Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 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

COMMENTS OF THE WCS COALITION

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EXECUTIVE SUMMARY

With the *Notice*, the Commission has taken an important next step towards assuring that the WCS spectrum at 2305-2320 MHz and 2345-2360 MHz can be used for the provision of advanced mobile wireless broadband services, including services that comport with the IEEE 802.16e-2005 WiMAX standard. The ability of WCS licensees to meet the growing public demand for wireless broadband services is dependent on the Commission both affording WCS licensees relief from the obsolete and unduly restrictive spectral mask of Section 27.53(a), and adopting rules governing WCS and SDARS terrestrial repeater power levels that provide WCS licensees with reasonable protection against interference.

Sirius' proposed rules are skewed heavily in favor of the SDARS licensees, and their adoption would sound the death knell for WCS as a vehicle for providing wireless broadband services to the American public. By contrast, the WCS Coalition's positions reflect a good faith attempt to develop rules that should be reasonably acceptable to both services, but provide absolute interference protection to neither. The proposals of the WCS Coalition are not the optimum from the perspective of one hoping to utilize WCS spectrum. Even if they are adopted verbatim, WCS will continue to be subject to interference from SDARS terrestrial repeaters, and will continue to suffer the burden of meeting a more restrictive limit on OOBE than applied in other nations. However, adoption of the WCS Coalition's proposal will reduce these burdens to a tolerable level, allowing the deployment of viable wireless broadband systems without any material "real world" adverse impact on SDARS subscribers.

Absent a relaxation of the obsolete OOBE limitations imposed by Section 27.53(a) of the Commission's Rules on emissions by low-powered WCS subscriber equipment into the SDARS band, WCS cannot fully reach its potential for bringing innovative new wireless broadband services to the American public. No commercially-viable filters capable of satisfying the restrictions imposed by Section 27.53(a) on emissions into the 2320-2345 MHz SDARS band are available for incorporation into subscriber equipment. In addition, retention of the current OOBE limits precludes American consumers from enjoying the economies of scale that would be available with a spectral mask more consistent with that used globally.

The limited OOBE relaxation proposed by the WCS Coalition is narrowly targeted to apply only to low-power devices that utilize transmit power control to even further mitigate potential interference. Theoretical analysis, sophisticated simulations and actual testing all establish that SDARS receivers will be adequately protected under real world scenarios if the proposed new OOBE limits are adopted.

The power limits for SDARS terrestrial repeaters and WCS must be carefully set so that each service can meet its legitimate needs and so that neither is precluded from effectively providing service to the public. The WCS Coalition has proposed a compromise level of 2,000 Watts average EIRP, absent consent of all affected WCS and SDARS licensees. While this still results in some interference to each service, it keeps that interference within tolerable levels and restricts overload interference to the same general areas where OOBE interference from SDARS

terrestrial repeaters will occur. This proposal not only addresses WCS's concerns, but also mitigates the "dead zones" that Sirius has previously complained of.

By contrast, adoption of Sirius' proposed "average power level" limits would effectively preclude the use of the WCS band for wireless broadband services. Like most of what Sirius has proposed, its proposal is heavily skewed to protect the terrestrial repeater networks that it and XM chose to construct – at times, illegally. Restricting power levels as proposed will make it difficult for WCS licensees to deploy a cellularized network, because those networks of necessity must place relatively strong signals at ground level to assure ubiquitous service. Moreover, only restricting SDARS signal levels two meters above ground level will subject WCS base stations (which are installed farther above ground level) to destructive interference from SDARS terrestrial repeaters. In addition, Sirius' proposed limit on power levels for WCS subscriber units would limit power below the level permitted for unlicensed bands, and would make the provision of two-way services effectively impossible.

The proposals advanced by Sirius for restricting collocation are unnecessary. The Commission generally does not impose location restrictions to address intermodulation, and there is no compelling reason to do so here. If the Commission is disposed towards adopting rules that address intermodulation, the Commission should reject those aspects of the Sirius proposal that give undue preference to SDARS or that preclude various WCS licensees in a given geographic area from collocating.

While the WCS Coalition has no objection to reasonable information exchanges with the SDARS licensees, the Commission can and should leave it to industry to develop an information exchange program. Informal procedures, rather than Commission rules, will have the inherent flexibility to be modified as appropriate over time as a better understanding is gained as to what information is necessary, and how best to provide for a secure exchange of what might be commercially sensitive. Moreover, the Commission should reject Sirius' proposal to require WCS licensees to give SDARS at least 90 days advance notice of the technical parameters of base station facilities. Because cellular operators are constantly tweaking their networks by adjusting base station antenna orientations and beamtilts, changing antenna heights, adding or subtracting sectors, altering power levels and adding new cells, adoption of the Sirius proposal would effectively preclude the offering of a viable ubiquitous service. Moreover, the advance notice proposed by Sirius is totally unnecessary.

Finally, XM and Sirius should be given no more than twelve months to bring their terrestrial repeater networks into compliance with the final rules adopted in this proceeding. Otherwise, the WCS industry will be subjected to risk of significant interference if XM and Sirius can retain their existing facilities, but are freed from their current obligations to cure any interference they cause to WCS. SDARS secured their STAs knowing full well that WCS objected to the high power levels involved, and were placed on notice by the Commission that they might be required to comply with the final rules adopted to govern terrestrial repeaters. XM and Sirius can meet their needs for terrestrial repeaters under the WCS Coalition's proposed rules, and should be required to spend whatever it takes to bring their networks into compliance.

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COMMENTS OF THE WCS COALITION

The WCS Coalition,[1] by its attorneys and pursuant to Section 1.415 of the Commission's Rules,[2] hereby submits its initial comments in response to the *Further Notice of Proposed Rulemaking* in IB Docket No. 95-91 and the *Notice of Proposed Rulemaking* in WT Docket No. 07-293 (collectively, the "*Notice*").[3]

I. INTRODUCTION.

With the *Notice*, the Commission has taken an important next step towards assuring that the Wireless Communications Service ("WCS") spectrum at 2305-2320 MHz and 2345-2360 MHz can be put to its highest and best use – the provision of

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[1] The WCS Coalition was founded by the Wireless Communications Association International, Inc. ("WCA") and includes Horizon Wi-Com LLC, AT&T Inc., Comcast Corporation, NTELOS Inc. and NextWave Broadband Inc., who collectively hold virtually all the 2305-2320/2345-2360 MHz WCS spectrum within the fifty United States.

[2] 47 C.F.R. § 1.415.

[3] Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band; Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, Notice of Proposed Rulemaking and Second Further Notice of Proposed Rulemaking, FCC 07-215 (rel. Dec. 18, 2007) ["Notice"].

advanced mobile wireless broadband services, including services that comport with the IEEE 802.16e-2005 WiMAX standard. As the WCS Coalition often has noted, the ability of WCS licensees to meet the growing public demand for wireless broadband services is dependent on the Commission both affording WCS licensees relief from the obsolete and unduly restrictive spectral mask of Section 27.53(a), and adopting rules governing WCS and Satellite Digital Audio Radio Service ("SDARS") terrestrial repeater power levels that provide WCS licensees with reasonable protection against interference. To that end, on July 9, 2007, the WCS Coalition presented the Commission with a comprehensive proposal for modifications to Parts 25 and 27of the Rules that, if adopted, will allow WCS to flourish without any material adverse impact on SDARS subscribers.[4] The WCS Coalition is pleased that the *Notice* specifically solicits comments on the WCS Coalition's proposal, and looks forward to working with the Commission staff to address any concerns that may be raised in response to the *Notice*.[5]

As is discussed in detail below, the WCS Coalition remains convinced that adoption of its proposed rules will better provide for the coexistence of SDARS and WCS than the rules previously presented by Sirius Satellite Radio Inc. ("Sirius") and endorsed by XM Radio Inc. ("XM").[6] As the WCS Coalition has previously noted, and will again show below, Sirius' proposed rules are skewed heavily in favor of the SDARS licensees, and their adoption would sound the death knell for WCS as a vehicle for providing

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[4] *See* Letter from Paul J. Sinderbrand, Counsel to WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed July 9, 2007) [the "WCS Compromise Proposal"].

[5] See Notice at ¶ 14.

[6] *See* Petition of Sirius Satellite Radio Inc. for Rulemaking, and Comments, IB Docket No. 95-91 (filed Oct. 17, 2006) ["Sirius Petition"]; Letter from Bruce D. Jacobs, Counsel to XM Radio Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Jan. 5, 2007).

wireless broadband services to the American public.[7] By contrast, the WCS Coalition's positions reflect a good faith attempt to develop rules that should be reasonably acceptable to both services, but provide absolute interference protection to neither. The WCS Coalition cannot emphasize enough that the proposals it advances are not the optimum from the perspective of one hoping to utilize WCS spectrum. Even if the WCS Coalition's proposal is adopted verbatim, WCS will continue to be subject to interference from SDARS terrestrial repeaters, and it will continue to suffer the burden of meeting a more restrictive limit on out-of-band emissions ("OOBE") than applied in other nations where the 2.3 GHz band is allocated for wireless broadband services. However, adoption of the WCS Coalition's proposal will reduce these burdens to a tolerable level, allowing the deployment of viable wireless broadband systems without any material "real world" adverse impact on SDARS subscribers.

The WCS Coalition's focus on identifying reasonable middle grounds is fully consistent with the Commission's long-standing treatment of the two services relative to one another. This is perhaps best illustrated by the Commission's clear pronouncement that when establishing OOBE limits on WCS, its goal is "to limit the potential for interference to a reasonable level -- not to provide a pure, interference-free environment."[8] It is heartening that Sirius has conceded that SDARS must be "willing to

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[7] *See* WCS Compromise Proposal at 3-4 n.7; *infra* at Section II.B.3.

[8] Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service ("WCS"), Memorandum Opinion and Order, 12 FCC Rcd 3977, 3991 (1997) ["WCS Reconsideration Order"]. Along these lines, the Commission has consistently rejected claims by SDARS for excessive protection from possible interference, and should do so again here if SDARS continues to over-reach. See, e.g., Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems, Seventh Report and Order, 19 FCC Rcd 21350, 21374 (2004); Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, Memorandum Opinion and Order and Further

accept a level of interference that could significantly compromise" its service (although it is disappointing that to date Sirius' specific proposals have not hewed to its rhetoric).[9] WCS licensees are prepared to make significant operational and economic sacrifices to provide reasonable interference protection to SDARS subscribers, provided that reciprocal sacrifices are made by SDARS to facilitate the deployment of wireless broadband services by WCS. Fortunately, the WCS Coalition's proposed rules demonstrate that, so long as each side is prepared to compromise, rules can be crafted that minimize the inevitable interference between WCS and SDARS, while still permitting both to provide valuable services the public.

