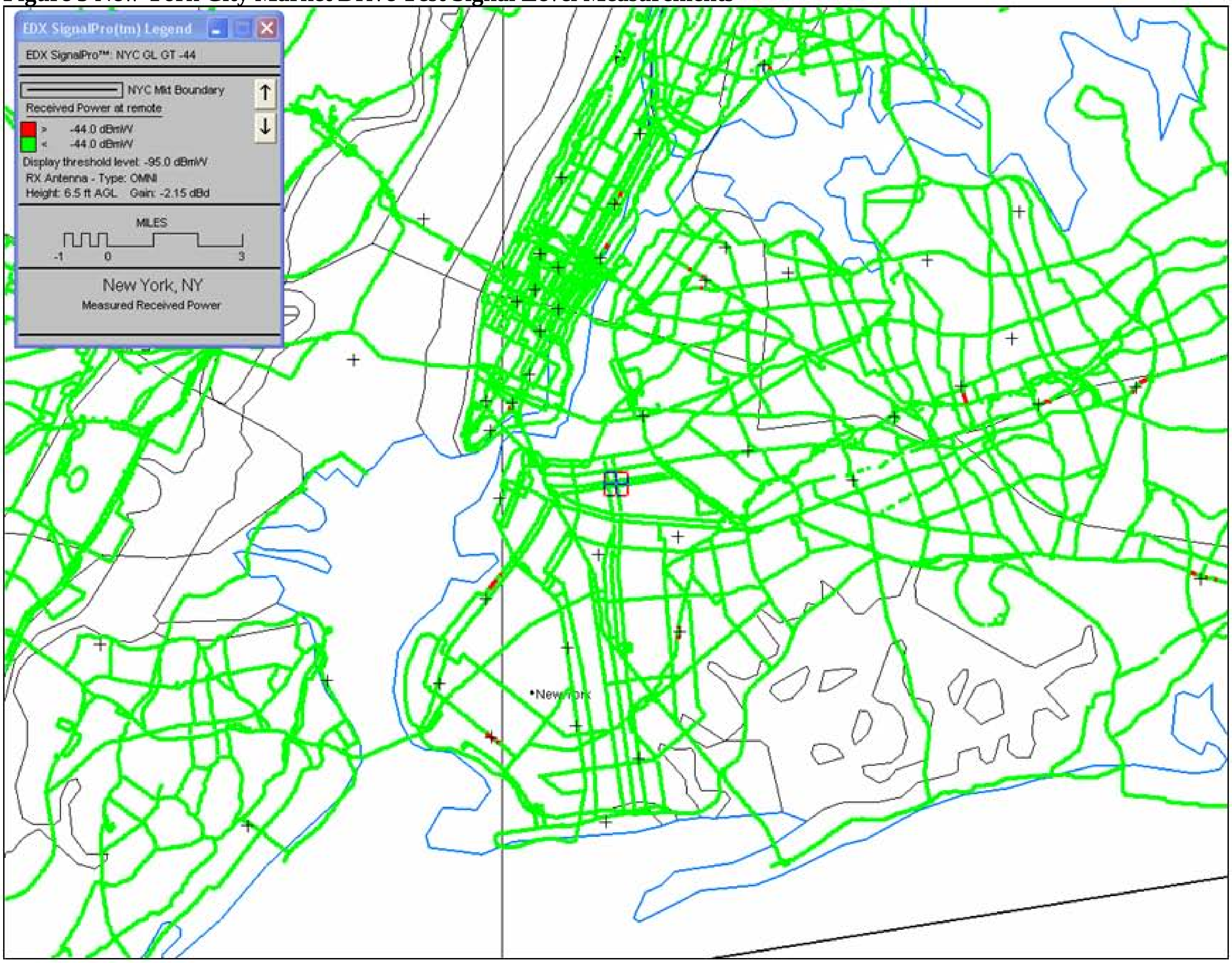
[11] Comments of XM Radio Inc., WT Docket No. 07-293, at 21-27 (filed Feb. 14, 2008) ("XM Comments"), *see also* Comments of Sirius Satellite Radio Inc., WT Docket No. 07-293, at 29-31 (filed Feb. 14, 2008) ("Sirius Comments").

Figure 4 New York City Market Predicted Ground Based Signal Levels >=-44 dBm



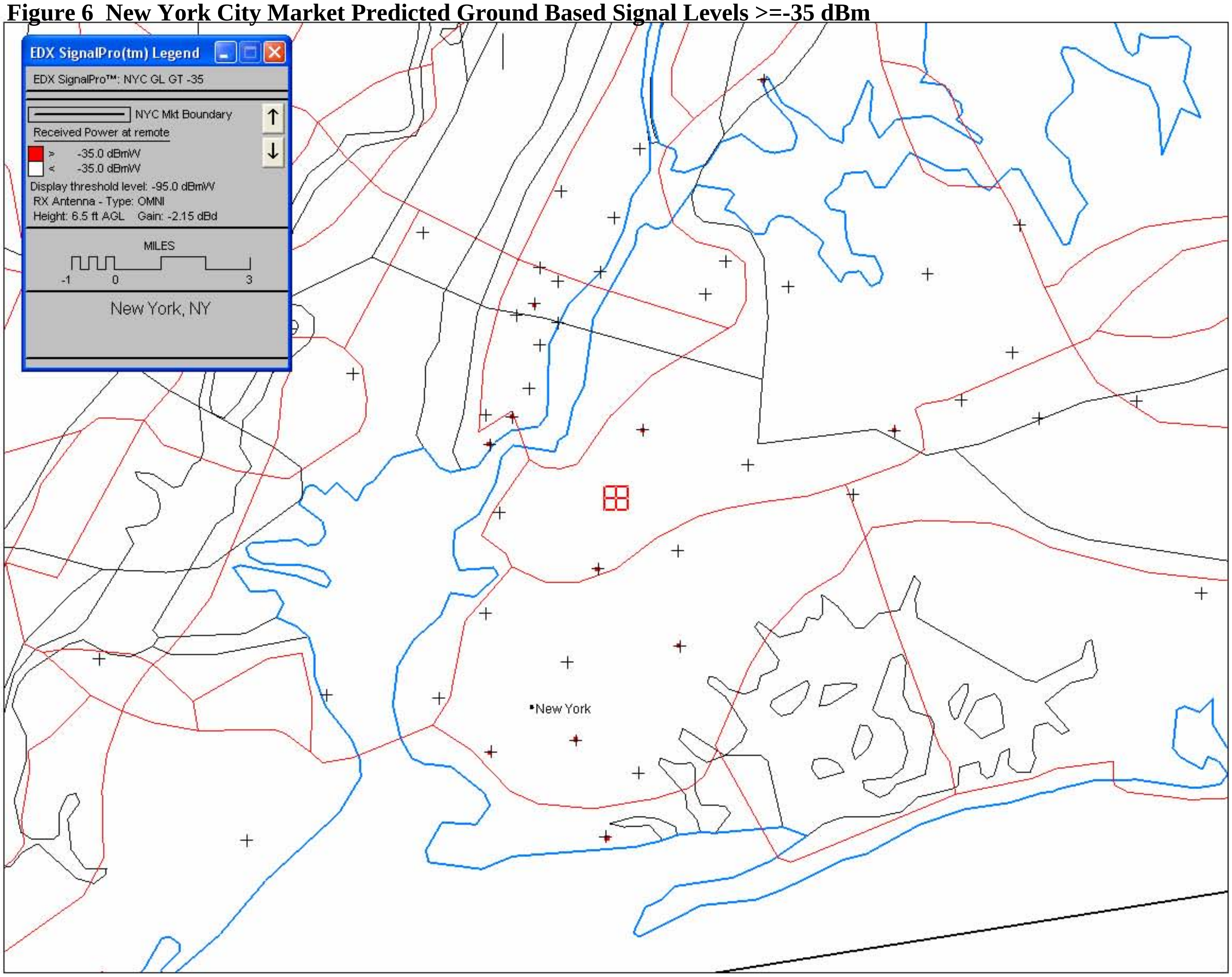
Note that there are very few areas on the map with signal levels > -44 dBm. . '+' represents repeater locations.

Figure 5 New York City Market Drive Test Signal Level Measurements



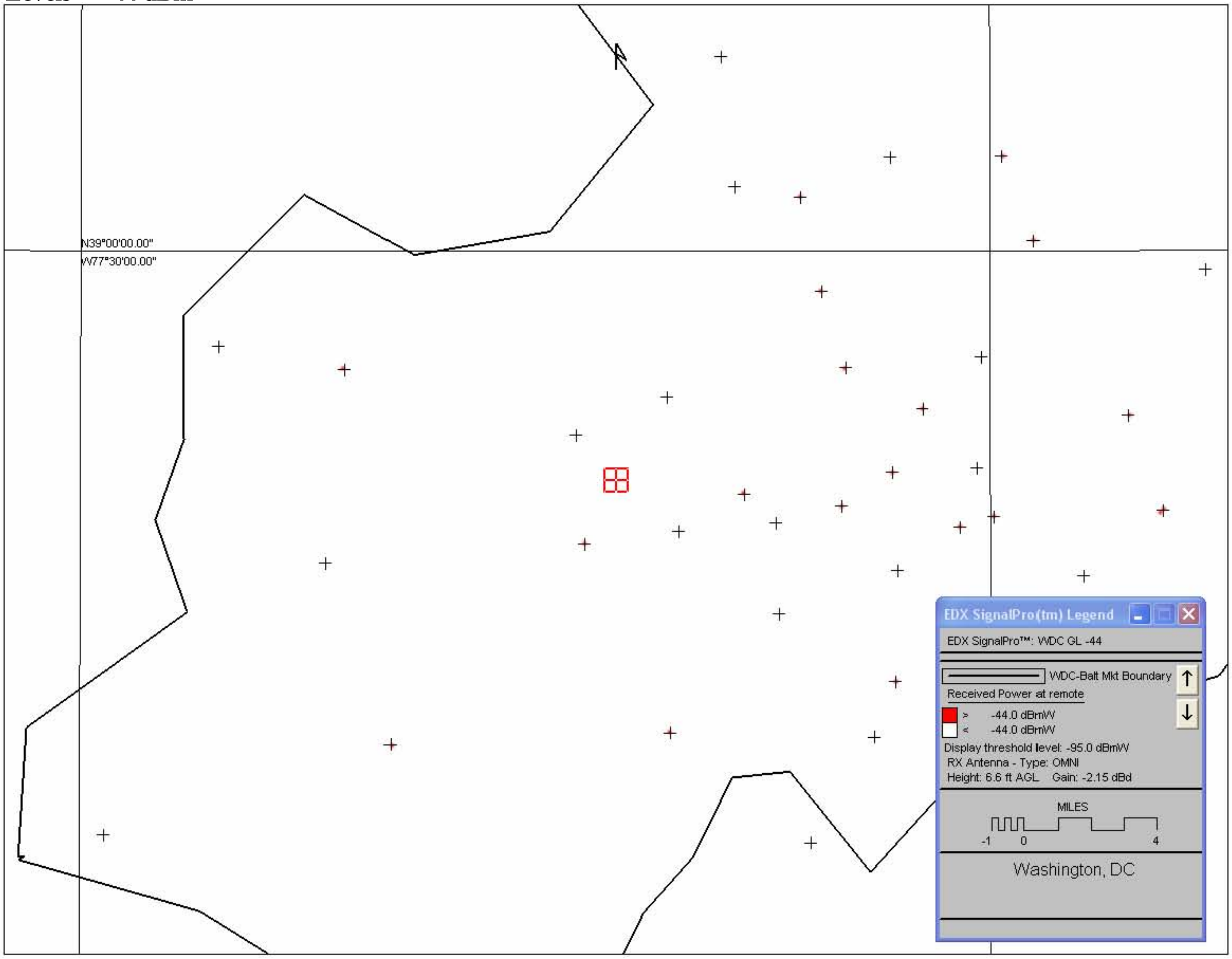
Note that very few of the measurements have signal levels > -44 dBm. '+' represents repeater locations.

Figure 6 New York City Market Predicted Ground Based Signal Levels >=-35 dBm



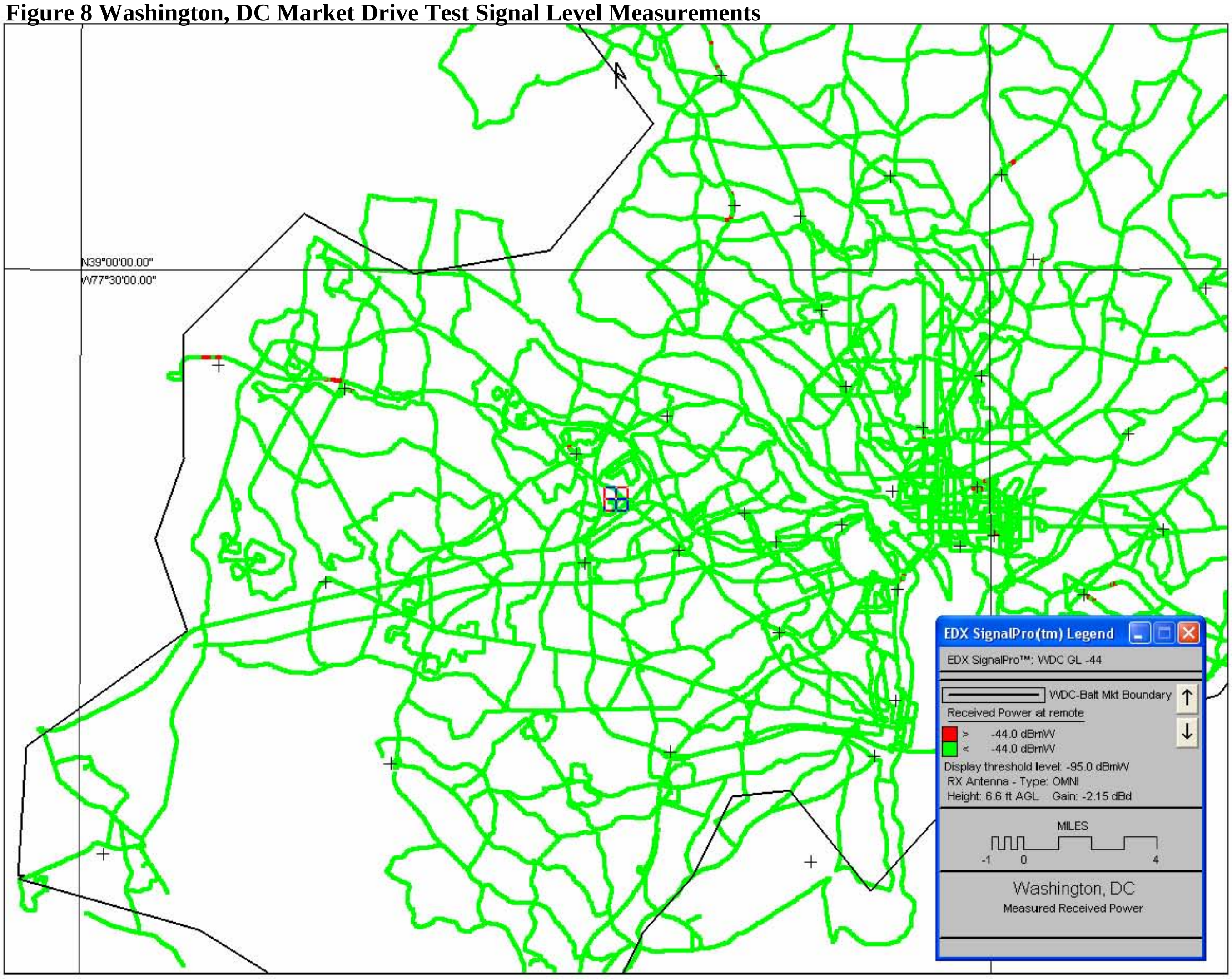
Note that there are very few areas on the map with signal levels > -35 dBm. '+' represents repeater locations.