II. DISCUSSION.

A. RELAXATION OF THE WCS SPECTRAL MASK AS PROPOSED BY THE WCS COALITION WILL PROMOTE THE HIGHEST AND BEST USE OF 2305-2320/2345-2360 MHZ WITHOUT UNDUE INTERFERENCE TO SDARS SUBSCRIBERS.

1. THE COMMISSION SHOULD RELAX THE SPECTRAL MASK IMPOSED ON LOW-POWER WCS TRANSMITTERS AS PROPOSED BY THE WCS COALITION.

Absent a relaxation of the obsolete OOBE limitations imposed by Section 27.53(a) of the Commission's Rules on emissions by low-powered WCS subscriber equipment into the SDARS band, WCS cannot fully reach its potential for bringing innovative new wireless broadband services to the American public. Indeed, the record before the Commission establishes, and XM and Sirius do not seriously dispute, that the unusually restrictive limits imposed a decade ago on WCS OOBE into the 2320-2345

Notice of Proposed Rule Making, 18 FCC Rcd 3857, 3898-06 (2003); Amendment of Part 15 of the Commission's Rules Regarding Spread Spectrum Devices, Second Report and Order, 17 FCC Rcd 10755, 10766-67 (2002).

[9] Sirius Petition at 5.

MHz SDARS band threaten to undermine the viability of the 2305-2320/2345-2360 MHz band for mobile wireless broadband services.[10]

The simple, unavoidable fact is that no commercially-viable filters capable of satisfying the restrictions imposed by Section 27.53(a) on emissions into 2320-2345 MHz are available for incorporation into subscriber equipment. Members of the WCS Coalition have attempted to secure a commercially-reproducible filter capable of supporting operations at 2305-2320/2345-2360 MHz that meet the 110 + 10 log (P) attenuation requirement imposed on mobile devices, and have been advised that such filters for mass market devices are beyond the state-of-the-art, primarily because the size of any filter capable of meeting the mask would be so large (brick-like, or larger) that it could not be utilized in a portable or mobile device.

In addition, retention of the current OOBE limits precludes American consumers from enjoying the economies of scale that would be available with a more reasonable spectral mask. This band is being globally harmonized as a home for wireless broadband services, but the WCS Coalition is aware of no other nation that has imposed OOBE

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[10] *See, e.g.*, WCS Compromise Proposal at 7. In responding to the WCS Compromise Proposal, XM and Sirius did not even attempt to suggest that WCS licensees could provide mobile services under the current 100 + 10 log (P) mask, but instead made the argument that the WCS band was not intended for mobile services. *See* Letter from Patrick L. Donnelly, *et al.* to Marlene H. Dortch, Secretary, Federal Communications Commission, at 4-6 (filed September 19, 2007) ["SDARS Response to WCS Compromise Proposal"]. That just is not true. Indeed, the Table of Allocations makes clear that the 2305-2320/2345-2360 MHz is clearly and unequivocally allocated by the Commission for fixed <u>and</u> mobile services. *See* 47 C.F.R. § 2.106. While 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, at the same time the Commission also made clear that it was open to loosening those OOBE restrictions should it be possible to do so without material adverse impact on SDARS subscribers. *See WCS Reconsideration Order*, 12 FCC Rcd at 3979, 3991. XM and Sirius miss the point – the issue here is not what services could or could not be provided in 1997, but whether the Commission can today free the WCS band for its current highest and best use without subjecting SDARS subscribers to unreasonable levels of interference.

restrictions anywhere near as restrictive as those imposed by the United States.[11] Not surprisingly, then, equipment designed for global use cannot operate over the entire 2305-2320/2345-2360 MHz band in the United States because it cannot meet the uniquely restrictive American OOBE limits. Moreover, although the 2.3 GHz band is in proximity to the 2.5 GHz band that is also being used for wireless broadband in the US and abroad, the far more restrictive OOBE limits at 2305-2320/2345-2360 MHz impose significant impediments to what otherwise would be the relatively simple task of migrating 2.5 GHz band equipment to 2305-2320/2345-2360 MHz.[12] The net result is that retention of the current OOBE limits will preclude Americans from securing the benefits of the economies of scale that would otherwise be available – at best increasing the cost of WCS-based wireless broadband service and at worst precluding the realization of the highest and best use of the 2.3 GHz band WCS allocation.

This is hardly news. Indeed, the Commission previously has recognized that the OOBE restrictions set forth in Section 27.53(a) have impeded the emergence of WCS as a viable source of competition in the wireless broadband marketplace.[13] Even Sirius has

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[11] The WCS Coalition is aware that, in addition to the well-known 2.3 GHz WiBro service in South Korea, the 2.3 GHz band is or will soon be, available for WiMAX use in Andorra, Australia, Bangladesh, Barbados, Bolivia, Canada, Cayman Islands, Cook Islands, Curacao, El Salvador, Hong Kong, India, Malaysia, Mali, Mozambique, New Zeeland, Niger, Nigeria, Norway, Peru, Poland, Saint Marteen, Saudi Arabia, Senegal, Singapore, Tonga, Trinidad and Tobago, and Vietnam.

[12] Section 27.53(l)(4) of the Commission's Rules requires 2.5 GHz mobile equipment to attenuate their OOBE by "not less than 43 + 10 log (P) dB at the channel edge and 55 + 10 log (P) dB at 5.5 MHz from the channel edges." 47 C.F.R. § 27.53(l)(4). As discussed *supra*, the WCS Coalition's proposed subscriber station mask would be substantially more restrictive than that applied to 2.5 GHz mobile equipment.

[13] *See* Consolidated Request of WCS Coalition for Limited Extension of Deadline for Establishing WCS Compliance with Section 27.14 Substantial Service Requirement, WT Docket No. 06-102, at 4 n.9 (filed Mar. 22, 2006) ["WCS Extension Request"] ("These out-of-band emission limits have proven problematic because potential 2.3 GHz band equipment manufacturers have been unable to effectively migrate equipment designed for other bands to

conceded that the current WCS OOBE restrictions are inappropriate.[14] The *Notice* affords the Commission the opportunity to amend Section 27.53(a) and, in the process, unlock the potential of the 2305-2320/2345-2360 MHz band for meeting the demand in America for advanced wireless broadband services. To do otherwise, despite the evidence that the WCS Compromise Proposal can be adopted without material adverse impact on SDARS subscribers, would be to ignore the evolving demand for mobile and portable wireless broadband services that WCS licensees are uniquely situated to provide.

a) Future Loosening Of The WCS Spectral Mask Was Contemplated When The Commission Adopted The Current Rules Based On Worst-Case Assumptions.

Revisiting the OOBE restrictions imposed on low-powered WCS equipment at this juncture is fully consistent with the Commission's expectations when it adopted those limits a decade ago. In explaining the rationale for the OOBE limits adopted in the initial *Report and Order* in General Docket No. 96-228, the Commission has noted that:

> In authorizing DARS, it was our desire to ensure a high quality radio service. However, a desire for an interference-free radio service must be balanced with the need to provide reasonable operating parameters for adjacent services. Accordingly, our intention in determining out-of-band emission limits for WCS into the spectrum used by DARS has been to limit the potential for interference to a reasonable level -- not to provide a pure, interference-free environment. In determining the out-of-band emission limits adopted in the *Report and Order* we had to take into

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WCS"). As the WCS Coalition made clear at the time, relief from the restrictive OOBE limits currently imposed on WCS is not essential for licensees to meet their revised deadline for providing substantial service. *See* Reply Comments of WCS Coalition to WCS Extension Request, at 12 (filed June 23, 2006). However, revised OOBE rules will go a long way to assuring that the band is used to provide low-cost portable and mobile wireless broadband services, including services based on the IEEE 802.16e-2005 WiMAX standard.

[14] *See* Letter from Carl R. Frank, Counsel to Sirius Satellite Radio Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, File No. 0002240823, DA 05-1662, WT Docket No. 05-256, WT Docket No. 03-264, IB Docket No. 95-91, Attachment, "White Paper: Interference to the SDARS Service from WCS Transmitters," at 5, 17-18 (filed Mar. 29, 2006) ["Sirius White Paper"].

> consideration the wide flexibility that we are providing WCS licensees to provide any services consistent with the Table of Frequency Allocations. *Because we are unable to determine the specific operating parameters of a WCS service until the service is actually implemented, we found it appropriate to adopt limits that take into account any possible system configuration*.[15]

As such, the Commission expressly acknowledged that, because its initial OOBE limits were based on a "worst-case" analysis, relief would be appropriate in the future where worst case conditions will not occur. Specifically, the Commission recognized that:

> it is possible to provide a reasonable level of protection to DARS by taking into account a specific WCS system, although it may exceed the out-of-band emission limits adopted in the *Report and Order*. A specific system configuration may have certain attributes that were not taken into account when developing the general emission limits but which reduce its potential to interfere with DARS. For instance, a system may have reduced gain in the direction of Satellite DARS receiver, or the probability of the transmitters of a certain type of WCS system being close enough to interfere with Satellite DARS systems may be very low.[16]

The Commission's willingness to revisit its WCS OOBE rule is hardly surprising, as it is consistent with the Commission's overall obligation to continually re-assess its regulations and assure they keep pace with changes in technology and spectrum usage. The WCS Compromise Proposal has been developed with just this sort of re-evaluation in mind. For example, because the WCS community now has a far better concept of how WCS spectrum will be used, it can propose to amend Section 27.50(a)(2) to *reduce* the maximum permissible power of transmissions by fixed WCS customer stations from the 2000 watts peak Equivalent Isotropically Radiated Power ("EIRP") currently permitted to 20 watts average EIRP – a substantial benefit to SDARS licensees that WCS licensees now know they can accept because their service deployment plans are better

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[15] *WCS Reconsideration Order*, 12 FCC Rcd at 3991 (emphasis added).

[16] Id.

understood.[17] Similarly, because more is known about how WCS likely will be utilized, because we now know how actual SDARS receivers will perform in the presence of an interfering signal, and because it is highly likely that the final rules adopted by the Commission will permit SDARS repeater networks to operate at higher power levels than the very low power "gap-fillers" that were contemplated at the time the original WCS OOBE rules were adopted, the rules adopted by the Commission a decade ago to address SDARS susceptibility to OOBE interference can and should be revisited.[18]

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[17] The willingness of WCS licensees to accept a reduction in the maximum permissible transmission power of user stations is predicated on adoption of the other proposals advanced in the WCS Compromise Proposal. Those proposals, taken as a whole, will permit WCS licensees to adopt a business model in which high-power user stations will have no role. By contrast, if the Commission were to reject the regulatory relief requested in the WCS Compromise Proposal, it is certainly possible that the WCS band will only be used as the home to fixed point-to-multipoint services that will require the substantially higher power level at customer locations permitted under the current rules. Thus, were the Commission to retain the *status quo*, SDARS subscribers might find themselves subject to far greater interference than would be likely under the WCS Compromise Proposal.

Moreover, as the WCS Coalition notes *infra* at note 45, fixed transmitters used in a point-to-point systems should be treated as base stations under the WCS Compromise Proposal. Thus, they would not be subject to the proposed 20 Watt average EIRP limit on fixed user stations.

[18] When the Commission adopted service rules for SDARS in 1997 just prior to the WCS auction, it acknowledged that "some satellite DARS applicants intend to implement, as necessary, terrestrial repeaters, or 'gap-fillers', in urban canyons and other areas where it may be difficult to receive DARS signals transmitted by a satellite." *Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band*, Report and Order, Memorandum Opinion and Order, and Further Notice of Proposed Rulemaking, 12 FCC Rcd 5754, 5810-12 (1997) ["*DARS Order and FNPRM*"]. *See also Satellite CD Radio, Inc.*, Order and Authorization, 13 FCC Rcd 7971, 7987 n.103 (1997) ["*1997 Sirius Order*"] ("Terrestrial repeaters may be necessary to implement ('gap-fillers') in urban canyons and other areas where it may be difficult to receive SDARS signals transmitted by a satellite."). As is discussed *infra*, the preference of the SDARS licensees to blanket metropolitan areas with high-power repeater signals, rather than to just use low-power gap-fillers targeted to serve shadowed areas, is highly significant. Theoretical modeling, and actual testing have shown that because SDARS terrestrial repeaters generate higher signal levels than SDARS satellites at the heights above ground where SDARS receivers tend to be located, SDARS receivers are unlikely to suffer interference from the WCS Coalition's proposed OOBE limits when terrestrial repeater service is available. Although SDARS will no doubt seek to minimize this fact by asserting that little of the geographic area of the US will be served by terrestrial repeaters, the Commission cannot ignore that most metropolitan areas already are served by terrestrial repeaters, and it is in these highly-populated metropolitan areas where it is most likely that a WCS subscriber unit will be

b) The WCS Coalition Compromise Proposal is Narrowly Tailored to Mitigate the Possibility of SDARS Subscribers Suffering Actual Interference.

For all the *in terrorem* arguments advanced by SDARS against a modification of the WCS mask, the Commission should not ignore that the WCS Coalition's proposal for addressing the burdens imposed by Section 27.53(a) has been narrowly tailored to mitigate the possibility that SDARS subscribers might suffer actual interference. The WCS Coalition is not asking for blanket OOBE relief, but only relief for a limited class of subscriber equipment. Specifically, as recognized in the *Notice*, the WCS Coalition is proposing that relief be afforded only for subscriber equipment operating at low power levels – fixed user stations transmitting at less than 2 Watts average transmitter output power, and mobile stations transmitting at less than 2 Watts average EIRP.[19] Moreover, the relaxed mask proposed by the WCS Coalition would be available only if the device incorporates transmitter power control mechanisms that reduce transmit power to a lower level that is sufficient to accomplish the desired communications.[20] For this limited subclass of low-power subscriber stations, attenuation of OOBE would be required by a factor of not less than 55 + 10 log (P) dB on all frequencies between 2320 and 2324 MHz, and between 2341 and 2345 MHz; by a factor of not less than 61 + 10 log (P) dB for frequencies between 2324 and 2328 MHz, and between 2337 and 2341 MHz and by 67 + 10 log (P) between 2328 and 2337 MHz.[21]

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transmitting when in close proximity to a SDARS receiver. By contrast, in areas where repeater coverage is non-existent, the lack of population density makes it unlikely that a WCS subscriber unit will be transmitting when in close proximity to a SDARS receiver, and thus the odds of any interference actually occurring are highly diminished.

[19] *See Notice* at ¶ 24 n.70.

[20] See id.

[21] *See id*. ¶ 24.

Is the possibility of interference from WCS to some SDARS subscriber under every conceivable scenario completely foreclosed under our proposal? No, no more so than interference from a SDARS terrestrial repeater to a WCS base station or WCS subscriber is precluded under the WCS Compromise Proposal. As noted above, however, the Commission must engage in a balancing act in this proceeding, and the Commission has made clear that SDARS cannot reasonably expect either absolute protection from interference or *carte blanche* to cause interference to WCS.[22] Again, this proposal is hardly optimal for WCS. In a perfect world, the Commission would impose upon WCS the same 43 + 10 log (P) dB attenuation requirement that governs so many other wireless broadband services both here and abroad.[23] However, the WCS Coalition recognizes the need to provide reasonable protection levels to highly-sensitive (indeed, one could argue, overly-sensitive)[24] SDARS receivers. Based on the analysis and testing the WCS

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[22] *See, e.g.*, Reply of WCS Coalition, File No. SAT-STA-20060623-00067 (filed Oct. 16, 2006) (disabusing Sirius of notion that WCS is a secondary service relative to SDARS).

[23] *See, e.g.*, 47 C.F.R. §22.917(a)(Cellular Mobile Service); §24.238(a)(Broadband Personal Communications Service), §27.53(j)(1670-1675 MHz); §90.1323 (3650-3700 MHz). *See also supra* note 12 (discussing less restrictive 2.5 GHz mask for mobile subscriber equipment).

[24] It is worth noting that while many XM and Sirius devices do not include any filtering of WCS transmissions, filters used in some of Sirius' receivers do substantially attenuate WCS signals. Sample XM and Sirius subscriber antennas have been tested by a WCS Coalition member in a screen room facility to measure the frequency response. The frequency response of one Sirius and one XM antenna is shown in Attachment A. The response of the Sirius antenna indicates the presence of a bandpass filter that significantly attenuates most WCS blocks. However, not all Sirius antenna models demonstrated effective attenuation of the WCS blocks. The XM antenna shows an essentially flat frequency response across the WCS band, and every XM antenna tested was substantially similar. The WCS Coalition is aware of no technical reason why Sirius could not achieve the same WCS attenuation in all its devices, or why XM could not utilize the same filter technology employed by Sirius to provide similar rejection of the WCS band.

While the WCS Coalition does not believe the Commission should be mandating any particular filtering in WCS or SDARS devices, we do believe (as suggested in Paragraph 20 of the *Notice*) that in crafting its technical rules in this proceeding, the Commission should consider the ability of WCS and SDARS to utilize filtering to mitigate interference, while at the same time recognizing the practical limits of filtering technology. To the extent that filtering is available to

Coalition has conducted to date (discussed in more detail below), we are confident that the relaxed OOBE requirements proposed for low-power consumer equipment employing transmit power control will provide reasonable levels of protection to SDARS operations, while affording significant benefits to WCS licensees and their wireless broadband subscribers.

c) Analysis of the Sirius White Paper Shows That The Current Rule Provides Far More Protection To SDARS Receivers Than Necessary.

That adoption of the WCS Coalition's proposal would not subject SDARS to unreasonable interference can be demonstrated in the first place based largely on Sirius' own filings with the Commission. As Sirius previously recognized, "[b]lanketing interference dominates the impairment mechanism for a receiver incorporating best practice filtering and overload mitigation technology" and "[i]t can be clearly seen from the typical blanket interference levels that an SDARS receiver will be impaired due to

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mitigate interference (as Sirius has proven by filtering WCS in some of its devices), licensees should be free to omit such filtering, but they do so at their peril.

That said, the crafting of rules assuming that WCS licensees can deploy 16 dB front end band pass filters in their portable and mobile devices would prove problematic. WCS Coalition members have been advised that given the state of the art in bandpass filters, vendors today can achieve for a 2305-2320/2345-2360 MHz portable or mobile device only about 10 dB rejection of an SDARS repeater with a 4 dB of insertion loss using bulk acoustic wave technology. While this filtering would be effective to mitigate interference in an environment where SDARS is transmitting at no more than 2 kW average EIRP, it is not adequate to protect WCS if SDARS terrestrial repeaters are grandfathered and transmitting at far higher powers. Thus, even were the Commission to assume the use of these 10 dB filters, the risk of interference to WCS from the existing high-powered SDARS repeater network is real and beyond the control of the WCS community.

Moreover, and ultimately more importantly, adding filters to WCS customer equipment will not solve the problem of interference to WCS base stations. As discussed throughout this pleading, while interference to WCS customer equipment is certainly a problem, even reasonably filtered WCS base stations (with 40 dB attenuation of SDARS repeater signals) operating across the 2305-2320/2345-2360 MHz WCS band will suffer significant interference from SDARS terrestrial repeaters under the rules being advocated by the SDARS licensees.

blanketing interference well before it is impaired due to the WCS source out-of-band emissions causing a significant rise in the satellite noise floor."[25] This susceptibility of SDARS receivers to overload interference is critical, for it makes no sense for the Commission to impose unduly restrictive OOBE attenuation requirements on WCS to address scenarios where SDARS receivers mute anyway due to overload (even in the presence of WCS power levels permissible under the Commission's long-standing Part 27 rules).

Sirius has represented to the Commission that "intermodulation or overload interference impacts satellite service around -54 dBm input power to Sirius or XM SDARS receivers."[26] Under the WCS Coalition's compromise proposal, a WCS mobile station afforded OOBE relief would be permitted to operate at a maximum EIRP of 2 watts (or 33 dBm), as opposed to 20W under the current rules. Such a WCS mobile station operating at maximum permissible power (*i.e.*, without any benefit from the mandatory transmitter power control) will cause overload interference to a SDARS receiver when there is a path loss of 87 dB (33 dBm - (-54 dBm)) from the SDARS receiver. Knowing this path loss, one can calculate the OOBE energy from the WCS user station that would impact the SDARS receiver's noise floor by 1 dB (a typical industry value for noise floor protection). According to Sirius, the noise floor for its receivers when operating in satellite mode is -111 dBm.[27] This value is consistent with WCS Coalition calculations for a 1 dB noise floor impact, assuming a typical noise figure, thermal noise, and the bandwidth of a Sirius terrestrial emission. Therefore, a WCS user

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[25] Sirius White Paper at 17.

[26] *Id*.