Figure 7 Washington, DC Market Predicted Ground Based Signal Levels Showing Ground Based Levels >=-44 dBm



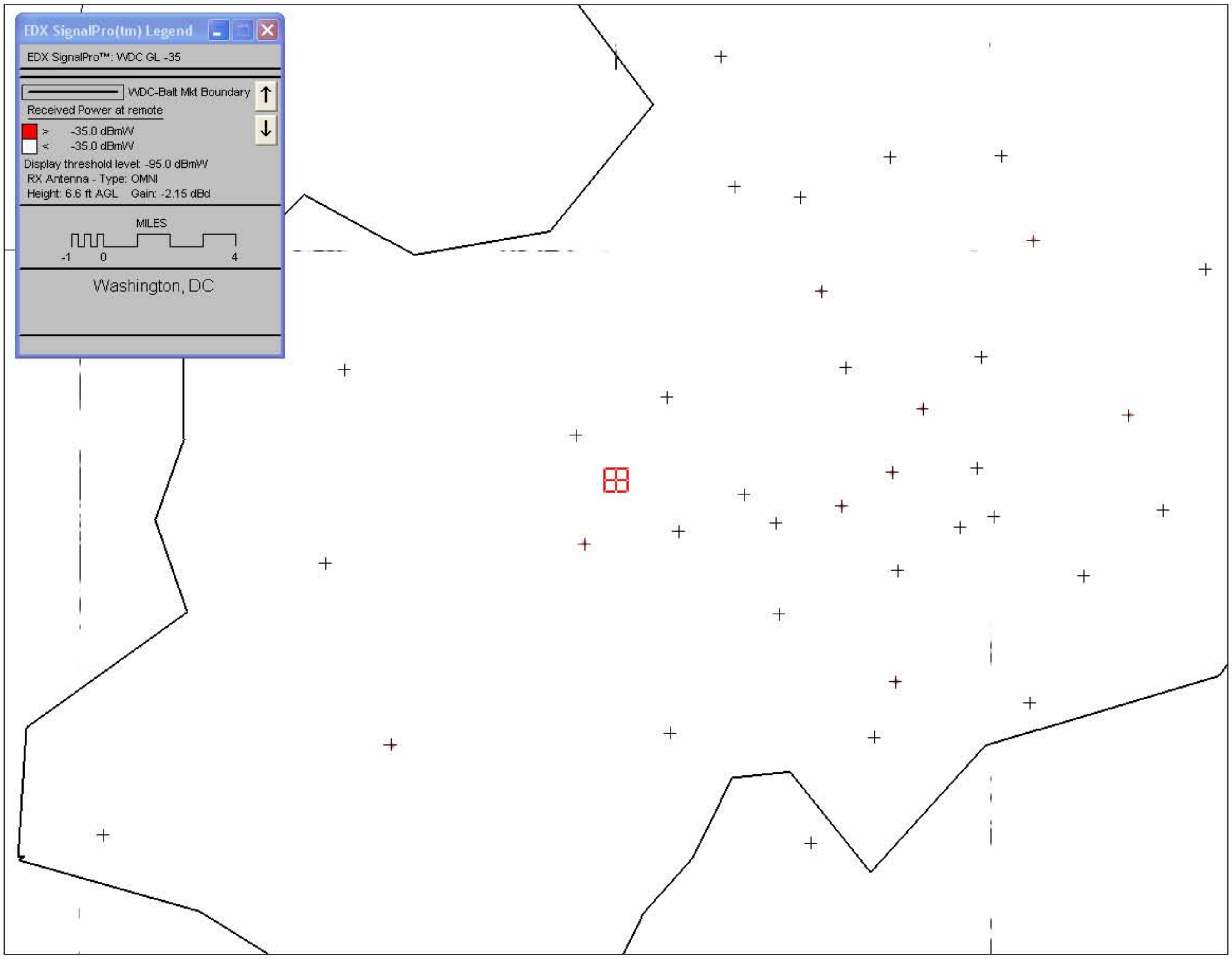
Note that there are very few areas on the map with signal levels > -44 dBm. '+' represents repeater locations.

Figure 8 Washington, DC Market Drive Test Signal Level Measurements



Note that very few of the measurements have signal levels >-44 dBm. '+' represents repeater locations.

Figure 9 Washington, DC Market Predicted Ground Signal Based Levels >=-35 dBm



Note that there are very few areas on the map with signal levels > -35 dBm. . '+' represents repeater locations.

Appendix D

XM Repeater Coverage Maps for New York City and Washington, D.C. Markets Showing WCS Base Station Receive Levels >-40 dBm

Introduction

The WCS Coalition's Comments in this proceeding attempt to address the impact of SDARS repeater signal levels on WCS base station receive overload.[12] The WCS Coalition's position is that this interference mechanism is not constrained by a purely ground-based limit. The Coalition offers maps purporting to show SDARS repeater coverage in the New York City and Washington DC metropolitan areas.

In response, the analysis presented here consists of two elements:

- A more accurate base prediction for each market using the original parameters supplied by the WCS Coalition,[13] which claims that a -40 dBm overload level is appropriate for a typical WCS base station; and

- In response to the WCS Coalition's claim that assumed base station filter rejection is significantly less than is achievable by current receive filters for this band, XM uses a more representative filter rejection to re-predict the anticipated potential base station receive overload interference.

Prediction Information

Calculation of WCS Base Station Receiver Overload Parameters

WCS Coalition Receiver Overload Signal Level Calculation[13]

It is not entirely clear how the WCS Coalition arrived at the -40 dBm value used for its analysis. However, in the interests of clarity, XM herein lists its assumption regarding WCS BTS receiver overload parameters (based on the terminology of Footnote 60 of the WCS Coalition filing) as follows:

Reference sensitivity = -121 dBm

<u>XM assumption</u>: This is the noise power value **in 1 MHz** that would cause a 1 dB rise in the base station input thermal noise floor. The thermal noise floor for a 1 MHz bandwidth can be approximated by $-174 + 10\log(10^6) = -114$ dBm. A noise level approximately 6dB below this would cause a 1 dB noise floor rise, hence the -121 dBm WCS Coalition figure.

Base Station Adjacent Channel Selectivity (ACS) = 58 dB

<u>XM assumption</u>: This is the receiver adjacent channel selectivity (ACS) appropriate to the frequency separation between the WCS channel being received and the location of the nearest repeater signal. This separation would have a minimum value of approximately 4MHz for the adjacent blocks and up to 14 MHz for the A blocks.

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[12] WCS Coalition Comments at 32-33.

[13] *Id.* at 28-29 n.60.

RX Impairment level for jammer = -63 dBm
XM assumption: this is the interference level, in a 1 MHz bandwidth, referenced before the adjacent channel filtering, that would lead to the -121 dBm noise level (=-121+58 dB).

Filter Attenuation = 40 dB
XM assumption: This is the receiver adjacent channel rejection produced by a separate receive filter, ahead of the LNA, appropriate to the frequency separation between the WCS channel being received and the location of the nearest repeater signal. This separation would have a minimum value of approximately 4 MHz for the adjacent blocks and up to 14 MHz for the A blocks. Based on our own experience with deploying base station filters and on technical material available from filter manufacturers,[14] the 40 dB value used does not represent the currently available performance and 60 dB would be a more realistic number.

RX antenna Gain = 17 dBi
XM assumption: This is the antenna sector gain. It is unclear whether the WCS Coalition includes any cable loss in this number, but XM assumes it has done so. The Coalition does not specify any downtilt which is inconsistent with the stated WCS application, i.e. mobile broadband service.

The overload level for the simulation is then estimated as follows:

Impairment (in 1 MHz) = -63 +40 -17 dBm referenced to the antenna input

= -40 dBm (1MHz).

The XM repeater signal has a bandwidth of 5 MHz and so the total received power to be modeled is -40+10log(5/1) = -40+7 = -33 dBm.

This value, -33 dBm, is different from the -40 dBm used by the WCS Coalition and we believe this to be an error on their part. This corrected value is used for our predictions, which also includes more realistic receive filter attenuation values.

Model Parameters

The model parameters used are shown in Table 7 for the base comparison case and in Table 8 for what XM believes to be a more realistic case. A comparison of the resulting areas of potential impact is shown in on the following maps.

[14] One such filter vendor is Trilithic, Inc. *See* http://www.trilithic.com.

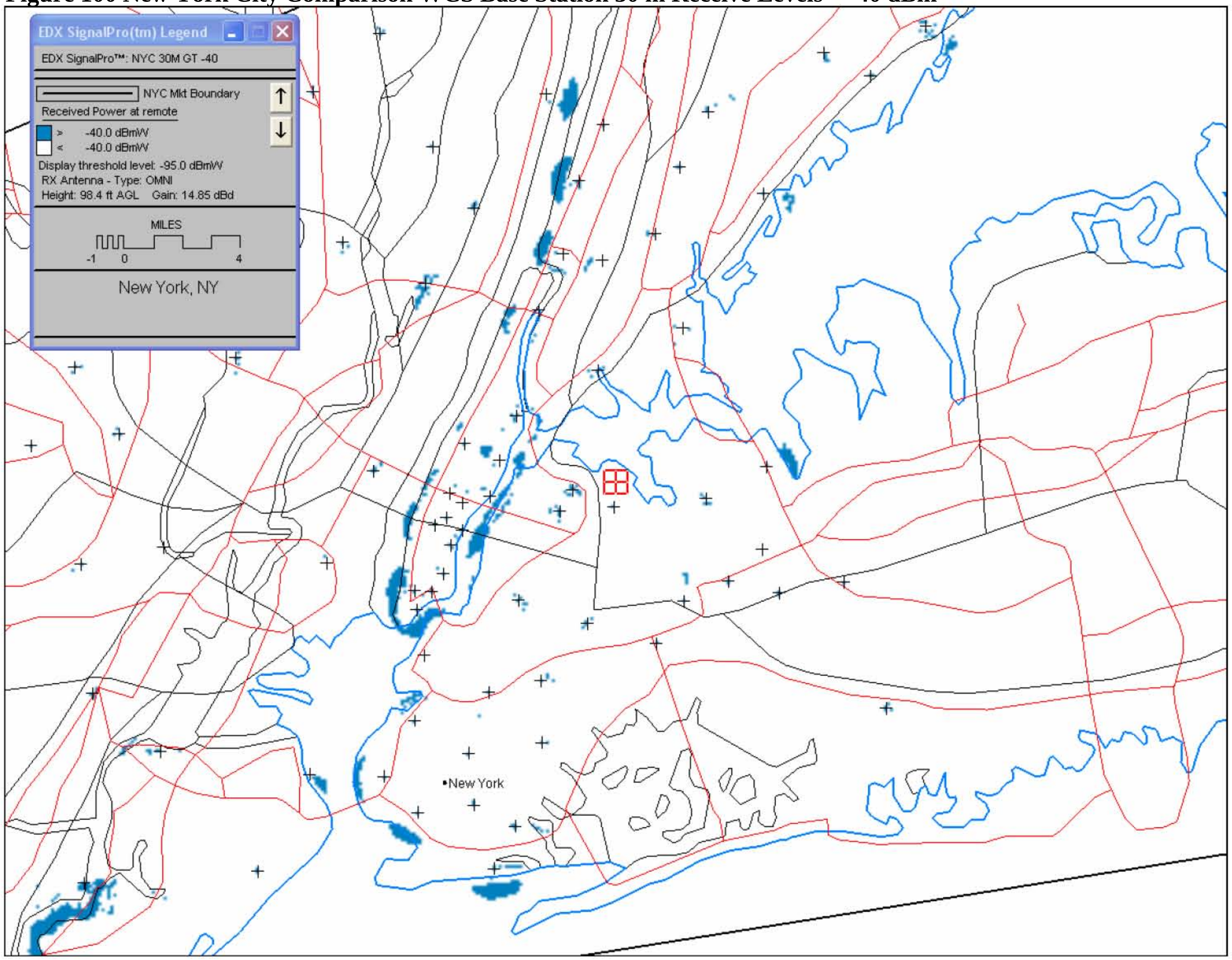
Table 7 Model Parameters Used for Comparison with WCS Coalition Prediction

Item	Value
Model type	EDX Signal Pro®
Terrain resolution	30 meters
Clutter	11 categories, 30 meter resolution, based on 2006 satellite imagery
Coverage criteria	Signal level > -40 dBm
Receiver height	30 m
Location probability	50%
Fading margin	n/a dB
WCS Base Station Antenna Gain	17 dBi
WCS Base Station Antenna Downtilt	0 degrees
Reference sensitivity	-121 dBm
BTS ACS 10 MHz	58 dB
Rx Filter attenuation	40 dB
WCS base Station Antenna Pattern	Not specified,

Table 8 Model Parameters Used for Realistic WCS BTS Rx Overload Prediction

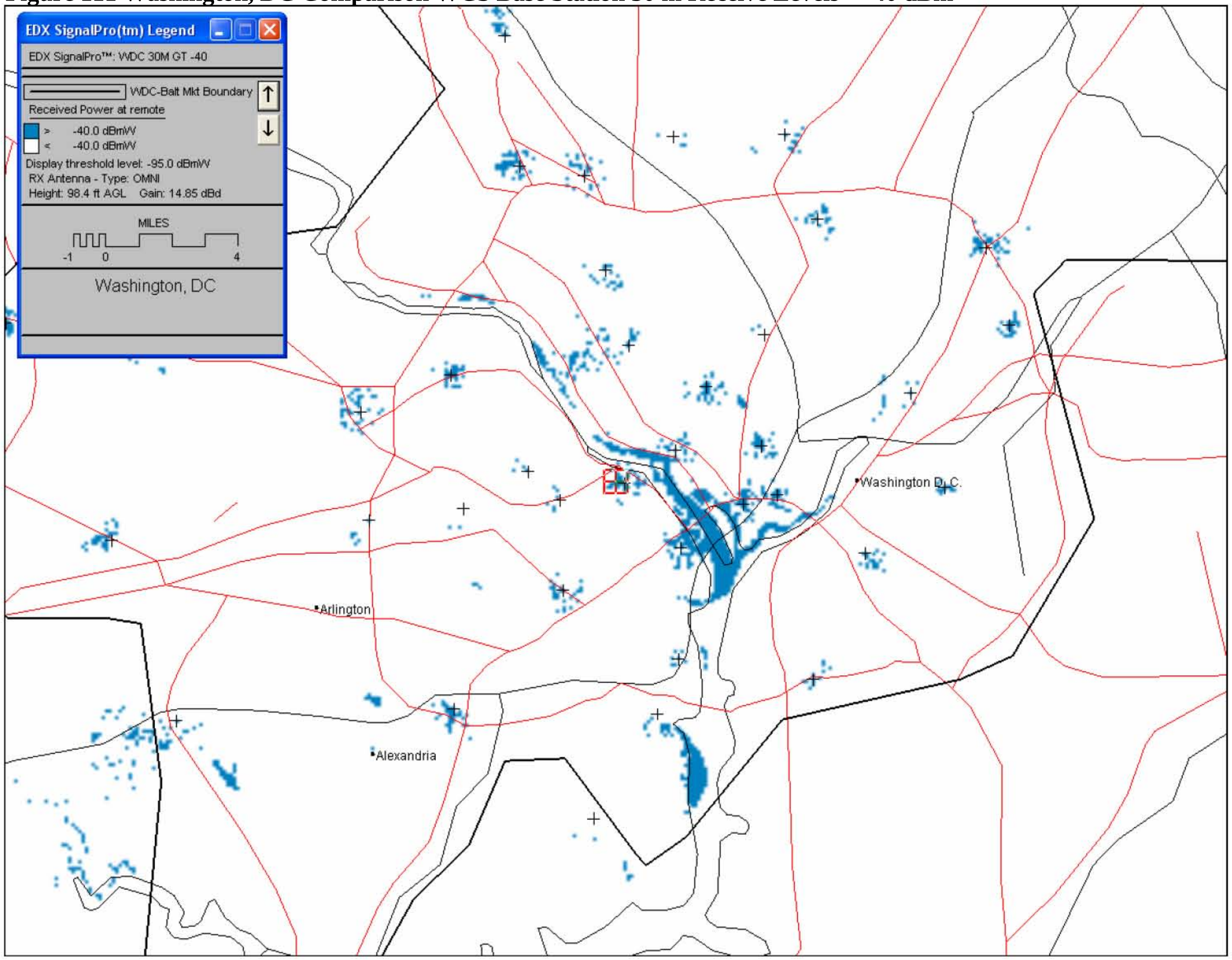
Item	Value
Model type	EDX Signal Pro®
Terrain resolution	30 meters
Clutter	11 categories, 30 meter resolution, based on 2006 satellite imagery
Coverage criteria	Signal level > -30 dBm
Receiver height	30 m
Location probability	50%
Fading margin	n/a dB
WCS Base Station Antenna Gain	17 dBi
WCS Base Station Antenna Downtilt	0 degrees
Reference sensitivity	-121 dBm
BTS ACS 10 MHz	58 dB
Rx Filter attenuation	60 dB
WCS base Station Antenna Pattern	17 dBi ITU or equivalent

Figure 100 New York City Comparison WCS Base Station 30 m Receive Levels > -40 dBm



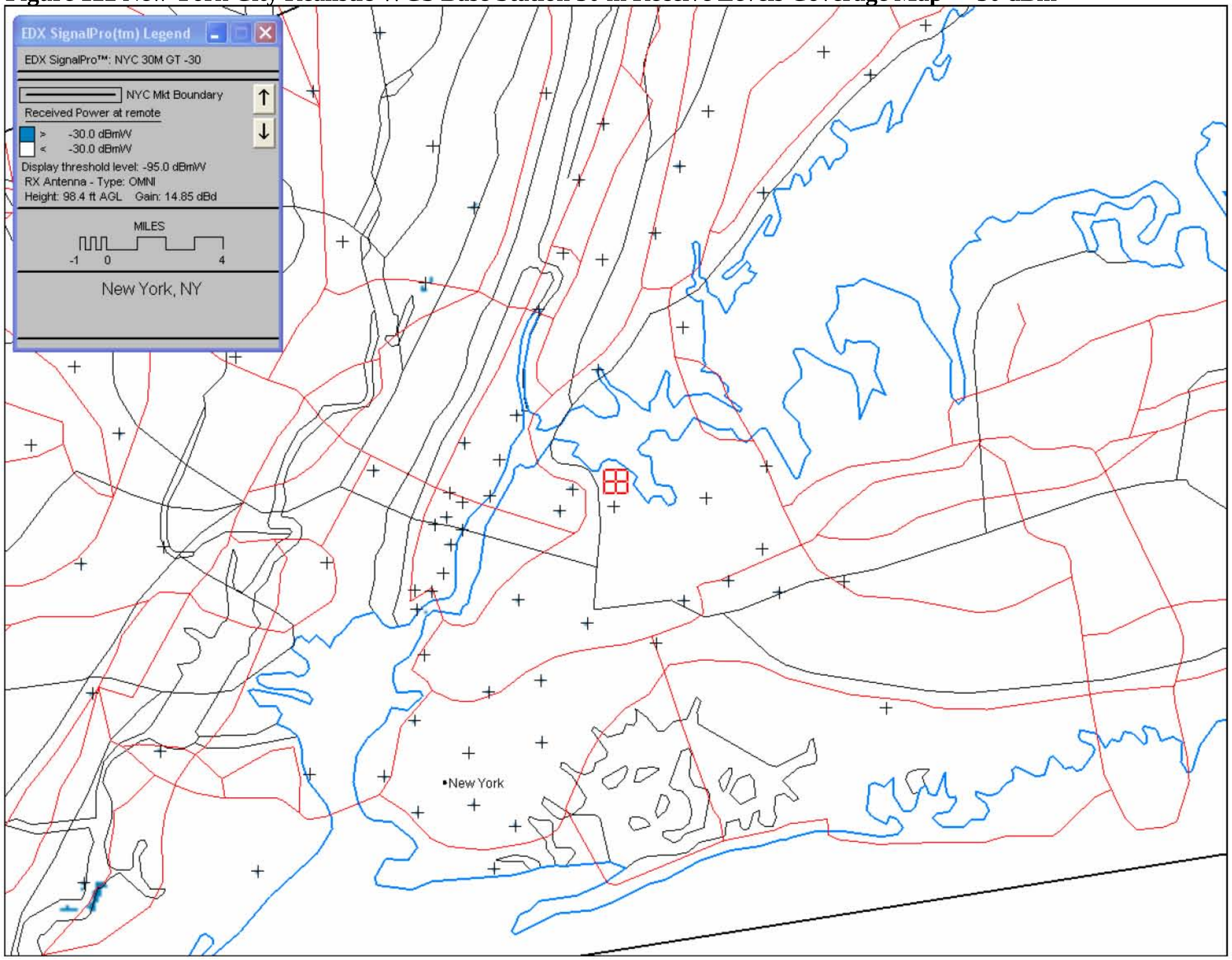
The blue areas show the predicted XM terrestrial signal level > -40 dBm at the WCS base station antenna terminal, 30 m AGL.

Figure 111 Washington, DC Comparison WCS Base Station 30 m Receive Levels > -40 dBm



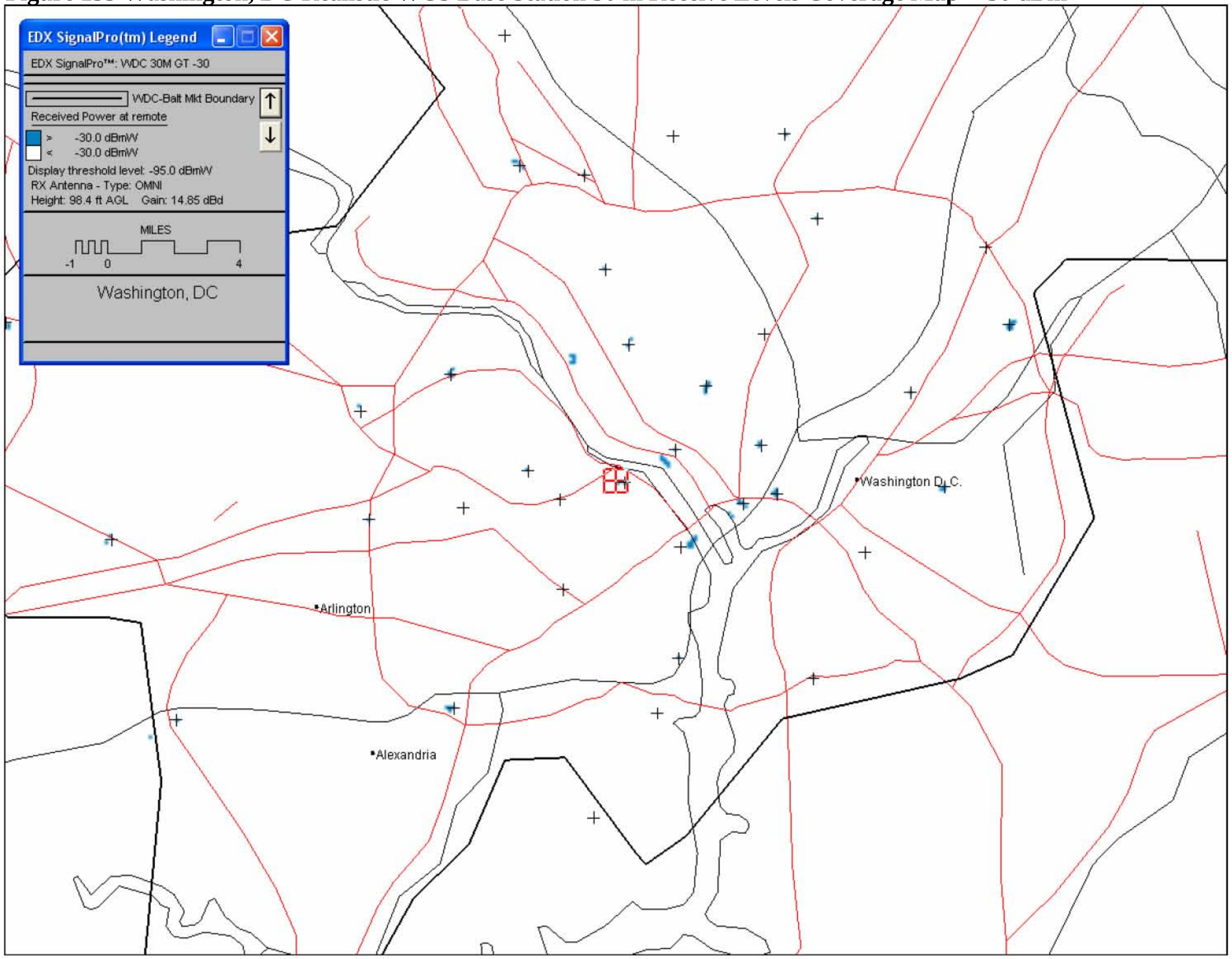
The blue areas show the predicted XM terrestrial signal level > -40 dBm at the WCS base station antenna terminal, 30 m AGL.

Figure 122 New York City Realistic WCS Base Station 30 m Receive Levels Coverage Map > -30 dBm



The blue areas show the predicted XM terrestrial signal level > -30 dBm at the WCS base station antenna terminal, 30 m AGL.

Figure 133 Washington, DC Realistic WCS Base Station 30 m Receive Levels Coverage Map >-30 dBm



The blue areas show the predicted XM terrestrial signal level > -30 dBm at the WCS base station antenna terminal, 30 m AGL.

Exhibit B

WCS Portable/Mobile /SDARS Interference Modeling

Path Loss
Overload/OOBE Trade Space

Introduction

An essential component of the engineering arguments surrounding the potential introduction of mobile service into the 2.3 GHz band and its impact on SDARS service is the estimation of path loss in a variety of possible mobile terminal interference use cases.

Unlike "normal" propagation modeling (which typically aims to predict path loss over moderate to large distances and between "tall" radio towers and low height consumer devices), the low transmit heights and short distances involved in evaluating interference between peer consumer devices is less well documented.

This problem of estimating "Short-Range Mobile-to-Mobile Propagation " has been recognized in a recent extensive NTIA study[1] and in a small number of technical publications.[2]

This exhibit identifies the general characteristics of relevant use cases and summarizes available technical material for path loss estimates in comparison to that used in the NPRM filings by the parties.

Interference Model Use Cases and Associated Path Losses

Based on the available literature[3] the anticipated use cases for the type of mobile/portable services that would be enabled by the proposed rule changes are similar to existing cellular service.

The use cases considered in this exhibit are given in Table 1. The term "mobile" is used generally to apply to "mobile," "portable," and "nomadic" cases.

Table 1

	Interferer	Victim	Applicable distance range	Description
1	WCS handheld or nomadic terminal in a car	SDARS Receiver in a separate car	>= 3 meters	See Figure 1
2	WCS handheld or nomadic terminal by the road side	SDARS Receiver in a passing car	TBD	TBD

1 Nicholas DeMinco, Propagation Loss Prediction Considerations for Close-In Distances and Low Antenna Height Applications, NTIA Report, TR-07-499 (Jul. 2007) ("NTIA Report").

2 T.J. Harrold et al., Propagation Studies for Mobile-to-Mobile Communications, Vehicular Technology Conference 2001, IEEE VTS 54th, vol. 3, 1251-55 (Oct. 2001) ("IEEE Mobile-to-Mobile Propagation Study").

3 See http://www.wimax-industry.com/ar/9w.htm

Distances Relevant for WCS Mobile to SDARS Vehicular Reception Interference Models

The use model here is interference from either a nomadic terminal (*e.g.,* smart phone or laptop) or a handset (*e.g.,* VoIP) user in the driver or back seat of a car to an SDARS receiver located in a nearby car. This is illustrated in Figure 1.

We can estimate lane widths from the Bureau of Transportation Statistics. Average lane widths and spacing are given in Table 2.[4]

Table 2 Lane Widths

Description	Min	Max	Mean	Median
Average lane width on major road (m)	3.30	4.00	3.58	3.60
Average lane width on minor road (m)	3.40	4.00	3.69	3.60
Number of lanes on major road (lanes/traffic direction)	2	5	2.6	2.0

This information demonstrates that a separation distance of 3 meters is directly relevant to this analysis.[5]

Path Loss Estimation

The calculation of path loss between two devices that are both at low heights and short separations requires special consideration. The results of two separate studies are discussed herein.

The results in Figure 2 show measurements made 2 at 2.1 GHz under a variety of conditions (line of site and non line of sight) for a transmitter and a receiver at low heights and separated by distances up to 25 meters.[9] Only a small difference in path loss would be expected between this data and that at 2.3 GHz. At 3 meters, a path loss of 50 dB or less would be seen under these types of circumstances.

One of the results from the recent comprehensive NTIA evaluation of mobile to mobile propagation loss modeling is shown below in Figure 3, Predicted Path Loss (from NTIA Report). This too, allowing for the slightly different frequencies puts the expected path loss at 3 meters at approximately 50 dB.

These measurements and estimates of path loss are both consistent with the values measured and used in XM's Comments[6] and also re-measured for this filing.[7] They are also consistent with the approach taken recently by Motorola, supported by AT&T and Verizon Wireless in filings in the FCC's AWS-3 proceeding, WT Docket No. 07-195 ("Service Rules for Advanced Wireless Services in the 2155-2175 MHz band").[8]

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[4] http://www.bts.gov/publications/journal_of_transportation_and_statistics/volume_07_number_23/html/paper_03/table_03_01.html.

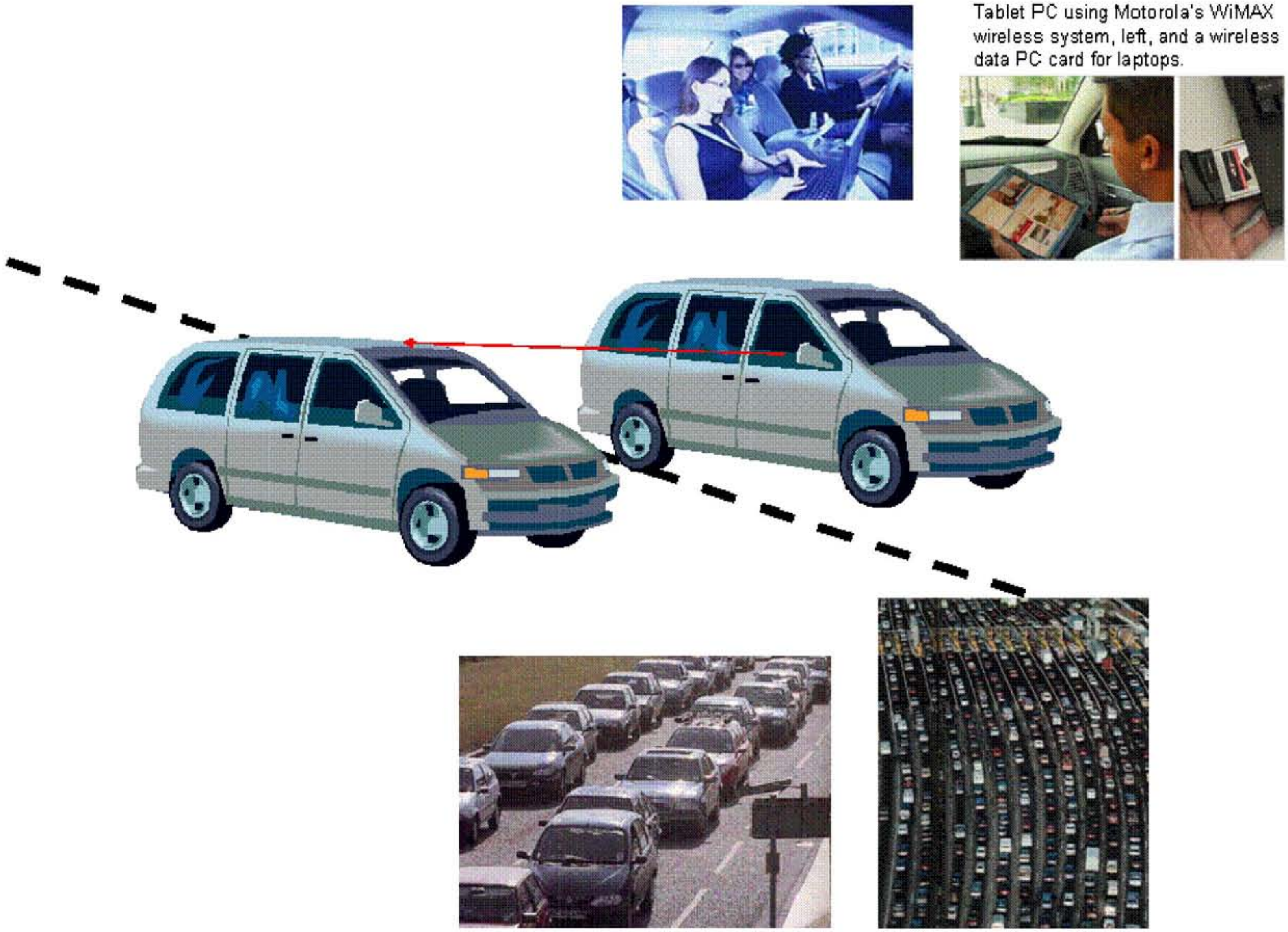
[5] A three meter separation parameter is approximately the same protection accorded to SDARS receivers under current rules restricting WCS OOBE. This separation parameter makes sense for purposes of protecting SDARS receivers, most of which are installed in automobiles. *See* 47 C.F.R. § 27.53(a)(3) (110 + 10 log (P) dB).