[27] See id.

station OOBE of -24 dBm will result in a -111 dBm at the input of the receiver, with 87 dB of path loss between the two devices. This -24 dBm is measured across 4 MHz of receiver bandwidth, and is equivalent to -30 dBm/MHz. The equivalent OOBE mask to realize this -30 dBm/MHz is 60 + 10 log (P) where P is transmitter power in Watts. Therefore, for a 2 Watt EIRP mobile WCS transmitter, the current 110 + 10 log (P) mask exceeds that which is required to protect a SDARS receiver by a margin of 50 dB!

d) The WCS Compromise OOBE Limits Will Provide Adequate Protection To SDARS Receivers Under Real World Conditions.

The stepped mask proposed by the WCS coalition for low-powered subscriber equipment requires attenuation of 55 + 10 log (P) in the 4 MHz of the SDARS spectrum closest to WCS. Although this is 5 dB less than the 60 + 10 log (P) figure calculated in the preceding paragraph, under the WCS Coalition's proposal all devices must use transmit power control to minimize power levels below the maximum permitted to enjoy the benefits of the mask relaxation. The Commission has recognized that requiring transmitter power control is an effective mechanism for minimizing interference.[28] As the WCS Coalition previously reported to the Commission, modeling by a member of the WCS Coalition indicates that mobile WCS transmitters will operate at least 5 dB below

[28] See Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band, Report and Order, 18 FCC Rcd 24484, 24499 (2003); on recon. Memorandum Opinion and Order, 21 FCC Rcd 7672, 7675 (2006); Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands, Report and Order and Notice of Proposed Rulemaking, 18 FCC Rcd 1962, 1993, 2021 n.306 (2003) ["MSS/ATC Report and Order"]; Revisions to Broadcast Auxiliary Service Rules in Part 74 and Conforming Technical Rules for Broadcast Auxiliary Service, Cable Television Relay Service and Fixed Services in Parts 74, 78 and 101 of the Commission's Rules, Report and Order, 17 FCC Rcd 22979, 22999 (2002); Facilitating Opportunities For Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies, Report and Order, 20 FCC Rcd 5486, 5489-90 (2005).

maximum authorized power 90% of the time.[29] A subsequent more sophisticated analysis, which is reported in detail in the white paper "Interference to SDARS Receivers from WCS Subscriber Transmitters" annexed to these comments as Attachment B, further establishes that, even when one considers that there will be times at which WCS subscriber equipment will be at cell edge and thus will operate at higher power levels, transmitter power control and other "real world" factors make it highly unlikely that a WCS mobile device operating with the proposed relaxed OOBE mask will interfere with a SDARS subscriber. More specifically, this white paper concludes that:

- 99% of the time, a WCS mobile transmits at least 3 dB below its allowable maximum, which has a significant impact on its interference potential to an adjacent band SDARS receiver.
- 99% of the time, the adjacent channel power originating from a typical WCS mobile is below -44 dBm at the SDARS receiver (the level at which an SDARS receiver would be blocked from receiving service).
- 94% of the time, the OOBE from a WCS device operating with a 55+10 log (P) emissions mask in the SDARS band will have less than a 1 dB impact on the SDARS receiver noise floor.

Notably, the simulations underlying the white paper show a low probability of both overload and OOBE despite several conservative assumptions. As discussed in more detail in the white paper, the path loss computations assumed that an unobstructed propagation path always exists between the WCS transmitters and SDARS receivers. In reality, a certain percentage of propagation paths will be partially or fully obstructed, leading to greater path loss than was computed, and thus less probability of interference with SDARS receivers. In addition, the simulations were performed assuming full-buffer traffic (*i.e.*, assuming that the WCS devices always have data to send such that data is

[29] *See* WCS Compromise Proposal at 11.

transmitted in every available radio frame). In reality, WCS users would have more periodic data transmission which would further reduce the probability of interference to an SDARS receiver. Moreover, the simulations did not take advantage of multi-user multiplexing, which a WCS wireless broadband radio resource scheduler will exploit. The scheduler will attempt to organize mobile transmissions according to the reported link quality for the mobile, avoiding transmission when more power is required to overcome radio link impairments. In the simulations, the mobiles were forced to transmit during each frame, thus maximizing the probability of interference. Yet the simulations still yielded a low instance of actual interference.

While the requirement for transmit power control alone validates the OOBE limits that the WCS Coalition is proposing, there are a variety of factors (in addition to those identified in the paragraph above) that the Commission can and should consider as it moves away from the worst case analysis it undertook a decade ago when virtually nothing was known of WCS and SDARS to a more realistic assessment of possible OOBE interference. For example, now that SDARS has deployed extensive terrestrial repeater networks, the Commission can take comfort in the fact that any potential for OOBE interference to a SDARS subscriber is substantially mitigated by the multiple diversity path system design employed by both SDARS licenses. XM and Sirius both transmit two identical satellite signals, plus an identical repeater signal. Sirius has conceded that because muting does not occur unless all three signals are impaired, it can accept interference so long as the marginal level of one signal allows continued service to a user.[30] Thus, even in those rare occasions where OOBE interference to one of the

[30] *See* Sirius Petition at 5.

SDARS streams occurs (and the SDARS receiver does not otherwise mute due to overload), it is likely that another stream will be available and that muting of the signal will not occur.

This is particularly true because a SDARS subscriber in an area served by a terrestrial repeater is highly unlikely to suffer OOBE interference from WCS, as he or she will be receiving a relatively strong terrestrial signal rather than a relatively weak satellite signal. While terrestrial repeater coverage is not ubiquitous, 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. For example, Attachment C provides a graphic illustration of how extensive XM and Sirius repeater coverage is in the New York, NY and Washington, DC metropolitan areas.[31] Repeater coverage, not surprisingly, is concentrated where population is concentrated, and it is reasonable to assume that the WCS usage will be most extensive in the same densely populated areas served by terrestrial repeaters. While a terrestrial repeater that makes a SDARS receiver virtually immune to OOBE interference may not always be present when a WCS subscriber transmits in proximity to a SDARS receiver, the odds of interference occurring are diminished because one often will be available. Thus, as the Commission considers the likelihood that a WCS subscriber will be transmitting while sufficiently near a SDARS receiver to cause OOBE interference, the potential availability

[31] The coverage of the XM and Sirius repeaters portrayed in Attachment C is simulated using the CelPlan propagation modeling software using terrain and morphology adjustments, a 7 dB fade margin, a 90% probability of coverage and a -95 dBm signal level to denote the edge of the repeater coverage area. Repeater configurations used are those on file with the FCC when the simulations were computed in the Fall 2007.

of a terrestrial signal to a SDARS subscriber when in proximity to a potential WCS interferer cannot be ignored.

To confirm that the WCS spectral mask imposed on low-powered WCS subscriber devices can safely be loosened, the WCS Coalition recently undertook preliminary field testing. As previously reported to the Commission,[32] the WCS Coalition utilized a WiMAX-compliant transmitter provided by Navini Networks, Inc. that is capable of maintaining a fixed, continuous transmit power and center frequency.[33] That testing showed that at power levels as high as 250 mW, no muting could be induced in the tested SDARS receivers when those receivers were served by SDARS terrestrial repeaters. When the testing was repeated in an area where SDARS only has satellite coverage, muting could only be induced at 250 mW at distances of 4 to 13 ft, and at 100 mW at distances of 2 to 10 feet.

While SDARS will no doubt complain that the results are skewed by the use of equipment compliant with the current fixed 80 + 10 log (P) spectral mask rather than the loosened mask we propose, it must be stressed that the design of this particular test did not replicate "real world" conditions that will inevitably mitigate interference from WCS OOBE to SDARS subscribers. For example, because the test equipment maintained a

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[32] *See* Letter from Paul J. Sinderbrand, Counsel to WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Nov. 14, 2007).

[33] Because the SDARS licensees had been consistently objecting to testing with loosened spectral masks, the WCS Coalition undertook its preliminary testing utilizing fixed equipment that comported with the requirement of Section 27.53(a) that WCS fixed transmitters attenuate OOBE by 80 + 10 log (P). While this may somewhat understate the potential impact of adoption of the WCS Compromise Proposal on SDARS, as discussed below the test was designed in a manner that greatly overstates the potential impact by ignoring the benefits of transmit power control, the odds against a WCS subscriber transmitting when in proximity to an SDARS licensee, polarization mis-match and the use of long-duration interleavers in SDARS receivers. The Commission has recently granted WCA authority to re-conduct these tests utilizing equipment capable of replicating the spectral mask proposed by the WCS Coalition, and the results of those tests will be provided to the Commission when they are completed.

stable transmit power, the substantial benefits of duty cycle and transmit power control were not recognized in the results. The test set-up provided no attenuation between the WCS transmitter and the SDARS receiver, although in the real world attenuation due to humans, automobile bodies, or other factors is likely. Moreover, the test design did not take into consideration the low probability that a WCS subscriber unit actually will be transmitting at the same time it is in close proximity to a SDARS receiver where only satellite coverage is available (particularly without attenuation between the two caused by bodies, walls or automobile bodies). Yet, it is well-settled that the probability of proximate operations must be considered. For example, in relaxing the OOBE restrictions on WCS operators employing portable Personal Access Communications Service ("PACS") technology, the Commission recognized that PACS generally was unlikely to operate within twelve feet of a SDARS receiver and accordingly loosened the OOBE mask.[34] More recently, in permitting Mobile Satellite Service Ancillary Terrestrial Component ("ATC") operations, the Commission recognized that it would be inappropriate to assume that ATC and PCS handsets are operating in close proximity under line-of-sight conditions.[35] It is similarly fair to assume here that a WCS subscriber generally will not be transmitting in close proximity to a SDARS subscriber (particularly not in areas where SDARS has satellite-only service), at least not with an unobstructed path between the two.

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[34] See WCS Reconsideration Order, 12 FCC Rcd at 3993.

[35] See MSS/ATC Report and Order, 18 FCC Rcd at 2026. See also Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, Including Third Generation Wireless Systems, Order on Reconsideration, 21 FCC Rcd 5606, 5629 (2006).

Nor did the preliminary testing provide WCS with the benefit of DARS receivers long-duration interleavers that buffer short-term interruptions in signal receptions (such as when a car drives under a bridge or into a tunnel). WCS subscriber transmissions will tend to be extremely short, far shorter than the duration of the buffer. Thus, if a WCS subscriber unit happens to be transmitting in close proximity to a SDARS receiver that happens to be in the satellite reception mode, the OOBE interference likely will be of a shorter duration than the buffer capacity, meaning that the SDARS subscriber will not suffer any interruption in his or her listening. For testing, however, the WCS transmission was continuous, so that worst-case results could be measured.