[6] Comments of XM Radio Inc., Docket WT 07-293, Exhibit C (filed Feb. 14, 2008) ("XM Comments").

[7] *See* Exhibit C.

[8] Comments of Motorola, Inc., WT Docket No. 07-195 at A-2 (filed Dec. 14, 2007); V-Comm Telecommunications Engineering Presentation of Feb. 19, 2008, at 5 *submitted with* Letter from Donald C. Brittingham, Director, Wireless / Spectrum Policy, Verizon Wireless, to Marlene H. Dortch, Secretary, Federal Communications Commission, Ex Parte Presentation, WT Docket No. 07-195 (filed Feb. 19, 2008).

Figure 1 WCS Mobile Use Interference to SDARS in Car Receiver Use Case



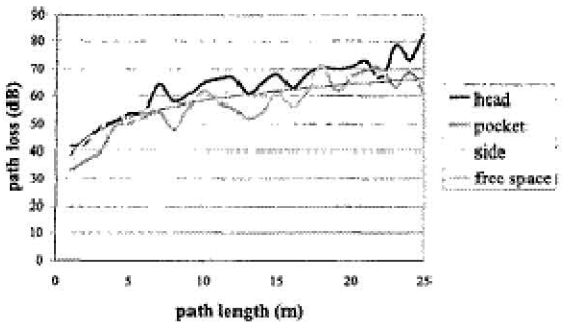


Fig. 6. Path loss for transmitter at side height, LOS path

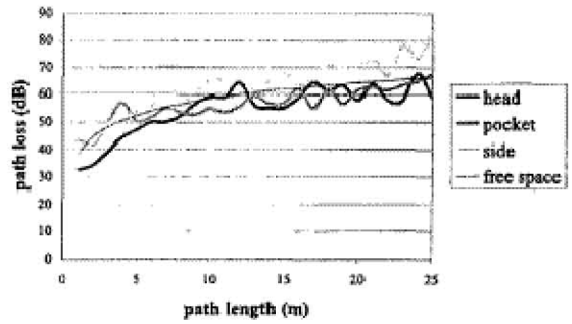


Fig. 4. Path loss for transmitter at head height, LOS path

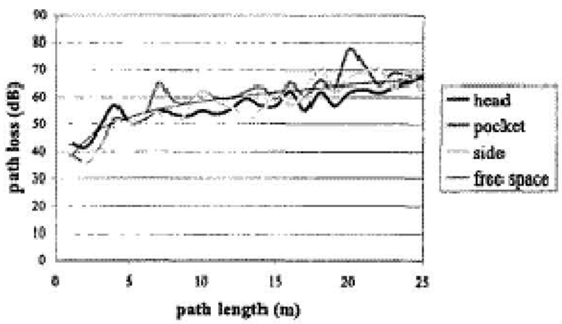


Fig. 5. Path loss for transmitter at pocket height, LOS path

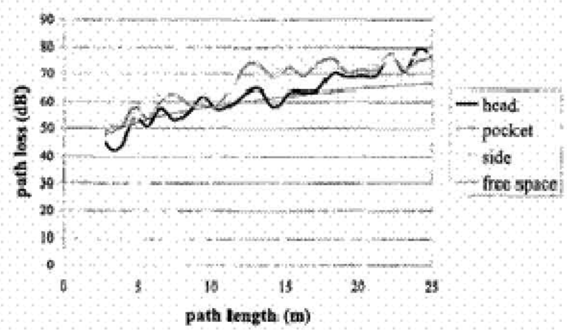


Fig. 7. Path loss for transmitter at head height, non-LOS path

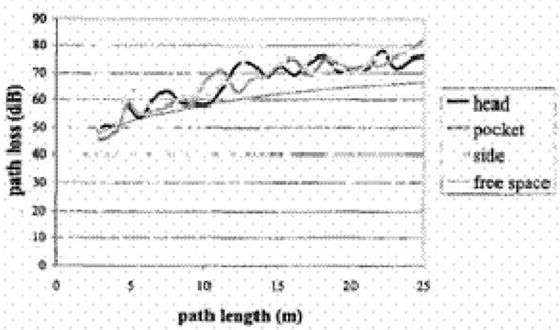


Fig. 8. Path loss for transmitter at pocket height, non-LOS path

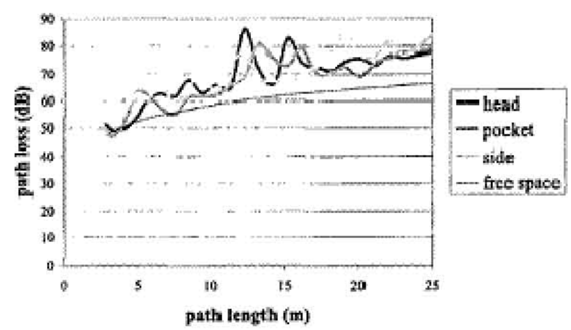


Fig. 9. Path loss for transmitter at side heigh, non-LOS path

Figure 2 Measured Peer to Peer Path Loss at 2.1 GHz [9]

[9] IEEE Mobile-to-Mobile Propagation Study at 1251-55.

Figure 3 Predicted Path Loss (from NTIA Report)

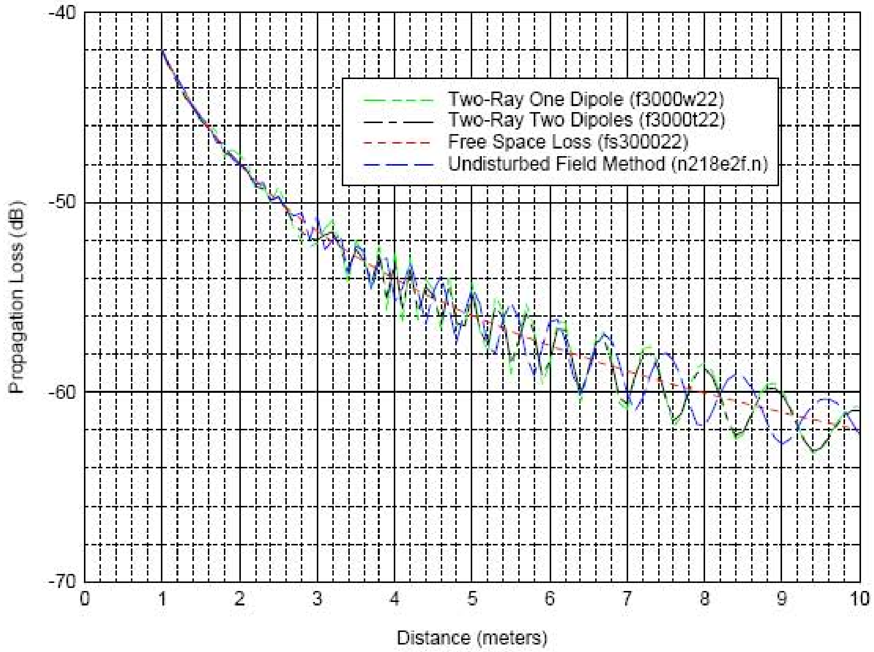
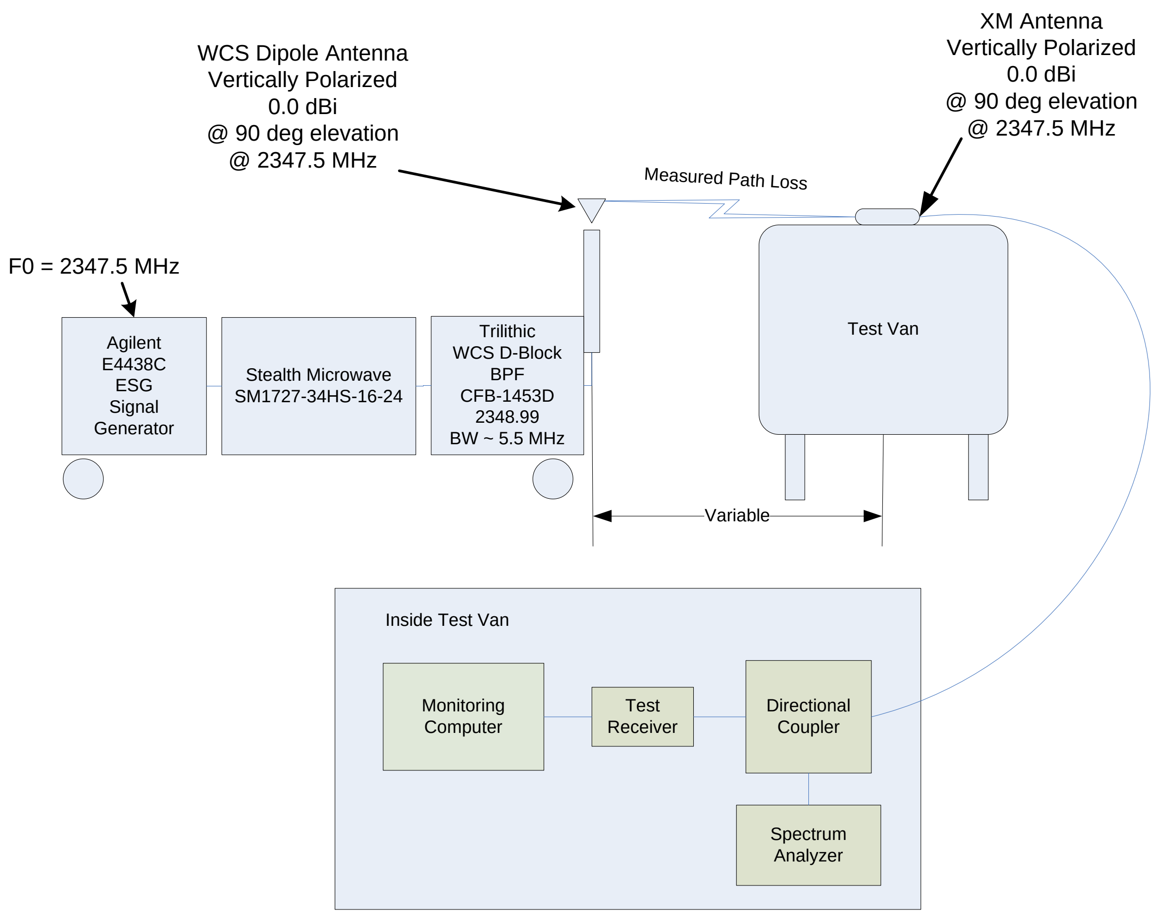


Figure F-34. Comparison of the undisturbed-field method with other methods at 3000 MHz for antenna heights h_1=2m and h_2=2m.

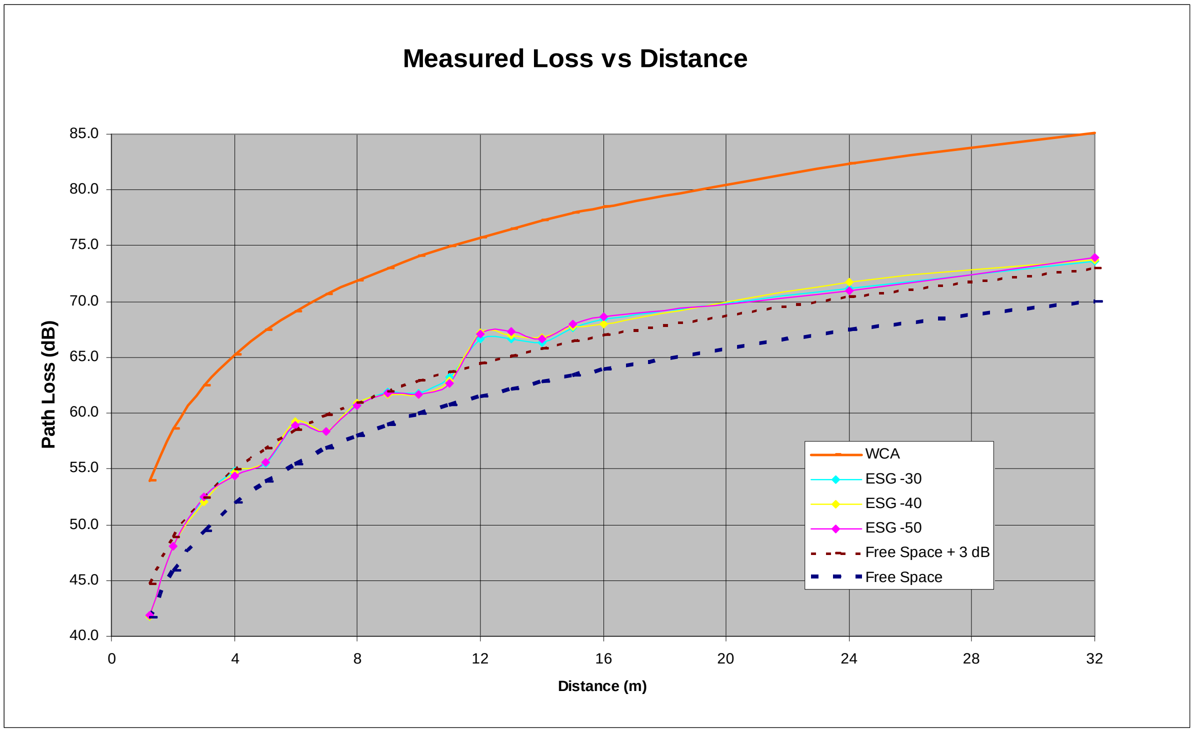
Additional XM Path Loss measurements

Measurements were taken to document the path loss that could be expected between a potential WCS subscriber interferer operating on D-block and a typical XM radio receiver installed in a vehicle. The WCS interferer was positioned 6 feet AGL (above ground level) and the standard aftermarket XM radio antenna was mounted on the center front portion of the roof of a minivan.

The equipment setup is illustrated in the figure below and is the same equipment and setup used for the WCS interference testing described in Exhibit C. The gains and losses of all the conducting components in the transmit-to-receive path were measured prior to the test so that the path loss between the transmit and receive antennas could be determined from the experiment. The cart containing the WCS transmitting equipment was moved through a series of separation distances and the signal generator (ESG) was operated at 3 output power levels (-30 dBm, -40 dBm and -50 dBm) for each of these separation distances. The power level received at the spectrum analyzer for each of these conditions was recorded.



The plot below illustrates that XM's path loss vs. distance measurements validate the expected path loss used by XM (free space path loss + 3 dB) to determine the WCS interference impact on XM receivers. The plots show each of the data points for various ESG power levels (shown on the legend as ESG-30, ESG-40 and ESG-50). As demonstrated, the collected data points match up closely with free space path loss + 3 dB. Also shown is the path loss curve proposed by the WCIA which is at least 10 dB greater path loss than can be expected.



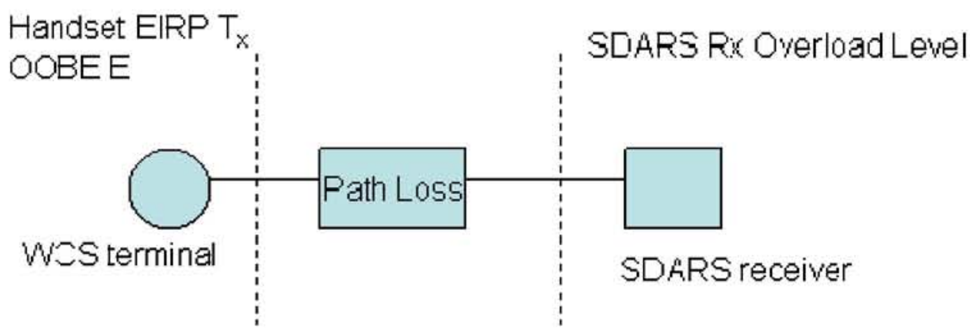
Trade Space Relationship between WCS Terminal Transmit Power and Out of Band Emission Limits

Introduction

One of the central issues in this proceeding is the proposed significant relaxation of mobile terminal out of band emission (OOBE) limits (by a factor of over 100,000). To fully explain the issues, we have analyzed the relationship between OOBE and mobile transmit power in terms of the interference impact on satellite radio reception as they are linked together in terms of their overall effect on reception.

Figure 4 illustrates the basic interference model of a WCS handset at a distance D from a satellite receiver. The WCS handset has an EIRP of T_x dBm and an out of band emissions limit of OOB dBm (1MHz) (which can also be expressed in the form xxx+10 log (P) where P is the transmitter output power in watts). For simplicity, the WCS handset antenna gain is assumed to be 0 dBi and so transmitter output power = EIRP.

Figure 4 Trade Space Model



The distance D has associated with it a certain path loss which equally attenuates both the transmitted WCS signal and the out of band emissions. We also calculate the pair of values (*i.e.* the values of WCS Terminal EIRP and WCS Terminal OOBE), associated with a given distance D that each cause the satellite radio to be impaired. In the case of the transmitted WCS signal, the satellite receiver will fail when it receives a level of -44 dBm in A, B blocks and -55 dBm in C and D blocks. In the case of OOBE, the 1 dB noise rise criteria implies the impairment occurs when -125 dBm is received in a 1MHz bandwidth.[10]

To establish the trade space, we chose a path loss model that is appropriate to the short distances used. For the calculation, the path loss associated with the separation distance is calculated using free space + 3 dB.[11]

[10] XM Comments, Exhibit C.

[11] This calculation is consistent with, for example, Motorola's approach described in their filing in the AWS-3 proceeding. Comments of Motorola, WT Docket No. 07-195, A-2 (filed Dec. 14, 2007) ("Motorola AWS-3 Reply Comments"). *See also* Reply Comments of AT&T, 3-5 WT Docket No. 07-195, (filed Jan. 14, 2008) ("AT&T AWS Reply Comments"). Notably, Motorola is one of the commenter in this docket and AT&T is a WCS licensee. As discussed in Exhibit A, this approach is significantly at odds with the WCS Coalition's path loss estimates in its Comments in this docket.

The calculation proceeds as follows:

- At a given distance "D," the path loss is calculated using the free space + 3 dB approach described above.

- The maximum allowable WCS terminal EIRP is then calculated by adding the path loss to the appropriate receiver overload level (-44 dBm in the case of A and B blocks and -55 dBm in the case of C and D blocks).

- The maximum allowable OOBE in 1 MHz bandwidth is then calculated by adding the path loss to that noise power that (in 1MHz) causes a 1 dB increase in the Sirius noise floor.

- The maximum WCS terminal EIRP and the maximum WCS terminal OOBE are then plotted on separate axes as a function of the separation distance.

Figure 7and Figure 8 show the resulting trade space charts.

Sirius has proposed 3 meters as the appropriate exclusion distance to establish the balance between mobile terminal EIRP and OOBE requirements. This is in contrast to the even shorter distance of 1 m used by the CTIA, AT&T, Motorola, et al. in the AWS proceedings.[12]

It should be noted that the WCS Coalition used an argument linking overload and OOBE with a 2 W mobile terminal[13] which would then require 77 dB of path loss for A and B blocks and 87 dB of path loss for C and D blocks. Based on the established free space + 3 dB model, this corresponds to an exclusion distance of over 51 meters for A and B blocks and over 163 meters for C and D blocks. Clearly such exclusion zones would significantly impact SDARS reception over large areas. This is illustrated in Figure 5 and Figure 6 for different highway types.

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[12] *See, e.g.,* AT&T AWS-3 Reply Comments at 4-5; Motorola AWS-3 Reply Comments, at 5-7, A-5; Comments of Verizon Wireless, WT Docket No. 07-195, Attachment A (filed Dec. 12, 2007).
[13] WCS Coalition Comments at 10.

Figure 5 C and D Block Interference Zone, 2 W WCS Terminal

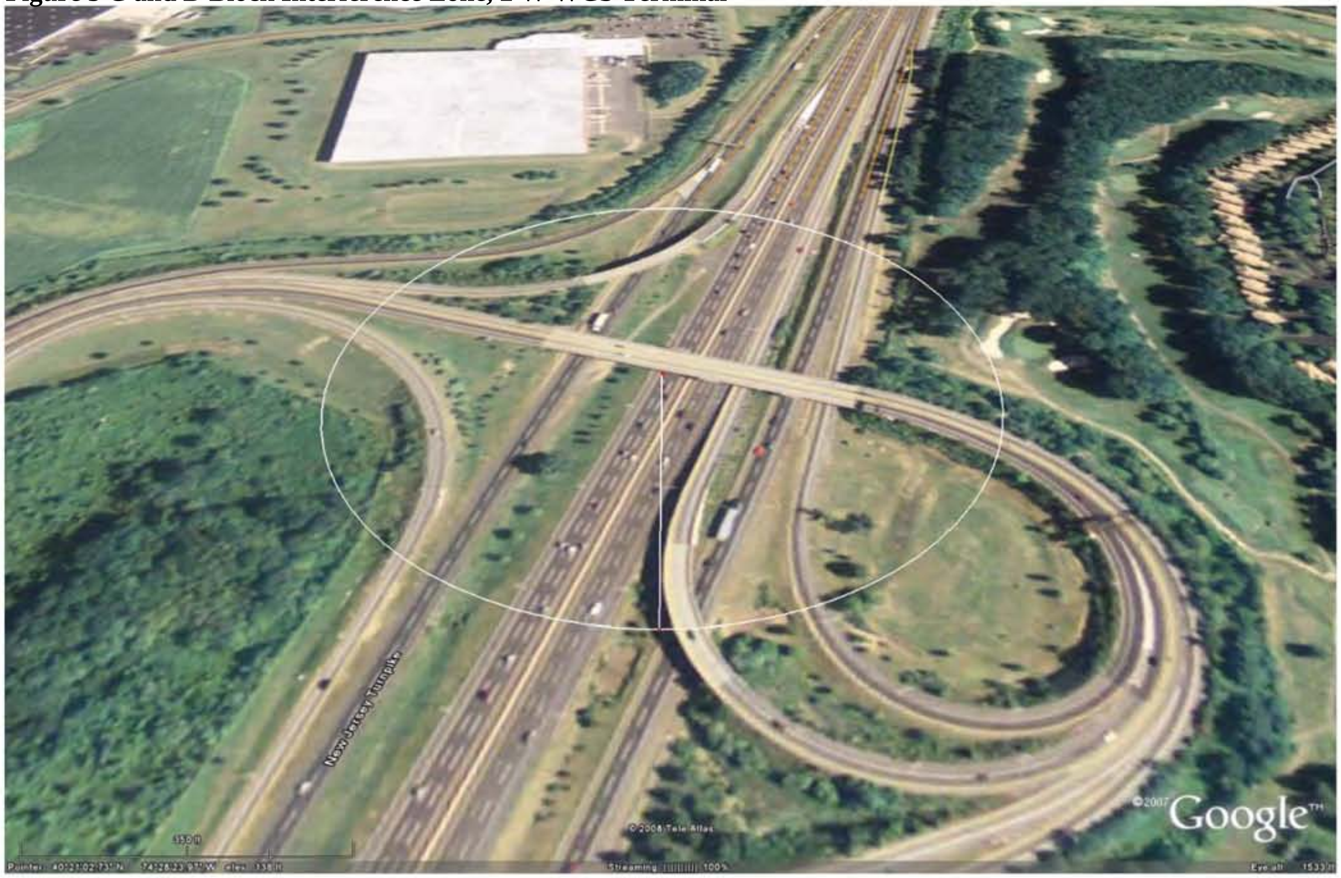


Figure 6 A and B Block Interference Zone, 2 W WCS Terminal

Figure 7 WCS Terminal EIRP/OOBE Trade Space (A and B Blocks)

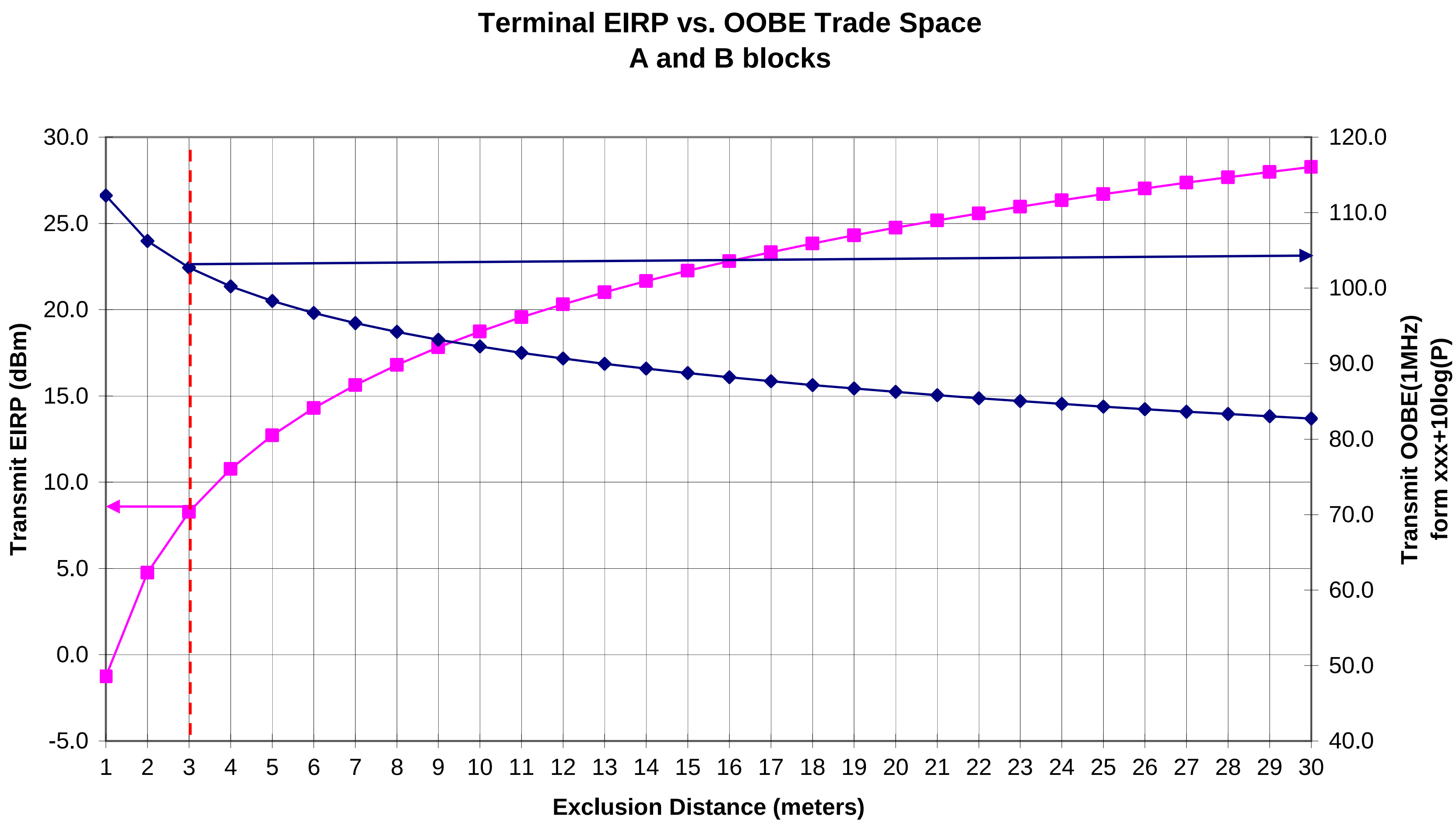


Figure 8 WCS Terminal EIRP/OOBE Trade Space (C and D Blocks)

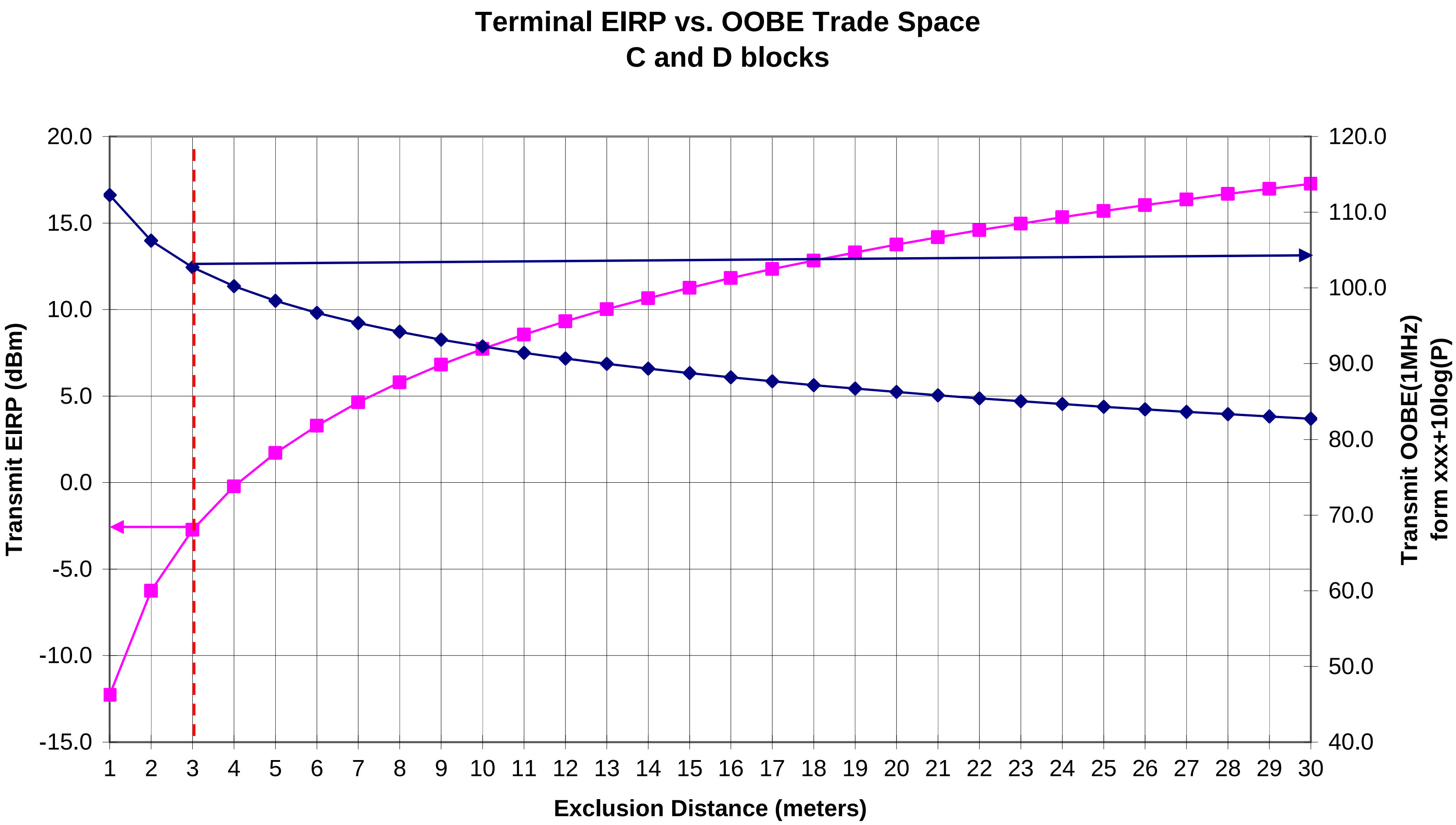


Exhibit C

Experimental Measurements of Overload Interference from WCS Transmitters to DARS Receivers and the SDARS Noise Floor

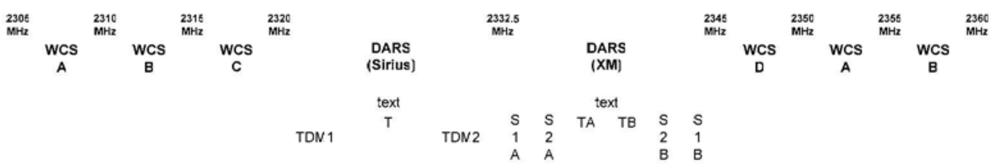
I. Introduction

XM has recently conducted a series of laboratory and field tests to establish the signal levels that would block the reception of the SDARS service satellite signals due to overload interference from devices deployed in the various WCS blocks.[1]

Also attached to this section are tests that were conducted by independent engineering authorities at the EMI Research and Development Laboratory of the Florida Atlantic University to confirm the value of the received noise floor in the presence of no interference, appropriate for out of band emissions calculations in the SDARS service bands, as well as to measure the overall path loss between the WCS transmitter and the XM receiver at three meter interference coordination distance. XM provided this test in Exhibit C of the Technical Appendix to its Comments in this proceeding. The tests are provided here as well for ease of reference.