In addition, given the complex, reflection-filled urban and suburban environments in which WCS and SDARS subscriber equipment will most likely be operating when in proximity to one another, it is highly likely that there will be polarization mis-match. Similarly, it is highly unlikely that proximate subscriber equipment will be perfectly aligned. Yet for purposes of the test, the antennas were aligned and co-polarized. Thus, as it has done in similar situations, the Commission can and should assume that there will often be polarization and angular discrimination when evaluating the potential for interference from WCS subscriber transmissions to SDARS consumer receivers.[36]

Consideration of all of these factors is appropriate here, as they all go to what should be the Commission's public policy objective – assuring that SDARS subscribers do not receive an undue level of interference from WCS user transmissions. In setting WCS OOBE and in a variety of other contexts, the Commission has recognized that

[36] *See id*. (acknowledging the importance of considering angular and polarization discrimination in considering the possibility of interference).

similar factors are relevant, and there is absolutely no reason for the Commission to abandon that approach here.

2. THE COMMISSION SHOULD ADOPT A COMMON OOBE FOR WCS AND SDARS FIXED TRANSMITTERS.

Consistent with the philosophy of maximizing mutuality where possible, the Commission should adopt a common restriction on OOBE for both WCS and SDARS fixed transmission facilities, requiring all WCS and SDARS licensees to attenuate emissions into the other service's band by a factor of 75 + 10 log (P) dB.

Sirius proposed a similar restriction for WCS in its petition for rulemaking,[37] and the WCS Coalition has previously indicated that it is prepared to accept that limit.[38] In addition, the WCS Coalition proposed that the same limit apply to SDARS terrestrial repeaters.[39]

This proposal, it should be noted, provides SDARS with 16-24 dB of relief as compared to the 75 + 10 log (P_{EIRP}) mask previously proposed by the Commission.[40] To date, neither XM nor Sirius have objected to the WCS Coalition's proposal to subject SDARS terrestrial repeaters to the same restriction as WCS base stations. Make no mistake, WCS licensees will face a significant threat of OOBE interference at their base stations if this proposed SDARS mask is adopted. For example, Attachment C

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[37] *See* Sirius Petition at B-4.

[38] *See* WCS Compromise Proposal at 6; *Notice* at ¶ 24.

[39] *See id*.

[40] *See* Public Notice, "Request for Further Comment on Selected Issues Regarding The Authorization of Satellite Digital Audio Radio Service Terrestrial Repeater Networks," 16 FCC Rcd 19435, 19437 (2001) ("Below 2320 MHz and above 2345 MHz, the power of any SDARS repeater emission shall be attenuated below the peak equivalent isotropically radiated power (P_{eirp}) within the assigned frequency band(s) of operation between 2320 MHz and 2345 MHz, measured in watts, by a factor not less than 75 + 10log (P_{eirp}) dB, where P_{eirp} is measured in watts.").

graphically illustrates those areas in and around Washington, DC where WCS operations will potentially be vulnerable to OOBE interference if the WCS Coalition's 75 + 10 log (P) proposal is adopted.[41] However, the WCS Coalition recognizes that some interference to WCS operations from SDARS terrestrial repeaters is inevitable, and is prepared to accept a common spectral mask for most fixed operations and the resulting interference to WCS, in the interest of compromise. What WCS cannot accept, however, is allowing SDARS terrestrial repeaters to operate at such high power levels that interference to WCS extends far beyond the OOBE impairment zones.

B. POWER LIMITS FOR SDARS TERRESTRIAL REPEATERS AND WCS MUST BE CAREFULLY SET SO THAT EACH SERVICE CAN MEET ITS LEGITIMATE NEEDS AND NEITHER SERVICE IS PRECLUDED FROM PROVIDING SERVICE TO THE PUBLIC.

1. THE COMMISSION SHOULD ADOPT A COMMON 2,000 WATT AVERAGE EIRP LIMIT FOR WCS BASE STATIONS AND SDARS TERRESTRIAL REPEATERS.

As the *Notice* recognizes, "a principle challenge in establishing a regulatory framework for SDARS repeaters has been the difficulty of resolving potential interference issues between SDARS repeaters and the proposed operations of terrestrial

[41] More specifically, Attachment D illustrates in red the impairment zone surrounding each of the known XM and Sirius repeaters in the Washington, DC and New York City, NY areas where operations under the proposed 75 + 10 log (P) mask could result in a 1 dB or more increase in the noise floor at hypothetical WCS base station sites owing to the proposed transmitted noise level of -45 dBm/MHz (-38 dBm/5 MHz) from each SDARS repeater. Future SDARS repeaters would obviously add to this noise level. For purposes of this analysis, the WCS Coalition has assumed thermal noise of -114 dBm/MHz, a receiver noise figure of 4 dB, an adjustment of 7 dB to reflect the 5 MHz receiver bandwidth, and a -6 dB adjustment for the 1 dB noise rise, resulting in a receiver impairment threshold of -109 dBm/5 MHz. It has further assumed that the WCS base station antenna will be located 30 meters above ground level, with a gain of 17 dBi. Actual SDARS antenna patterns and gains are used for the impairment area plots. Note, for example, that the net result is a zone of approximately 1400 meters around each SDARS repeater where WCS base stations would potentially suffer OOBE interference, assuming a repeater antenna gain of 15 dBi and strong mutual coupling between the antennas at the two sites. Also note that the plots show an impairment area threshold of -93 dBm due to issues in the CelPlan software which require use of an offset to the transmit and receive power levels since negative ERP values (such as -38 dBm) are not allowed as inputs.

licensees in the [WCS] in adjacent frequency bands that will permit the two services to co-exist."[42] Indeed, for the past decade the WCS community has been raising concerns that allowing the low-power SDARS "gap-fillers" originally contemplated by the Commission[43] to morph into multi-kilowatt high-power transmitters that could severely limit the economic viability of WCS as a vehicle for providing wireless broadband services.[44] To assure that 2305-2320/2345-2360 MHz can achieve its full potential, while providing SDARS with adequate flexibility to meet its terrestrial needs, the WCS Coalition urges the Commission to adopt a common 2,000 Watt average EIRP limit for SDARS terrestrial repeaters and WCS base stations,[45] subject to the procedure set forth in Section II.B.2 below permitting higher power upon consent of all affected licensees.

This proposal has been informed by Sirius prior's acknowledgement that coexistence of WCS and SDARS terrestrial repeaters is best promoted by rules that impose "'equal and mutual obligations upon both services.'"[46] As is a matter of record before the Commission, the WCS Coalition had, until filing the WCS Compromise Proposal, advocated that SDARS terrestrial repeaters be limited to 2,000 Watts *peak* EIRP, which is the same restriction faced today by WCS licensees.[47] The SDARS

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[42] *Notice* at ¶ 2.

[43] *See supra* note 18.

[44] *See infra* note 89.

[45] To eliminate any ambiguity, the WCS Coalition envisions that point-to-point link transmitters would be treated as base stations for purposes of its proposal, and suggests that whatever rules the Commission adopts to govern the 2305-2320/2345-2360 MHz band make clear that a point-to-point transmitter will be treated as a WCS base station.

[46] WCS Compromise Proposal at 3, *quoting* Sirius Petition at 2.

[47] *See, e.g.*, Letter from William M. Wiltshire, Counsel to AT&T Wireless Services, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 2 (filed Feb. 20, 2001) ("ATTWS submits that the Commission should not grant the unprecedented blanket license for high-power repeaters that the SDARS licensees have requested;

licensees, however, have pressed aggressively for higher power levels and for the use of average power measurement to govern their operations. 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.

The WCS Coalition's accommodation to SDARS represents a willingness on the part of the WCS community to accept up to 13 dB more interfering power from SDARS terrestrial repeaters. The current peak-to-average ratio of SDARS repeater technology is 6 dB.[48] However, it is possible that future technologies deployed by XM and Sirius will employ even greater ratios, thus subjecting WCS to even greater potential interference. The WCS Coalition has advised the Commission[49] 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, which is the same PAR limit recently adopted for the 700

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rather, *it should adopt a blanket authorization for standard power transmitters -- operating under the same maximum power levels applicable to WCS – with a notice requirement*.") (emphasis added); Letter from William M. Wiltshire, Counsel to AT&T Wireless Services, to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 8 (filed April 30, 2001) ("the rule would limit SDARS repeaters to peak EIRP levels of no more than 400 W/MHz, evenly distributed across the band, for a total of 2 kW per 5 MHz of repeater spectrum. This would place SDARS repeaters on a par with the EIRP limitations placed on WCS operators and allow them to operate, as XM admits, 'at a power level that is completely standard in this part of the spectrum.'") *citing* Letter from Bruce D. Jacobs, Counsel to XM Radio Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 2 (filed April 25, 2001); Letter from Paul J. Sinderbrand, Counsel to Wireless Communications Ass'n Int'l, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 1-2 (filed Jan. 25, 2001); Letter from Paul J. Sinderbrand, Counsel to Wireless Communications Ass'n Int'l, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 2 (filed Dec. 15, 2000).

[48] *See* Sirius White Paper at 11.

[49] *See* Letter from Paul J. Sinderbrand, Counsel to WCS Coalition, to Marlene, H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 1-2 (filed Aug. 16, 2007). Thus, the WCS Coalition is at a loss to explain why the *Notice* suggests that the WCS Coalition has supported a maximum 6 dB peak-to-average ratio. *See Notice* at ¶ 22.

MHz band.[50] For purposes of this limit, the Commission should make clear that peak 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, and that average power or "mean power" is defined as the average power supplied to the antenna transmission line by a transmitter during an 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.[51]

In proposing a 2,000 Watt average EIRP limit for both services, the WCS Coalition is cognizant of the significant problem Sirius has faced as a result of brute force overload or blanketing interference from XM. In prior filings with the Commission, Sirius has complained of "dead zones" – areas in which a mis-match between high-power transmissions from XM and low-power Sirius signals have caused muting of Sirius' service.[52] Sirius has correctly recognized that where low-powered systems operate in proximity to high-powered systems, overload is a "significant interference mechanism."[53] Of course, WCS faces the same potential problem – high-powered transmissions from SDARS terrestrial repeaters will inevitably cause areas in which WCS low-powered,

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[50] *See Service Rules for the 698-746, 747-762 and 777-792 MHz Bands*, Report and Order and Further Notice of Proposed Rulemaking, 22 FCC Rcd 8064, 8103-04 (2007) ["*700 MHz Report and Order*"].