The following chart illustrates the SDARS and WCS spectrum plans for reference in the following discussion.

Figure 1 WCS/SDARS Band plan



The following assumptions were used during these tests:

- The WCS operators' deployment will be based on the 802.16e WiMAX standard.
- The services provided by the WiMAX providers will include a range of defined WiMAX profiles.
- The tests used standard off the shelf test equipment along with reference IEEE 802.16e WiMAX signals supplied by the test equipment vendor.
- XM "inno" and "SkyFi2" receivers were used for the tests. These represent the majority of the XM receiver platforms deployed in the market (including the automotive OEM market where typical product lifecycles are 10 years).

1 XM conducted these tests in coordination with, and under the supervision of, Sirius Satellite Radio pursuant to Special Temporary Authority originally issued in January 2008 (file nos. 0591-EX-ST-2007, 0085, EX-ST-2008, call sign WD9XDT).

- The upper XM satellite ensemble signals were tested using the upper WCS frequency blocks (D, A-upper, B-upper) as the interfering sources.
- The tests were conducted with representative WCS uplink and downlink transmit profiles, represented by the different WiMAX TX duty cycles.
- The tests using the WCS D block were done with the assumption of zero guard band, even though a guard band will be required for the WCS D block due to filtering required to meet the WCS out of band emission limits into the SDARS band.
- In the case of the laboratory tests, the SDARS wanted signal was set to a reasonable satellite signal level on the ground for the testing at -100 dBm.
- In the case of the field tests, the radio used was put into a test mode to select the individual signals that formed the basis of the test case.

II. Test Set Up and Description

The test effort includes a laboratory component and a field component. The laboratory tests were designed to determine the overload levels (in dBm) for various XM receivers in response to WCS interference signals. XM defined the overload point to be the received WCS interference power at which the audio stream experiences interruption, i.e., muting.

The laboratory tests were executed in a conducted environment, with the instrumentation and relevant equipment connected by cable. The field tests were designed to determine the distances at which a WCS emitter causes overload interference to a XM receiver, as well as the maximum WCS transmit power required to interfere with a XM receiver at a 2 meter distance.

Additionally, XM engaged a third party to measure our receiver’s thermal noise floor.

II.a. Laboratory Tests

II.a.I. Test Setup:

The XM signals used in the test cases were either SAT1B, SAT2B, or Terrestrial B (COFDM). XM signals were generated in the laboratory tests, while the field tests used the live, over-the-air XM downlink signals.

Overload tests were done with a single serving signal active, e.g. SAT1B, SAT2B or Terrestrial B (COFDM). The serving signals for SAT1B and SAT2B were -100 dBm, with COFDM set to -95 dBm.

XM created the WCS interference signals using an Agilent E4438C generator equipped with the capability to create and run WiMax compatible waveforms. The waveforms are based on a mobile WiMax 5 MHz TDD profile at various duty cycles to emulate downlink or uplink traffic. The interference signals operated in the WCS A (upper), B (upper), and D blocks.

The test setup is shown in Figure 2, below.   The output of the WiMAX signal generator, centered at the WCS channel center frequency, passed through a band pass filter appropriate for each WCS block. After passing through an isolator and variable attenuator, the WCS signal was combined with the desired SDARS signal through a directional coupler. The composite signal was then split, with one path routed to a spectrum analyzer/power meter (Rhode and Schwartz FSQ-26) for monitoring the signal levels and the other routed to the input of a SDARS LNA. The LNA was originally embedded in an actual production XM antenna module, but removed and repackaged in a suitable enclosure for this effort. The output of the LNA was applied to the victim SDARS receiver input and the receiver's audio output was connected to a speaker to monitor and detect audio interruptions.

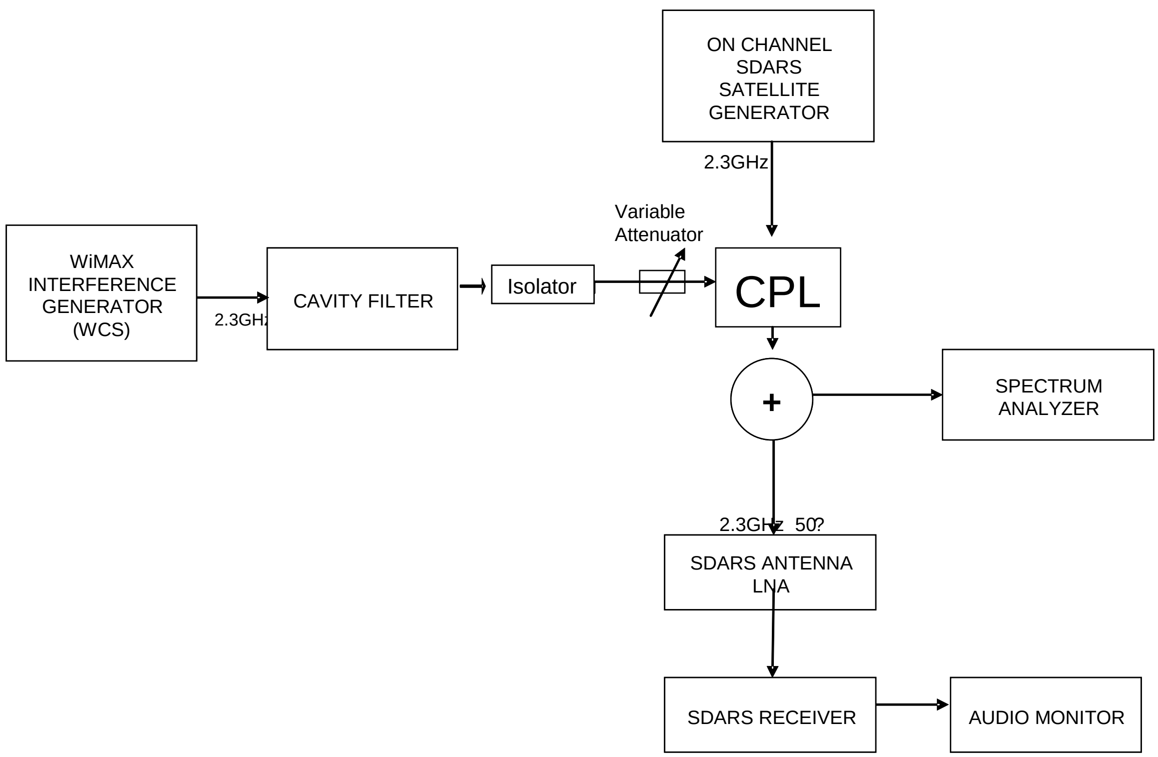


Figure 2 Laboratory Test Block Diagram

II.a.II. Laboratory Test Procedure

For each test case, the test team used the following procedure to conduct the tests. The steps below are simplified and occur after the system has been configured and calibrated:

- Set the SDARS SAT1B/ SAT2B serving signal to a level of -100 dBm at the LNA input. For COFDM signals, the level is -95 dBm;

- For each SDARS serving signal, increase the WCS signal from a low level until audio muting occurs in the SDARS receiver;
- Reduce the WCS signal in 1 dB steps until audio is restored;
- Fine tune the WCS signal level to the highest setting where the SDARS will play unimpaired audio for one minute. This setting is then recorded as the maximum tolerable WCS level before the onset of audio muting.

These steps are repeated for each desired permutation of WCS Block, Duty Cycle, Receiver, and Serving Signal.

II.b. Field Tests

Field tests demonstrated the distances and signal levels at which signals from a WCS mobile device cause muting in the XM receiver. In contrast to the laboratory tests, these tests were conducted under best case conditions: in an open environment, with full satellite link margin. In addition, the test team executed a test to determine the net path loss between the WCS transmitter and SDARS receiver.

II.b.I. Field Test Setup:

Figure 3 shows the block diagram of the field test scenario. The WCS mobile transmission equipment consists of a signal generator (Agilent E4438C), amplifier (modified prototype XM μRepeater PA), filter, dipole antenna and required cabling. The signal generator output fed a power amplifier and the signal levels adjusted to achieve the desired transmit power (*i.e.*, 112 mW for interference distance tests). The amplifier output is then fed into a band pass filter (selected by WCS Block), which is in turn connected to the antenna. The antenna is a dipole antenna with an overall antenna gain of 0 dBi toward the horizon. The WCS transmitter equipment suite was mounted on a cart, with the antenna elevated approximately six feet above ground.

On the SDARS receiver victim side, the XM receivers were installed in the typical aftermarket fashion: antenna mounted on the middle portion of a minivan roof, with the receivers inside the vehicle. The test team inserted a directional coupler in-line with the SDARS antenna output to monitor the received desired and undesired signals on a spectrum analyzer. Figure 4 below shows photographs of the test setup in action.

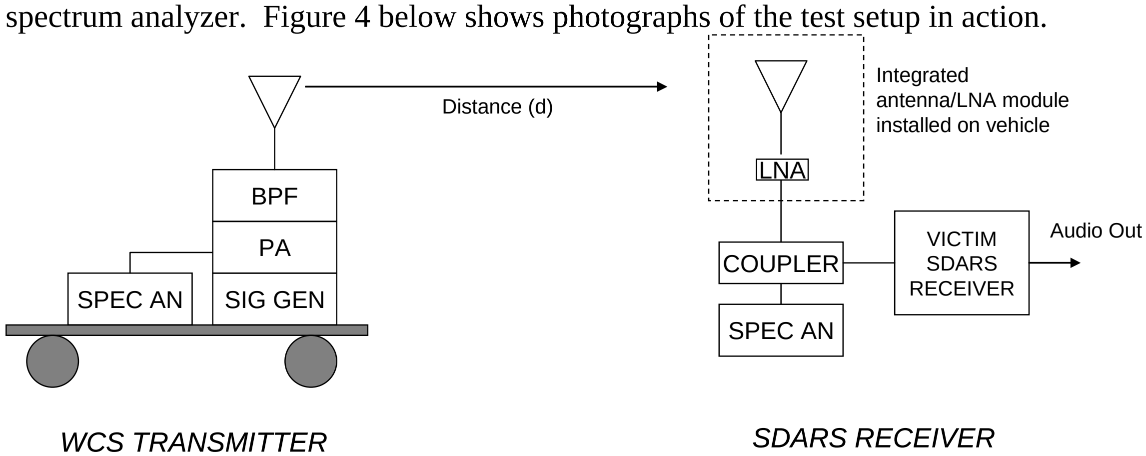


Figure 3 Static Field Tests Block Diagram

Figure 4: WCS Transmitter Interference Distance Measurement Test, where the WCS transmitter power was fixed at 112 mW and the interference distance between the WCS transmitter and the XM OEM installed receiver was measured.

II.b.II. Field Test Procedure:

The test team first set the WCS transmitter to an EIRP of 112 mW (20.5 dBm). Starting from a distance close enough to cause the victim receiver to produce uncorrectable Reed-Solomon code word errors when decoding the satellite signal, the transmitter cart was moved away from the XM receiver in 1 meter increments until there were no uncorrectable Reed-Solomon code word errors. The test team then varied the position of the cart until at least 60 seconds of error free XM reception was observed. This process was repeated to confirm the measurement. The test team then logged the received power vs. distance.

A second test determined the maximum WCS transmitter power that allows error free SDARS reception at a 2 meter distance. For this test, the cart was fixed at a point 2 m from the SDARS antenna. The test team increased the transmit power until the receiver produced uncorrectable Reed-Solomon code word errors when decoding the satellite signal, and then reduced the power in 1 dB increments until error free reception was observed for 60 seconds. The corresponding transmit and receive powers were then logged.

The separation distance test was performed on D-block using a Trilithic CFB-1453D filter (f_0=2348.99 MHz, 3 dB bandwidth = 5.5 MHz), with a 44% uplink WiMax signal centered on D-block (f_0=2347.5 MHz). The separation test was repeated with the WiMax 44% uplink signal centered on Au-Block (f_0=2352.5 MHz), but without using an Au-Block filter. The second test to determine the maximum interfering power at 2 meter separation distance was performed using only the D-block WiMax signal with D-block filter.

The field tests were performed under clear sky conditions with the test radios tuned to a B ensemble channel, which would experience the greatest potential interference from transmissions on WCS blocks D, A-upper and B-upper.

III. Test Results

III.a. Laboratory Results:

Table 1 shows the maximum WCS interference levels, in dBuV/m, that still allow uninterrupted audio performance. Increasing the WCS interferer beyond these levels caused the onset of muting in the audio stream.

Table 1 Laboratory Test Results

WiMAX TX Duty Cycle	XM Wanted Signal	WCS - Upper Block D Interfering Signal (dBuV/m) XM Ref #1	D XM Ref #2	A-upper Interfering Signal (dBuV/m) XM Ref #1	A-upper XM Ref #2	B-upper Interfering Signal (dBuV/m) XM Ref #1	B-upper XM Ref #2
50%	S2b	77.6	82.6	108.6	100.6	109.6	103.6
50%	S1b	77.6	82.6	109.6	98.6	108.6	102.6
7%	S2b	79.6	85.6	105.6	103.6	110.6	107.6
7%	S1b	79.6	84.6	103.6	103.6	108.6	106.6

III.b. Field Test Results:

Table 2 below shows the minimum distance at which a XM satellite stream will play uninterrupted audio in the presence of a 112 mW WCS transmitter, under clear line of site conditions with full link margin. Moving the WCS transmitter closer to the victim receiver caused the onset of uncorrectable Reed-Solomon code word errors, resulting in audio muting.

Table 2 Stationary Field Tests,-Distance to Mute with a 112 milliwatt WCS Transmitter

Band-Duty Cycle	D-44%	A-44% (no filter)
inno	6.7 m	10.1 m
SkyFi2	16.2 m	13.1 m

For the results in Table 3, the distance between the WCS transmitter and the XM victim receiver was fixed at 2 meters, and the WCS transmit power was varied. The results shown below indicate the maximum WCS transmit power before the onset of audio muting occurs.

Table 3 Stationary Field Tests-Measured WCS Transmitter Power at Onset of Muting at a 2 meter DARS receiver separation

Band-Duty Cycle	D-44%
inno	6 dBm
SkyFi2	-3 dBm

In addition to the tests discussed above, XM also measured the received power at the receiver as the transmitter was moved away in 1 meter increments. Using the known received and transmitted powers, we then calculated the overall path loss between the two antennas. The calculated overall path loss is in agreement with the loss assumption of Free-Space-Loss + 3 dB applied in the analysis throughout this document, confirming our assumptions.

III.c. Noise Floor Test Results

The results of the noise floor tests are shown in Appendix 1. This data confirms that the operating noise floor for the XM satellite service is -113 dBm in the 4 MHz channel.

IV. Discussion of Results

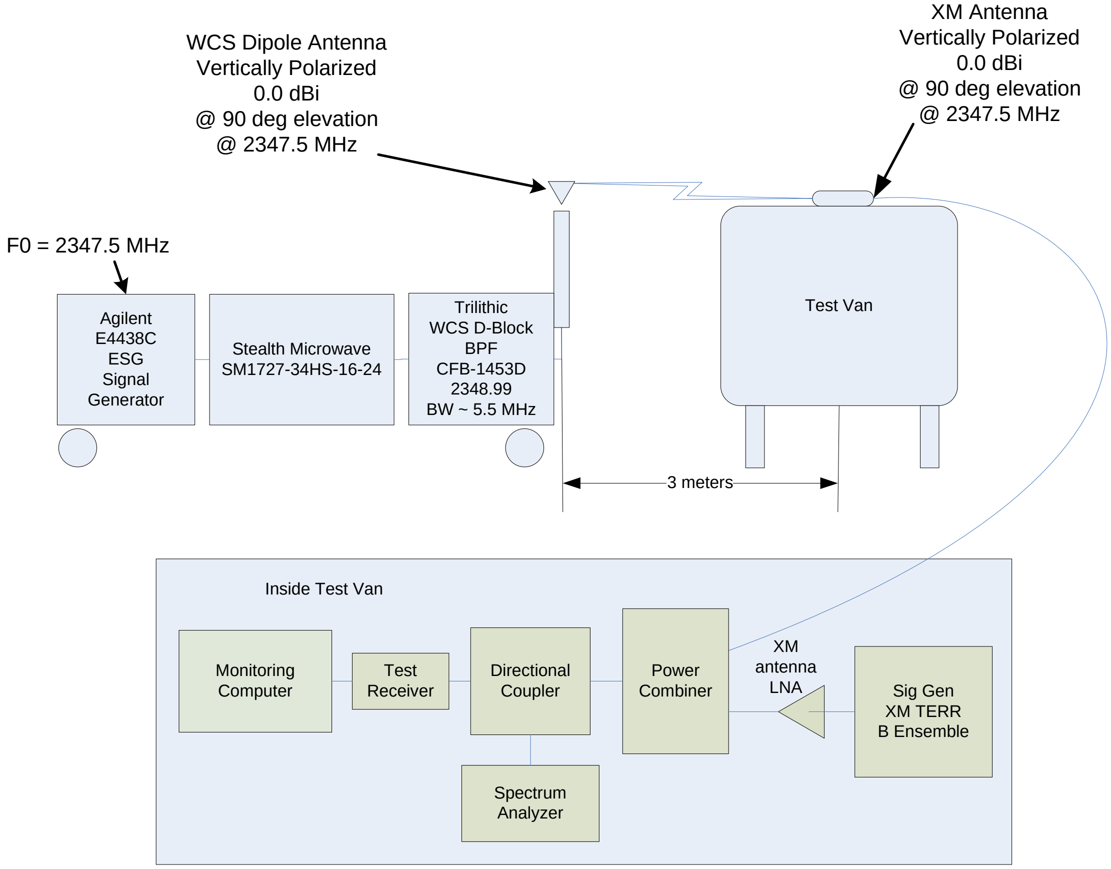
These test results demonstrate the following:

- The level that DARS receivers experience overload interference can be broken down into two major categories.
  - WCS D block (Muting at < 16.2 meters separation)
  - WCS Upper A & B blocks (Muting at < 13.1 meters separation)
- Previous proposals assumed a guard band would be required for WCS D block devices to meet the WCS out of band emission limits. However, if no guard band is in place, then a level of 90 dBuV/m (-55 dBm) or lower WCS Field Strength at the satellite radio receiver would be required to protect the SDARS reception.
- The noise floor appropriate for out of band emissions calculations is -113 dBm in the 4 MHz channel.

V. Repeater Signal Serving Levels Required to Overcome WCS Interference

Additional testing was performed to determine the XM terrestrial repeater signal levels that would be required to overcome WiMax subscriber interferers. Specifically, the test was configured to determine the repeater serving levels that would be required at the XM subscriber antenna to overcome a WiMax subscriber interferer operating at 250 mW EIRP at a distance of 3 meters from the XM antenna on the roof of the test van.

The test setup was similar to the one used to determine the impact of WiMax interference on XM satellite receivers, but it also included the controlled insertion of an XM terrestrial signal component into the receive path of the XM receiver. The XM terrestrial B ensemble signal was produced using an SMIQ signal generator and coupled into the receive path via a XM antenna LNA and power combiner. A Stealth Microwave SM1717-34HS-16-24 power amplifier was used to produce the 250 mW EIRP WiMax output power level. The figure below illustrates the test setup.



As with the case of the satellite interference tests, the WCS waveform was a 44% duty cycle Mobile WiMax uplink signal operating on the WCS D-block. The WCS interfering antenna was positioned 6 feet AGL with 3 meters separation from the XM antenna located on the top of the test van. The 250 mW EIRP WCS signal at this separation distance will block the XM satellite signals on the B ensemble received at the XM antenna.

The XM terrestrial signal generator was set to a high output power and gradually decreased in power until the radio under test began to mute due to the WCS interference. The signal power was then increased until the radio under test produced a minute of mute-free audio (no uncorrected Reed-Solomon symbol errors for one minute). The associated XM terrestrial power level at the input to the XM antenna was then recorded and is presented in the table below.

Table 4 Stationary Field Tests – Measured Repeater Serving Level at Onset of Muting with 3 meters Separation from 250mW EIRP WiMax Interferer

Band-Duty Cycle	D-44%
Inno	-61 dBm
SkyFi2	-57 dBm

Appendix 1
Noise Floor Measurement

EMI Research and Development Laboratory
Department of Electrical Engineering
Florida Atlantic University
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Boca Raton, Florida 33431
(561) 361-4390

Technical Report No. 07-119a

Noise Floor Measurement in the Satellite Radio Band
for XM Satellite Radio Systems

Performed:	26 November 2007
Customer:	Think Wireless, Inc. 5497 Wiles Road, Suite 205 Coconut Creek, FL 33073
Company Official Responsible for Product(s) Tested:	Argy Petros, Ph.D., President (954) 977-4470
Test Performed and Reported by:	Thierry Jean-Charles, BSEE FAU EMI R&D Laboratory
Approved by:	Vichate Ungvichian, Ph.D., P.E. Director, FAU EMI R&D Laboratory

1. INTRODUCTION

This document presents the results for the noise floor measurements for XM Satellite Radio Systems. The results apply only to the specific items of equipment, configurations and procedures supplied to the Florida Atlantic University EMI R&D Laboratory as reported in this document.

2. OBJECTIVE

This evaluation was performed to determine the sensitivity of XM Satellite Radio Systems in their Digital-Audio-Radio-Services (DARS) receive frequency allocation through noise floor measurements.

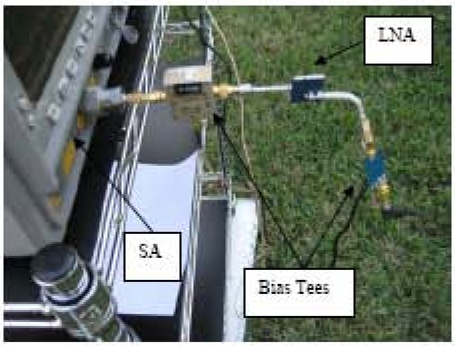
3. CONCLUSION

The noise floor levels for XM Satellite, in their corresponding DARS receive frequency allocation, were determined to -113.25 dBm (upper-edge of XM DARS band), as described in the following pages.

4. TEST PROCEDURES AND RESULTS

4.1 TEST PROCEDURES

The XM Satellite Radio receiver noise floor measurements were executed outdoor. The Satellite Digital-Audio-Radio Service (DARS) antenna module for the XM Satellite receivers, which consists of an antenna, a low-noise amplifier (LNA) and a 21-foot cable, was placed on a 3-foot diameter aluminum counterpoise. The antenna module was connected in series with a low-noise amplifier of 16-dB gain to the input of an Agilent E4404B spectrum analyzer (SA). Bias tees were used to activate the LNAs. Photographs 1 and 2 and Diagram 1 depict the measurement setup.



Photographs 1 & 2: Measurement Setup

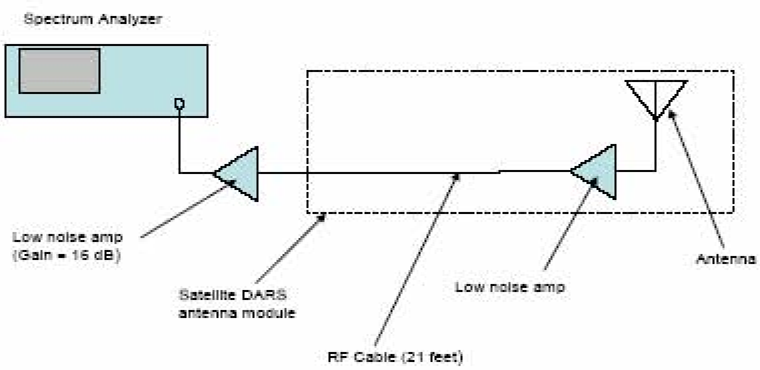


Diagram 1: Measurement Setup

4.1.1 XM NOISE FLOOR MEASUREMENTS

The DARS band corresponding to the XM Satellite Radio system was identified on SA (Diagram 2). Then the span was reduced to include only the DARS band covered by the XM SAT 1B and SAT 2B satellites, which ranges from 2341 MHz to 2345 MHz. Afterward, the location of the DARS antenna module with the counterpoise was changed so that the incident XM Satellite Radio signal is blocked by the test building. The noise floor of the system was measured using a resolution bandwidth and a video bandwidth of 3 kHz over the 4 MHz span. The data was recorded with SA on "max hold" and was averaged over 25 sweeps. Figure 1 shows the result for the noise floor measurements for the XM Satellite Radio receiver.

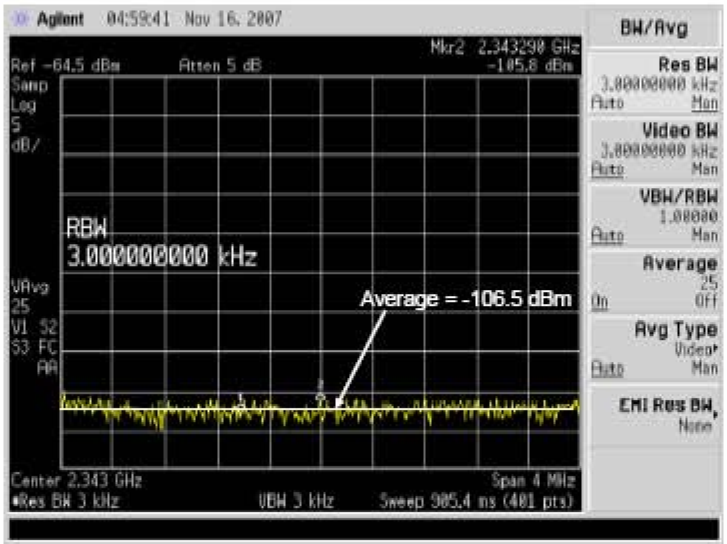


Figure 1: XM SAT 1B and SAT 2B Noise Floor Measurements

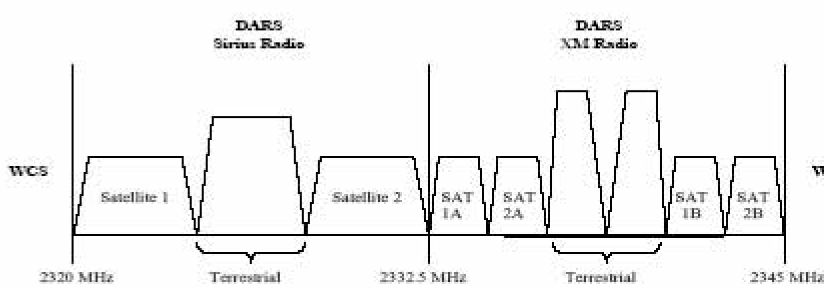


Diagram 2: DARS Receive Frequency Allocation

4.2 TEST RESULTS

Based on Figure 1 and the following parameters:

- Spectrum analyzer reading SA_NF (dBm)
- LNA in front of the Spectrum Analyzer, SA_LNA = 16 dB gain
- Spectrum Analyzer Resolution Bandwidth, RBW = 3 kHz
- Bandwidth of satellite signal, BW = 4 MHz
- Antenna module LNA gain (including the 21-foot cable loss), ALNA = 22 dB,

the calculated noise floor for the XM Satellite Radio receivers is recorded in Table 1.

Satellite Receiver	Figure No.	SA_NF (dBm)	SA_LNA (dB)	ALNA (dB)	BW (MHz)	RBW (kHz)	Calculated Noise Floor (dBm)*
XM	1	-106.5	16	22	4	3	-113.25

Table 1: Calculated Noise Floor at the Front-End of the Satellite Receiver

*Calculated Noise Floor (dBm) = SA_NF (dBm) – SA_LNA (dB) – ALNA (dB) + 10*LOG(BW/RBW)

Hence the calculated noise floor at the front-end of the satellite receiver is

- XM SAT1B & SAT2B
  - SA_NF = -106.50 dBm
  - Calculated Noise floor = -113.25 dBm

MAJOR TEST EQUIPMENT

Equipment Type	Manufacturer	Description	Model	Serial No.
Spectrum Analyzer	Agilent	9 kHz - 6.7 GHz	E4404B	MY41440110

End of Report

Exhibit D

Power Measurements

Executive Summary

This Exhibit addresses the issue of how to ensure a "fair and balanced" approach to power setting between two disparate systems such as WCS/WiMax and SDARS.

Regardless of the EIRP values that are finally established, it is important to establish how such EIRP values are to be measured. Any measurement method or methods must take into account the range of potential operating modes and waveform formats that may be used. In the case of SDARS for example, the Sirius and XM repeater waveforms are both continuous transmissions but they have different carrier structures and total bandwidths. In the case of one of the proposed WCS transmission formats (WiMax), a time division duplex (TDD) mode is one of the most likely modes which involves discontinuous transmission of complex frame formats.

XM agrees with the WCS Coalition that average power should be used as the basis for any rules but disagrees with the method of measurement proposed, which would lead to ambiguity in the actual transmitter power and associated interference potential that would result. XM also agrees with the WCS Coalition that it would be useful to impose a maximum peak to average requirement of up to 13 dB, but believes that additional refinement of this specification is needed to reduce the measurement ambiguity.

An additional factor, not addressed in any detail here, but that needs further study, is what additional measurement definitions are necessary to ensure that the effective EIRP of WCS base station configurations and terminals using MIMO or adaptive beam forming antenna technology are properly accounted for in any rules.[1]

Average Power Measurement

XM agrees with the WCS Coalition that any rules associated with transmitter power or EIRP should be based on the measurement of average power. The WCS Coalition has proposed that:

> To implement the objective of mutuality, and in the spirit of compromise, the rules proposed by the WCS Coalition would allow licensees in both services to operate at power levels up to 2,000 Watts average EIRP. [2]

The measurement procedure proposed is as follows:

> …average power or "mean power" is defined as the average power supplied to the antenna transmission line by a transmitter during an

---

[1] "MIMO improves capacity and signal strength with the use of parallel antennas and complex algorithms, while beamforming enhances range and quality by concentrating the strength of the signal in one desired direction instead of wasting much of it in a 360-degree dispersion pattern." http://www.navini.com/Press_Room/In_The_News/SMART_Alliance_Rethink_Article.htm.

[2] Comments of the WCS Coalition, WT Docket No. 07-293, 22 (filed Feb. 14, 2008) ("WCS Coalition Comments").

> interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions, consistent with the definitions for those terms set forth in Section 2.1 of the Commission's Rules.

Given a rule specifying a limit on EIRP, the WCS Coalition's proposed measurement procedure would have the consequence that the allowed power of a individual frame of a waveform using time division transmission (such as WiMax) would be inversely proportional to the duty cycle of such a waveform. A continuous waveform, such as that used by SDARS repeaters, would have a single allowed value. Therefore, in theory, an individual burst transmission could have a power level significantly exceeding the 2,000 watts proposed by the WCS Coalition, violating the very "objective of mutuality" that the WCS Coalition claims to be its intent.

XM has established, based on laboratory and field test measurements, that the interference potential of the WiMax waveform is a strong function of the individual frame "burst" power, not the "average" power as would be estimated using the WCS Coalitions method.[3] XM believes therefore that the individual frame "burst" power needs to have an unambiguous limit, regardless of the operating duty cycle (which in any case may be adaptive, further complicating a simple compliance procedure).