[51] See Biennial Regulatory Review Amendment of Parts 1, 22, 24, 27, and 90 to Streamline and Harmonize Various Rules Affecting Wireless Radio Services, Report and Order and Further Notice of Proposed Rulemaking, 20 FCC Rcd 13900, 13931 n.207-08 (2005).

[52] *See* Sirius White Paper at 3 ("With a terrestrial network nearly 10 times larger than Sirius', several XM repeaters today generate ground-level "dead zones" – muting reception of the Sirius satellite signal.").

[53] *See* Sirius White Paper at 5.

cellularized wireless broadband services will be unavailable to subscribers. That is why it is so important that the maximum permissible power levels between the two services be consistent. It is not expected that WCS licensees will routinely operate at 2,000 Watts average EIRP, because such high power is unnecessary to serve consumers in most environments and could result in self-interference. However, increasing the maximum permissible WCS power level to the same power level authorized for SDARS terrestrial repeaters will provide WCS licensees the ability, where necessary, to increase their own power levels to avoid interference from SDARS.[54]

Our proposal responds to that concern by identifying a reasonable middle ground[55] that mitigates, but hardly eliminates, the potential for interference to WCS and SDARS satellite reception due to brute force overload from terrestrial repeaters operating at 2,000 Watts average EIRP. While WCS will remain subject to overload interference from SDARS terrestrial repeaters operating at 2,000 Watts average EIRP, restricting

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[54] In addition, by allowing WCS licensees to transmit at up to 2 kW average EIRP, the Commission will eliminate the bias in the current rule against using wideband technologies that employ non-constant envelopes. As the Commission recently concluded in establishing power limits for the 700 MHz band based on average power:

> [a]lthough the use of "average" power will effectively result in an increase in 700 MHz Band power levels for non-constant envelope technologies, such as CDMA and WCDMA, the "average" measurement approach is a more accurate measure of the interference potential for these technologies. We find that any effective increase in power that would result through the use of an "average" measurement approach will be modest, and in any event will be outweighed by the benefit of measuring today's technologies using a more realistic and appropriate technique.

700 MHz Report and Order, 22 FCC Rcd at 8103.

And, allowing WCS licensees to transmit with some additional power will facilitate their ability to provide economic advanced wireless services in rural areas, since it will allow each base station to serve a somewhat larger geographic area.

[55] In WT Docket No. 03-264, XM had proposed that WCS licensees be permitted to transmit at up to 4000 watts per MHz. *See* Joint Reply Comments of WCS Wireless LLC and XM Satellite Radio Holdings Inc., WT Docket No. 03-264, at 9 (filed Jan. 17, 2006). Sirius vigorously opposed that proposal on the grounds that it would subject its subscribers to "dead zones". *See* Sirius White Paper at 3.

SDARS terrestrial repeater power as proposed will result in overload occurring in the same general areas where OOBE interference from SDARS terrestrial repeaters will occur (as discussed previously).

To date, the primary objection to this proposal from XM and Sirius has been that "limits on transmit power rather than power flux density would lead to the creation of "hot spots" that would frequently wipe out satellite radio service in many areas; including areas around the WCS base stations that are likely to be located near major roads carrying vehicles of satellite radio users."[56] It is certainly true that cellularized architectures such as those used by wireless broadband networks result in higher power levels near a base station – WCS base stations used for WiMAX or other advanced wireless broadband services will tend to be relatively low to the ground and utilize significant downtilt to facilitate spectrum reuse and assure ubiquitous coverage. Indeed, what the SDARS licensees conveniently ignore is that at the time of the Commission's SDARS auction, the WCS rules imposed no limit whatsoever on WCS transmissions,[57] and that the Commission's current approach to regulation of WCS interference through limits on transmit power, rather than power flux density, went into effect more than a decade ago without objection from the SDARS industry.[58] In other words, *WCS licensees are, and have always been, free to design their networks with power concentrated at ground level to facilitate the provision of ubiquitous cellularized services*, and they have crafted their

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[56] *See* SDARS Response to WCS Compromise Proposal at 2.

[57] *See* Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service, 12 FCC Rcd 10785 (1997) ["*WCS Report & Order*"].

[58] The SDARS auction commenced on April 1, 1997 and continued the following day. *See Notice* at ¶ 7 n.15. The Memorandum Opinion and Order adopting the current EIRP limit on WCS transmissions was not released until April 2, 1997, and the new rule restricting WCS power levels did not go into effect until publication in the *Federal Register*. *See WCS Reconsideration Order*, 12 FCC Rcd at 3994.

business plans predicated on their ability to do so. While the WCS Coalition is prepared to make reasonable accommodations, the discussion below establishes beyond peradventure that adoption of the Sirius proposal for restricting WCS transmissions would effectively end any hope that the 2305-2320/2345-2360 MHz band will be used to provide wireless broadband services to the public. And that is not something the WCS Coalition is prepared to accept.

2. THE COMMISSION SHOULD PERMIT LICENSEES TO EXCEED 2 KW AVERAGE EIRP UPON CONSENT OF ALL AFFECTED LICENSEES.

Notwithstanding the arguments advanced above, the WCS Coalition would not object to a policy under which a SDARS licensee could construct and operate terrestrial repeaters in excess of 2 kW average EIRP with the prior written consent of the other DARS licensee and all affected WCS licensees.[59]

Although it will not generally be the case, it is conceivable that in a specific circumstance a SDARS licensee could demonstrate to all of the affected WCS licensees that in that particular case, a specific terrestrial repeater could be deployed at a higher power level than otherwise permitted without an adverse impact on WCS (particularly if the SDARS licensee is willing to agree not to construct additional permissible repeaters in the same area). If a SDARS licensee can secure the consent of all of the potentially affected WCS licensees (which should be defined as all entities that hold a 2.3 GHz license for territory within ten kilometers of the proposed repeater location)[60] and the

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[59] See Notice at ¶ 30.

[60] The ten kilometer figure is based on a calculation showing that a 40000 watt average EIRP SDARS terrestrial repeater will potentially cause interference within 6.5 kilometers of a WCS base station.

Repeater EIRP	40000 watts Tx
EIRP	76.0 dBm (calculated)
Reference Sensitivity	-121.0 dBm

other SDARS licensee, there is no reason to preclude the parties from entering into an appropriate agreement. Similarly, although it is highly unlikely that any WCS licensee will desire to transmit in excess of 2 kW average EIRP, there is no reason to preclude higher powered WCS operations if the SDARS licensees and all affected WCS licensees consent.

3. ADOPTION OF SIRIUS' PROPOSED "AVERAGE POWER LEVEL" LIMITS WOULD EFFECTIVELY PRECLUDE THE USE OF THE WCS BAND FOR WIRELESS BROADBAND SERVICES.

The *Notice* solicits comment on Sirius' complex proposal that the Commission: (a) require all new WCS base stations and SDARS terrestrial facilities to comply with a "average power level"[61] limit of -44 dBm (100 dBµV/m) measured at 2 meters above ground level at any distance beyond the radiation center height above ground level from the base of a WCS base station or SDARS repeater antenna, except that within the area between (i) the radiation center height above ground level and (ii) 5000 meters, each licensee may designate and identify up to 20,000 square meters, with no contiguous area

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BTS ACS 10 MHz sep.	58.0 dB
Rx impairment level for jammer	-63.0 dBm
Rx antenna gain	17 dBi
Filter attenuation	40 dB
RSSI at antenna for overload	-40.0 dBm
pathloss required	116.0 dB (calculated)
exclusion distance (LOS)	6.511 Km (calculated)

The additional 3.489 kilometers provides necessary margin should the assumptions prove inaccurate.

[61] The *Notice* correctly points out that Sirius has wrongly claimed its proposal to be a "power flux density" limit. *See Notice* at ¶ 15 n.42. The *Notice* suggests that, were the Commission disposed to adopt a limit along the lines proposed by Sirius, "a final rule incorporating Sirius's basic idea could be expressed as an equivalent PFD or electric field strength limit" and notes that "[a]ssuming a 0 dBi measurement antenna (as Sirius does), the -44 dBm received power limit is equivalent to a PFD limit of -45.3 dBW/m² or a field strength limit of 100.5 dBµV/m." *Id.* Although the WCS Coalition does not support adoption of Sirius' proposal, we do agree with the Commission that were a similar approach to be adopted, it should be based on a specified power flux density or field strength limit. *See id.* at ¶ 18.

greater than 8,000 square meters, where such station shall not exceed an average power level of -32 dBm (112 dBµV/m) measured at 2 meters above ground level; and (b) to restrict the "average power level" of WCS subscriber stations to -44 dBµV/m (100 dBµV/m) at a distance more than one meter from the subscriber antenna.[62] Like much of what Sirius has proposed, its emission limits are heavily skewed to protect the terrestrial repeater networks that it and XM chose to construct – often illegally – and notwithstanding clear Commission warnings that any deployments were at their own risk and would not prejudice the Commission's flexibility when adopting final rules.[63] In fact, adoption of Sirius' proposed power limits would effectively preclude the introduction of the very advanced wireless systems, including mobile WiMAX systems based on the IEEE 802.16-2005 standard, that the Commission has sought to promote in the WCS band.[64]

Quite frankly, the WCS Coalition is astonished that Sirius continues to press its proposal when the record is so clear that it is unworkable from the WCS perspective.[65] Of course, it is patently obvious why Sirius would advance, and XM support, this

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[62] *See id*. at ¶¶ 15-16; Sirius Petition at Appendices A and B.

[63] *See XM Radio Inc., Application for Special Temporary Authority to Operate Satellite Digital Audio Radio Service Complementary Terrestrial Repeaters*, Order and Authorization, 16 FCC Rcd 16781, 16787 (IB 2001), modified, 16 FCC Rcd 18484 (IB 2001) ["*Initial XM STA Order*"] ("Any action taken as a result of this STA are solely at XM Radio's own risk. This STA shall not prejudice the outcome of the final rules adopted by the Commission in GEN Docket 95-91."); *see also Sirius Satellite Radio, Inc., Application for Special Temporary Authority to Operate Satellite Digital Audio Radio Service Complementary Terrestrial Repeaters*, Order and Authorization, 16 FCC Rcd 16773, 16779 (IB 2001), modified, 16 FCC Rcd 18481 (IB 2001) ["*Initial Sirius STA Order*"] ("Any action taken as a result of this STA are solely at Sirius's own risk. This STA shall not prejudice the outcome of the final rules adopted by the Commission in GEN Docket 95-91.").

[64] See Consolidated Request of the WCS Coalition For Limited Waiver of Construction Deadline for 132 WCS Licenses, Order, 21 FCC Rcd 14134, 14141 (WTB 2006) ["WCS Extension Order"].