XM has previously proposed[4] that the average power measurement should simply be based on a time gated average power measurement of the transmitted frame. This is consistent with the vast majority of test equipment and test procedures commercially available for WiMax systems and is a readily available feature on modern spectrum analyzers.[5]

Peak Power Measurement

XM agrees with the WCS Coalition that the concept of peak power needs to be more precisely defined. The WCS Coalition has proposed[6]:

> The WCS Coalition has advised the Commission that it would be amenable to the imposition of a maximum peak-to-average power ratio ("PAR") for both WCS and SDARS services of 13 dB.

The WCS Coalition has proposed the following measurement method:

> For purposes of this limit, the Commission should make clear that peak

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[3] Comments of XM Radio Inc., WT Docket No. 07-293, Exhibit C at Table 1 (filed Feb. 14, 2007) ("XM Comments"). As shown in this table, the measured overload level with a 6% duty cycle is less that that at a 44% duty cycle. This is due to the complex interaction of the time division waveform with the various gain control functions of the SDARS radio. This type of effect would be expected in any receiving system where the adjacent band services can be of almost any type and the systems are not synchronized.

[4] *Id.* Exhibit A, Section 3.3.

[5] See http://www2.rohde-schwarz.com/

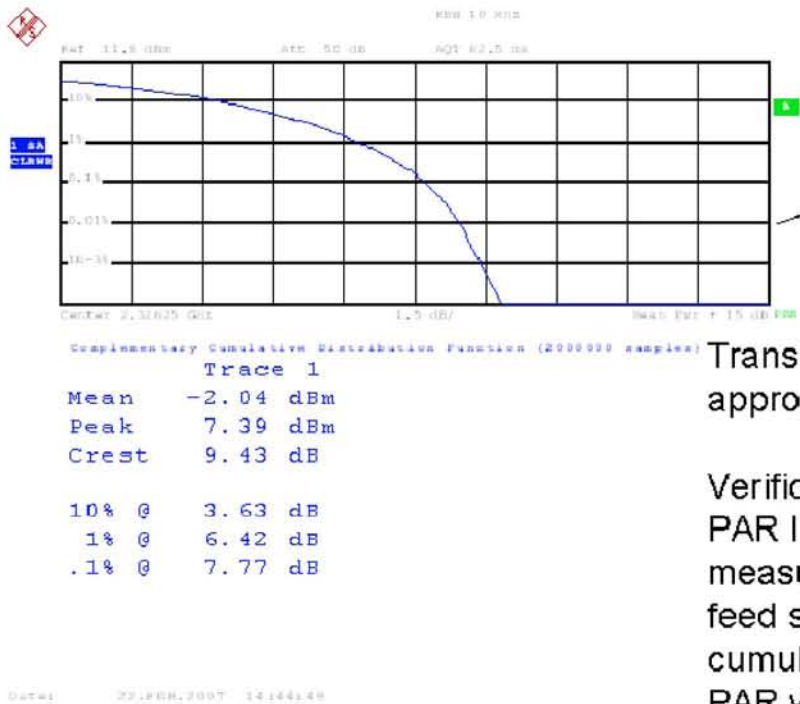
[6] WCS Coalition Comments at 24-25.

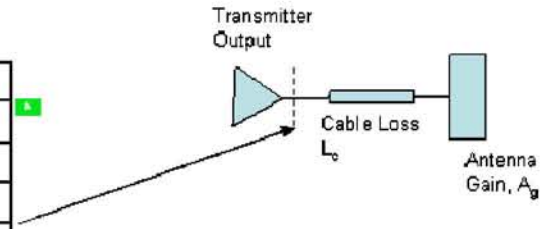
> power or “peak envelope power” is defined as the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions

XM believes that the WCS Coalition’s measurement proposal should be modified to reduce any ambiguity. In addition to specifying the Peak to Average Ratio, the cumulative amplitude probability should also be specified associated with that PAR. This would lead to a more precise and repeatable definition of the PAR. XM suggests an associated cumulative amplitude probability of 0.01%. As with the average power, in the situation where the transmission format involves a duty cycle, this measurement should be made using time gating to gather the statistics of the relevant transmission frames. As previously stated, this is consistent with existing test equipment and most modern spectrum analyzers.

An illustrative example of how an XM repeater would have its peak power verified under this proposal is given in Figure 1

Figure 1 Example of Peak Power Verification for an SDARS Repeater





Transmitter would be set to appropriate average power limit.

Verification of compliance with the PAR limit would use the CCDF, measured at the input to the antenna feed system to establish that, at a cumulative probability of 0.01%, the PAR was <13 dB. In this example the value is ~8.2 dB

Exhibit E

Comparison of the AWS-3 Proceeding (WT Docket No. 07-195) to the WCS/SDARS Proceeding (WT Docket No. 07-293)

Executive Summary

This Exhibit illustrates the structural similarities of the core technical issues (namely allowable services and associated mobile terminal characteristics) between the WCS/SDARS NPRM and the AWS-3 Proceeding.[1] It also highlights significant inconsistencies in the separate statements and conclusions made by certain members of the WCS Coalition in each proceeding.

The approach taken is to compare the results of studies by Motorola, Verizon Wireless, AT&T, the CTIA and Nextwave Wireless on the feasibility of adjacent band operations between PCS/WiMax-like mobile terminals in the AWS-3/2/1 bands with the almost identical situations addressed by some of the same parties (as expressed in comments filed by the WCS Coalition) in the WCS/SDARS proceeding.

This Exhibit demonstrates that the high level conclusion reached by these parties regarding AWS-3 block usage -- namely, the lack of feasibility of unfettered mobile broadband deployment -- is virtually identical to the conclusions reached by Sirius and XM regarding WCS band usage and its impact on SDARS.

Comparing the mobile PCS data developed by the parties in the AWS proceedings with equivalent SDARS measurements and parameters further confirms that the WCS Coalition's proposals for mobile transmitter power and OOBE relief are significantly in error and, if implemented would lead to significant interference to SDARS service.

In short, the AWS-3 analyses demonstrate that, given a band plan comparable to the current WCS/SDARS plan, even mobile broadband terrestrial services would cause significant interference to one another, under the WCS Coalitions proposals. The fact that the WCS band is adjacent to a satellite service makes the proposed deployment of unrestricted mobile service only more problematic and further emphasizes the inconsistent positions taken by certain members of the WCS Coalition.

Comparison Methodology

Map Bandplans

In order to most easily illustrate the structural similarities between the two proceedings on this issue, we have translated the block boundaries of the WCS/SDARS allocation and aligned them to the AWS bandplan. This allows the nature of the WCS/SDARS and AWS-3/AWS-1 adjacent channel operations to be compared more easily. This is shown in Figure 1.

As the AWS-3 proceedings focus on the issues of service interference from the AWS-3 block into the AWS "F" block, the block boundaries have been aligned with the SDARS allocation for XM Radio. In this fashion, the various arguments presented in the AWS

[1] *Service Rules for Advanced Wireless Services in the 2155–2175 MHz Band*, WT Docket 07–195, Notice of Proposed Rulemaking, 22 FCC Rcd 17035 (2007).

proceedings (namely, what type of services and associated equipment specifications can be used or allowed in the AWS-3 block, given their likely impact on services in the F block) can directly be compared with the arguments presented by the WCS Coalition regarding what kinds of services and associated equipment specifications can be used or allowed in the D, Au or Bu blocks and their likely impact on SDARS service (for the examples discussed herein, XM's satellite reception is the modeled victim equivalent of the AWS F block, although similar arguments would apply to the Sirius allocation).

The adjacent channel boundary at issue in the AWS-3 proceedings is at 2155 MHz. This is "mapped" to the adjacent channel boundary between the SDARS allocation and the WCS allocation at 2345 MHz. As noted, the "victim" AWS F block is a mobile receive block and is equivalent in function to the "victim" XM SDARS channels which are also used to receive transmissions. The D, Au and Bu blocks contain a total of 15 MHz, meaning the entire complement of this upper WCS allocation lies within the spectrum block at issue denoted "AWS3" which is 20 MHz wide.

Compare System Categorization

In both the AWS-1/AWS-3 case and the SDARS/WCS case, the systems can be considered as being "not synchronized." This condition was correctly described by the WCAI in a recent filing:[2]

"*Two systems are considered synchronized if they always transmit in the same direction (i.e., uplink or downlink) at the same time. They are not synchronized, however, if one system can transmit in the uplink direction when the other is transmitting in the downlink direction. For example, since the AWS-1 licensee immediately below the 2155-2175 MHz band is required to utilize its spectrum solely for downstream transmission (see 47 C.F.R. § 27.50(d)), that system will only be synchronized with an AWS-3 system that utilizes its spectrum solely for downlink transmission. It will not be synchronized with an AWS-3 system that is utilizing adjacent spectrum for upstream transmissions, either full-time as part of an FDD system paired with spectrum in some other band or part-time because that system is using a TDD technology. Similarly, two TDD systems will also be non-synchronized unless the system operators take steps to assure that their systems are always transmitting in the same direction at the same moment in time.*"

Clearly, a "not synchronized" situation is the worst case in terms of service compatibility. In this case, the proposed service in the WCS band would most likely be TDD WiMax-based where, for example, upstream transmissions in the WCS adjacent block (e.g., D) would not be synchronized with the "downstream" SDARS satellite channel.

Compare "Victim" Receiver Characteristics

In this case, the two victim receivers that need to be compared are an AWS-1 receiver (in the F block) and an SDARS receiver operating in the upper XM satellite channel(s). In the AWS analyses, the bulk of the data was collected using the model of two CDMA handsets interfering with each other -- one receiving in AWS-1 (F block) and one transmitting in AWS-3. In all the tests described, some form of guard band existed, so that the data represents a "best case" in terms of comparison to a D or C block interferer into a satellite channel. While there are various technical differences between the CDMA

[2] Comments of the Wireless Communications Association International, Inc., WT Docket No. 07-195, 3 n.6 (filed Dec. 14, 2007).

airlink and the SDARS system, the differences are essentially in the direction of the CDMA terminals being less susceptible to interference than an SDARS receiver,[3] meaning the AWS-3 conclusions can be regarded as "best case."

Motorola has provided details of their receiver testing,[4] which are helpful here in a high level comparison of receiver performance between the SDARS and AWS equipment.

Nominal Receiver Sensitivity

The reference AWS-1 receiver used by Motorola had a bandwidth of 1.23 MHz (CDMA). The reference sensitivity level used in the tests was -105 dBm. This can approximately be compared with the satellite levels used in the SDARS case of -102 dBm/4MHz or -108 dBm/MHz (SDARS) vs. -105.9 dBm/MHz for the victim AWS-1 receiver. One difference is that the AWS-1 receiver, at -105 dBm, is operating nominally with a higher noise floor (i.e., a lower threshold) than the SDARS receiver which relies on a lower noise temperature for satellite reception under land mobile conditions.

Compare Approach and Results for Maximum Mobile EIRP and OOBE

<u>Mobile EIRP</u>

Applying an almost identical methodology as XM did in this docket,[5] Motorola used a combination of measurements and analysis to estimate the maximum EIRP that a mobile AWS-3 terminal could have before it would cause the AWS-1 receiver to drop its call. Motorola used an exclusion zone distance of 1 m, for the reason that:

"Requiring commercial wireless devices from adjacent band services to co-exist at a distance of 1 meter is a metric that has been supported by a majority of the wireless industry including Motorola." [6]

By contrast, XM used a 3 meter distance in its study as being more representative of its vehicle based customer interference scenarios. Moreover, there was a guard band of one channel (1.25 MHz) between the AWS-3 transmitter and the AWS-1 victim receiver.

The Motorola results indicate that a received level of -34 dBm[7] from the AWS-3 transmitter caused the AWS-1 handset call to drop. Using Motorola's analysis approach adjusted for 3 m, this would be equivalent to an AWS-3 transmit level of +21 dBm. Applying the XM analysis, this would be equivalent to an AWS-3 transmit level of -34 +52=18 dBm at 3 m, and allowing an additional 2 dB for the difference in base sensitivity yields +16 dBm at 3 m.

---

[3] The units tested had narrower bandwidths (allowing better rejection for a fixed guard band), and could operate at lower carrier to noise margins

[4] *See* Comments of Motorola, Inc., WT Docket No. 07-195 (filed Dec. 17, 2007) ("Motorola AWS-3 Comments").

[5] Comments of XM Radio Inc., WT Docket No. 07-293 (filed Feb. 14, 2007) ("XM Comments").

[6] Motorola AWS-3 Comments at 5.

[7] *Id.*

Differences in demodulation thresholds and the presence of an effective guard band of one channel (1.25 MHz) between the transmitter and receiver would also apply here with the CDMA receiver operating at lower thresholds than the SDARS satellite link. This result can then be compared with the A and B block XM results (*i.e.*, at least one channel of guard band) of 10 dBm, illustrating that the AWS-3 results are "best case" from an SDARS perspective as previously discussed.

Significantly, 16 dBm is 17 dB less than the mobile EIRP proposed by the WCS Coalition.[8]

OOBE

Motorola measured -102.6 dBm in 1.23 MHz as the threshold of performance for the AWS3 handset receiving OOBE from the AWS-1 handset. This translates to a 3 m, 1 MHz referenced value of -103.5+52 dBm = -51.5 dBm or equivalently, **81.5+10 log (P)** where P is the transmitter power in watts. This is 26.5 dB more stringent than the WCS Coalition's proposal of 55+10 log (P).

Other AWS-3 Related Filings

Subsequent to the Motorola Filing used in the analysis above, AT&T filed reply comments and Verizon Wireless filed an ex parte in the AWS-3 proceeding. In those filings, both companies concurred with and elaborated on the Motorola submission, presenting additional technical and summary conclusions. These are summarized below in Table 1.

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[8] Comments of the WCS Coalition, WT Docket No. 07-293, 10 (filed Feb. 14, 2007).

Table 1 Summary Comparison

Company	OOBE Recommendation (corrected to 3 m and 1MHz)	Maximum Mobile EIRP Recommendation (corrected to 3m)	Conclusion
AT&T[9] (WCS licensee)	-56 dBm/MHz 86+10log(P) For H block -66 dBm/MHz 96+10log(P)	9.5 dBm	"Based on the record and its own analysis, AT&T has concluded that the downlink only model represents the highest and best use of the AWS-3 spectrum. Provision of uplink transmissions in the band would require stringent restrictions on operating power and out-of-band emissions ("OOBE") and render deployment of a commercial mobile network impractical."
Motorola[10]	n/r	n/r	"Based on recent test performed by Motorola, allowing mobile use in the 2110-2155 MHz band may require power and out of band emissions restrictions on AWS-3 operations that are more restrictive than those applied in other mobile bands."
Verizon Wireless[11]	-66 dBm/MHz 96+10log(P)	9.5 dBm	"To prevent interference and efficiently utilize the spectrum, AWS-3 should be designated for downlink only transmissions or fixed services."
Nextwave Wireless (WCS licensee)		10 dBm[12]	
T-Mobile	-56 dBm/MHz 86+10log(P)		
Sirius/XM (for WCS band)	-73 dBm/MHz 103+10log(P)	10 dBm (A,B) 0 dBm (C,D)	
WCS Coalition (for WCS band)	-25 dBm/MHz 55+10log(P)	33 dBm (all blocks)	

[9] Reply Comments of AT&T Inc., WT Docket No. 07-195 (filed Jan. 14, 2008).

[10] Comments of Motorola, Inc., WT Docket No. 07-195 (filed Dec. 17 2007).

[11] V-Comm Telecommunications Engineering Presentation of Feb. 19, 2008 *submitted with* Letter from Donald C. Brittingham, Director, Wireless / Spectrum Policy, Verizon Wireless, to Marlene H. Dortch, Secretary, Federal Communications Commission, Ex Parte Presentation, WT Docket No. 07-195 (filed Feb. 19, 2008).

[12] Reply Comments of Nextwave Wireless Inc., WT Docket No. 07-195 (filed Jan. 14, 2008). It is unclear in exactly what context this value was recommended and what the definition of the handset operating point was.

Figure 1 AWS and SDARS Bandplan Comparison