[65] *See* WCS Compromise Proposal at 3 n.7.

approach. They operate one-way broadcast systems with transmission antennas that tend to be mounted relatively far above ground and have minimal downtilt. Thus, limits on power levels measured two meters above ground level are uniquely tailored to their network designs and will have little adverse impact. Yet, preliminary analysis illustrates that the existing terrestrial repeaters exceed the very interference limits Sirius propose to protect WCS.[66] Thus, typical of its self-serving approach, Sirius proposes to exempt the current terrestrial networks, and even to extend that exemption to the myriad of terrestrial repeaters that XM and Sirius have built at variance from the parameters identified in their STAs.

a) The Demand For Ubiquitous Mobile Broadband Service Requires That Service Be Available Near WCS Base Stations.

The nature of the WiMAX and other advanced wireless broadband systems contemplated for the WCS band requires a very different network design compared to the broadcast-like design of SDARS repeaters. As discussed above, base stations in a cellularized network will tend to be lower to the ground and to utilize significant downtilt to facilitate spectrum reuse and assure ubiquitous coverage. While these base stations usually transmit at far lower power levels than SDARS repeaters, the lower height above ground level and the greater use of downtilt make it difficult for WCS to meet Sirius' proposed ground level restrictions and still provide the sort of high quality, ubiquitous

[66] For example, Attachment E graphically illustrates areas in New York City, NY and Washington, DC where CelPlan propagation modeling software determines the combined coverage area of XM and Sirius with a signal strength of -44 dBm or greater. The receiver antenna assumed is omnidirectional with 0 dBi of gain, at a height of 2m. Clutter and terrain data are used with typical clutter loss values. Sirius and XM were simulated separately and a composite plot showing both is attached. The simulation included a 7 dB of fade margin for 90% coverage probability.

service the public demands. Indeed, as is discussed in more detail below, Part 27 of the Commission's Rules has always permitted WCS licensees to construct cellularized networks with power concentrated near the base stations to maximize the potential for frequency reuse and to provide ubiquitous coverage. This sort of network architecture is fundamental to the business plans developed by WCS licensees, and precluding it now would be fundamentally unfair to the WCS community. Given that the WCS Coalition has previously identified this fundamental flaw with Sirius' proposal,[67] but Sirius and XM continue to advocate its adoption, one can only conclude that they view this as a "back door" way to assure WCS fails and the overly-sensitive SDARS receivers avoid interference.

b) The Sirius Proposal Fails To Provide Any Meaningful Protection To WCS Base Stations.

Moreover, while WCS base stations will tend to be lower to the ground than SDARS terrestrial repeaters, the receivers of those base stations will be mounted far more than the 2 meters above ground level measurement location proposed by Sirius. Indeed, it is likely that WCS base station receivers often will be mounted 30 meters or more above ground level, just as in other cellularized services. Yet it is patently obvious that the Sirius proposal does absolutely nothing to protect those base stations against overload interference from SDARS. When measuring signal levels 2 meters above ground level, attenuation from a variety of natural and manmade clutter will come into play, allowing greater powers at the transmitter than might otherwise be permitted without that attenuation. However, WCS base station receivers will be installed far above this clutter to provide adequate coverage and maximize their ability to receive relatively weak

[67] *See* WCS Compromise Proposal at 3 n.7.

signals from subscriber equipment. Thus, WCS base stations will suffer overload interference from SDARS terrestrial repeater signals that are sufficiently attenuated by clutter two meters above ground level that they meet the proposed limit. As such, Sirius could not be more wrong when it suggests that its approach is consistent with that adopted by the Commission in the Lower 700 MHz proceeding.[68] Although there the Commission did impose a power flux density limit, that limit was specifically designed by the Commission "in order to limit . . . interference and to make the various services compatible."[69] Sirius' proposal is the antithesis of the Commission's approach in the Lower 700 MHz proceeding, for it provides no meaningful interference protection to WCS base stations and assures that the two services will not be able to coexist.[70]

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[68] *See* SDARS Response to WCS Compromise Proposal at 8.

[69] *Reallocation and Service Rules for the 698-746 MHz Spectrum Band (Television Channels 52-29)*, Report and Order, 17 FCC Rcd 1022, 1064 (2002). It should be noted that the Lower 700 MHz band situation is further distinguishable because the Commission specifically authorized high-powered operations prior to the auction, and warned potential bidders to consider the potential risks associated with operating adjacent to high-powered facilities. *See id.* at 1065 ("[W]e expect that prospective licensees will take into account any costs that may be necessary to incorporate technical features to alleviate interference issues"). By contrast, as discussed throughout these comments, at the time of the WCS auction terrestrial SDARS repeaters were envisioned as low-powered "gap-fillers" designed to target areas such as overpasses and tunnels where satellite service might otherwise be unavailable.

[70] While the Commission identified a variety of mechanisms that could be utilized by 700 MHz licensees to mitigate interference from higher-powered operations (*see id.*), implementation of those measures could impose severe additional infrastructure costs on a WCS licensee, effectively making wireless broadband service non-viable. For example, while the Commission has suggested that a Lower 700 MHz licensee could avoid utilizing the spectrum near its band edge, that is simply not a viable option for C and D block WCS licensees, who only have 5 MHz of bandwidth to begin with. Forcing them to forgo use of some of that spectrum will effectively require a significant increase in the number of base stations deployed, since extreme frequency reuse will be necessary to recoup the bandwidth lost. That, in turn, will greatly increase the costs imposed on the WCS licensee relative to competitors that can provide service without the burden of an overly-cellularized network structure.

c) WCS Subscriber Stations Cannot Operate At the Unduly Low Power Levels That Would Be Required Under The Sirius Proposal.

It is equally disingenuous for XM and Sirius to proclaim that they "do not oppose plans by the WCS Coalition's members to use their spectrum to provide wireless broadband services, including using WiMAX or other technologies," when they advocate a restriction on subscriber emissions that effectively would preclude any two-way services in the WCS band.[71] WiMAX subscriber equipment must transmit reasonable power levels (in the range of several hundred milliwatts) to ensure two-way communication with a base station. Sirius' proposed limit on WCS subscriber station power levels to -44 dBm measured just one meter from the antenna would restrict WCS subscriber equipment transmit power to about *0.4 milliwatts*, at best (assuming a 0 dBi antenna and 5 MHz measurement bandwidth), and thus make a two-way system technically infeasible. As a point of comparison, unlicensed devices in the 2.4 GHz band are permitted to transmit at substantially higher power levels.[72]

The Commission should make no mistake -- adoption of SDARS's proposal would effectively preclude the use of the WCS band for two-way communications. Again, Sirius and XM are well aware of this flaw in their proposal,[73] and their continued advocacy of it speaks volumes as to their underlying objective here.

4. THE COMMISSION SHOULD MANDATE THAT SDARS TERRESTRIAL REPEATERS OPERATE BETWEEN 2324.2 MHZ AND 2341.285 MHZ.

In conducting the analyses that have led the WCS Coalition to propose the OOBE and power limits for SDARS terrestrial repeaters set forth above, it has been assumed that

[71] SDARS Response to WCS Compromise Proposal at 1.

[72] *See* 47 C.F.R. §15.247(b)(3).

[73] *See* WCS Compromise at 3 n.7.

repeater operations would be limited so as to be no lower in the SDARS band than 2324.2 MHz and no higher in the SDARS band than 2341.285 MHz. This is consistent with the current SDARS practice – Sirius operates its terrestrial repeaters at 2324.2-2328.3 MHz and XM operates its terrestrial repeaters at 2336.225-2341.285 MHz. While the WCS Coalition has no objection to XM or Sirius moving its terrestrial repeater usage closer to the center of the 2320-2345 MHz SDARS band (farther away from the boundaries with WCS), movement closer to the WCS band will only exacerbate the interference to which WCS subscribers will be subjected and should be prevented by rule.

5. GOVERNING INTERMODULATION AS PROPOSED BY SIRIUS WOULD IMPOSE UNREASONABLE BURDENS ON WCS LICENSEES AND IS UNNECESSARY.

The *Notice* seeks comments on proposals advanced by Sirius to address the potential for intermodulation by limiting collocation of WCS and SDARS facilities.[74] While intermodulation will have to be addressed by WCS and SDARS licensees on a case-by-case basis as additional facilities are constructed in the coming years, the WCS Coalition does not believe that the Commission should adopt the complex set of rules proposed by Sirius to address future collocation of facilities.[75] Those rules are unnecessary. Moreover, because XM and Sirius conveniently would be exempted from them by virtue of their prior construction under STAs (even their illegal construction), the proposed rules would have a disproportionate adverse impact on the ability of WCS licensees to deploy their cellularized networks as necessary to provide ubiquitous service.

The Commission has generally found that even where intermodulation interference is possible, "bright line" tests designed to avoid it are "ill fitting" because of

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[74] *See Notice* at ¶ 28.

[75] *See* Sirius Petition at A-2 and B-1 to B-2.

the complex nature of such issues.[76] As a result, the Commission's traditional approach is to refrain from adopting rules that place technical limits on licensees to prevent intermodulation interference from occurring.[77] Recently, to cite one example, the Commission refused to impose limits on commercial Upper 700 MHz Band licensees to minimize intermodulation interference, stating that to do so in the absence of a well-documented showing that serious interference would result "could dramatically compromise the usefulness of the Upper 700 MHz commercial spectrum blocks."[78] Rather than impose rules or other *a priori* restrictions on licensees, the Commission's general policy, absent special circumstances, is to rely on licensees to work out such issues privately: "Typically intermodulation issues are resolved between licensees, and we believe that is the appropriate approach for dealing with the increased potential for intermodulation products as a result of base station power increases . . . ."[79]

That approach is particularly appropriate here, as the risk of intermodulation interference when WCS base stations are located in close proximity to a SDARS repeater is anything but clear. For example, Horizon Wi-Com has collocated WCS base stations

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[76] Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems, Ninth Report and Order and Order, 21 FCC Rcd 4473, 4503 (2006).

[77] *See Amendment of Section 90.307(f)*, Report and Order, 56 Rad. Reg. 2d (P&F) 1352, ¶ 14 (1984) ("Intermodulation interference . . . is best controlled on a case-by-case basis at the actual transmitting site, rather than by a federal restriction on system ERP.").

[78] Petitions for Reconsideration of the Second Memorandum Opinion and Order, Service Rules for the 746-764 and 776-794 MHz Bands and Revisions to Part 27 of the Commission's Rules, Third Memorandum Opinion and Order, 17 FCC Rcd 13985, 13995-13996 (2002); Service Rules for the 698-746, 747-762 and 777-792 MHz Bands, Report and Order and Further Notice of Proposed Rulemaking, 22 FCC Rcd 8064, 8105 (2007) ("We also decline to impose any technical restrictions . . . to address potential [intermodulation] interference . . . .").

[79] *Mobile Satellite Ventures Subsidiary LLC*, Order and Authorization, 19 FCC Rcd 22144, 22172 (IB 2004).

with XM terrestrial repeaters in Pittsburgh and in New Jersey that would have been precluded under the Sirius proposal. Yet in neither case has Horizon Wi-Com experienced intermodulation interference, nor has Horizon Wi-Com received any complaint from XM of interference. This is hardly surprising. Intermodulation often does not prove problematical even where it is theoretically possible to occur, and this example illustrates why adoption of Sirius' proposal would unduly restrict the location of WCS base stations. Moreover, the Sirius proposal ignores that in many cases, collocation can be beneficial, in that it will tend to reduce the very WCS "hot spots" that Sirius complains of. If SDARS and WCS are collocated, then the received signal level of a SDARS subscriber receivers will tend to be, at worst, identical to that of the WCS signal, and the SDARS receiver likely will not suffer interference.

If the Commission is disposed towards adopting rules that address collocation, the Commission should reject aspects of the Sirius proposal that give undue preference to SDARS or that preclude the various WCS licensees in a given geographic area from utilizing all of their spectrum at a given base station location. As a practical matter, the rules proposed by Sirius would significantly limit the ability of WCS licensees to deploy new facilities, as they are constructing new networks from scratch, while Sirius has proposed to exempt the existing SDARS terrestrial repeaters from any obligation to control intermodulation interference.[80] Indeed, adding insult to injury, the rules proposed by Sirius would exempt not only its existing repeaters, but would allow SDARS licensees to relocate those repeaters within 3 kilometers under certain circumstances, even if the

[80] *See* Sirius Petition at A-2.

result is to cause intermodulation interference to existing WCS facilities.[81] The Commission must not allow the system to be gamed in a manner that unduly restricts the ability of WCS licensees to deploy networks that will meet the public's need for additional wireless broadband services, while providing the SDARS licensees a free pass.

6. SIRIUS' PROPOSAL TO REQUIRE WCS LICENSES TO PROVIDE PRIOR NOTICE AND PREDICTIVE ANALYSES BEFORE COMMENCING OPERATIONS IS UNNECESSARY AND UNDULY BURDENSOME.

With the *Notice*, the Commission has sought comment on a variety of notification and recordkeeping requirements.[82] As a general proposition, the WCS Coalition has no objection to the adoption of requirements that will facilitate the coexistence of SDARS and WCS, so long as those requirements impose no undue burden on either service. Unfortunately, several of the Sirius proposals on which the *Notice* seeks input do not meet that criteria.

The WCS Coalition certainly agrees with the proposition that information exchanges among licensees in the two services will assist in reducing the prospects for interference. In other situations where there is the potential for interference between adjacent licensees, however, the Commission has generally not mandated detailed information exchanges, and instead has left it to the parties to develop their own mechanisms. That approach makes eminently good sense, since it provides the flexibility for industry to modify the procedures as appropriate over time as a better understanding is gained as to what information is necessary, and how best to provide for a secure

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[81] It should be noted that XM and Sirius have not addressed how the numerous repeaters that they constructed and operated in violation of the terms of their STAs would be treated under this, or any of Sirius' other proposals to give preferential treatment to existing facilities. It would be passing strange, however, for the Commission to give preferential treatment to XM and Sirius facilities that were constructed illegally.

[82] *See Notice* at ¶¶ 29-32.

exchange of what might be commercially sensitive. Given the concerns that both WCS and SDARS have expressed regarding the potential for interference between the two services, there is no reason to believe that the licensees in those services cannot develop flexible mechanisms to govern the exchange of relevant information without Commission involvement.

If the Commission does, however, elect to intervene here, it must assure that the requirements do not impose undue restrictions on the ability of WCS licensees to provide wireless broadband services to the public. Yet that is exactly what would happen were the Commission to adopt Sirius' proposals. As a practical matter, requiring WCS licensees to provide XM and Sirius at least 90 days advance notice of the specific technical parameters of all base stations, as proposed by Sirius, would frustrate the ability of WCS licensees to provide ubiquitous wireless broadband service to the public. As WCS licensees deploy their cellular networks, they will be constantly "tweaking" as necessary to, for example, eliminate "dead zones" in coverage, avoid self-interference between the operator's own cell sites and add capacity needed to serve increasing demand from its customers. WCS licensees thus will constantly be adjusting base station antenna orientations and beamtilts, changing antenna heights, adding or subtracting sectors, altering power levels and adding new cells.

This is an iterative process – modifications to cell sites are done over and over again as, for example, dead zones arise due to new construction or new areas of self-interference are discovered. Invariably, one iteration begets another – for instance, a slight modification of one antenna's orientation to improve coverage may require a corresponding modification of a second antenna to avoid self-interference, which in turn

might require a reorienting of a third antenna to fill-in coverage, and so on. Often, the need for these network modifications cannot be predicted before hand, as propagation modeling tools are imperfect (particularly in urban and suburban areas with substantial man-made clutter). Thus, they must be effectuated in real time – adjustments are made, signal levels measured, further adjustments made, etc., until the system is in balance. However, under the rules proposed by Sirius, what often must take place over the course of hours or a few days would be stretched out for months, as each iteration of modification would require the filing of notices and a waiting period of at least 90 days before the system operator could actually implement any of the system modifications involved. This is totally unnecessary, and would effectively preclude the offering of a viable ubiquitous service.

As the *Notice* implicitly recognizes, other aspects of Sirius' proposal, such as its proposed requirement that WCS afford SDARS licensees detailed analyses of potential interference at least 90 days prior to any network modification, would be totally unnecessary if the Commission adopts the simple 2 kW average EIRP limit proposed by the WCS Coalition, as opposed to the complex "ground level emissions" approach advanced by Sirius.[83] But even if the Commission adopts some variant of the Sirius approach, there is no reason to require WCS licensees to demonstrate before deploying facilities that those facilities will comply with the rules. Absent evidence of an ongoing problem with non-compliance, the Commission should do here as it does in similar cases – assume that licensees will comply with its technical rules and only require detailed analyses where a documented complaint of interference is filed.

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[83] *See Notice* at ¶ 32.

C. SDARS LICENSEES SHOULD BE AFFORDED TWELVE MONTHS TO BRING THEIR TERRESTRIAL REPEATER NETWORKS INTO COMPLIANCE WITH THE FINAL RULES.

Of course, adoption of technical rules to protect consumers of WCS advanced wireless services from SDARS terrestrial repeater interference will be for naught if the Commission adopts Sirius' proposal that it and XM be permitted to continue operating non-compliant repeaters authorized under their STAs (and apparently even those constructed at variance from their STAs) *ad infinitum, but without their current absolute obligation to cure any interference that may be caused to future WCS deployments*.[84] Indeed, they even go so far as to propose that SDARS licensees be permitted to freely relocate any grandfathered repeaters within 3 kilometers of current sites, even if such relocation causes increased interference to WCS consumers.[85] The WCS Coalition's position remains as before: under no circumstances should the Commission grandfather the temporary terrestrial repeaters Sirius and XM have deployed under cover of STAs.[86] Rather, as the WCS Coalition has previously recommended, the Commission should require Sirius and XM to conform their temporary repeaters to the Commission's final

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[84] *See* Sirius Petition at 6 ("In order to preserve the service expectations of current subscribers, however, the rules [proposed in the Sirius Petition] permit grandfathering of existing terrestrial transmitters in both services."); *Notice* at ¶ 33. *See also Initial Sirius STA Order*, 16 FCC Rcd at 16779; *Initial XM STA Order*, 16 FCC Rcd at 16787 (obligating Sirius and XM to cure any interference caused to WCS operations by their terrestrial repeaters). The WCS Coalition is mystified as to why the SDARS licensees now insist on grandfathering all terrestrial repeaters constructed pursuant to STA, when previously then have been willing to consider modifications to at least the most offensive of their temporary facilities. *See, e.g.*, Letter from Mary N. O'Connor, Counsel to Wireless Communications Ass'n Int'l, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Nov. 13, 2003) (reporting on last joint meeting of WCS and SDARS licensees with Commission staff, and including materials jointly prepared and distributed by WCS and SDARS licensees that advised the Commission that "Transition period for making changes" was a topic under consideration during negotiations.).

[85] *See* Sirius Petition at A-2; *Notice* at ¶ 33.

[86] See Notice at ¶ 34.

technical rules no later than one year from the release of the Commission's Report and Order in this proceeding.[87] This transitional period should be more than sufficient to minimize disruption to SDARS consumers while enabling WCS licensees to commence deployment and initiate new advanced wireless services.

This issue, of course, is nothing new – Sirius and XM have long desired to transform their temporary repeaters into permanent facilities without any ongoing obligation to cure interference to WCS,[88] and WCS licensees have vigorously opposed them at every turn.[89] Even a brief review of the facts illustrates that grandfathering the existing XM and Sirius repeater networks would be a grave injustice to WCS licensees.

When the Commission adopted service rules for DARS in 1997 just prior to the WCS auction, it acknowledged that "some satellite DARS applicants intend to implement, as necessary, terrestrial repeaters, or 'gap-fillers', in urban canyons and other areas where it may be difficult to receive DARS signals transmitted by a satellite."[90] The

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[87] *Id.; see also* WCS Compromise Proposal at 13-14.

[88] *See, e.g.,* Sirius Satellite Radio Inc. and XM Radio Inc., Notice of *Ex Parte* Presentation, IB Docket No. 95-91 (filed Aug. 14, 2006).

[89] *See, e.g.*, Letter from Paul J. Sinderbrand, Counsel for the WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 3 (filed Nov. 7, 2006); Letter from Paul J. Sinderbrand, Counsel for the WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 3 (filed Nov. 7, 2006); Petition of BellSouth Mobile Data Inc. and BellSouth Wireless Cable, Inc. to Dismiss or Deny, File No. SAT-STA-20060623-00067 (filed Sept. 18, 2006); Petition of NextWave Broadband Inc. to Deny, File No. SAT-STA-20060623-00067 (filed Sept. 18, 2006) ["NextWave Petition"]; Petition of the WCS Coalition to Deny, File No. SAT-STA-20060623-00067 (filed Sept. 18, 2006); Reply of BellSouth Mobile Data Inc. and BellSouth Wireless Cable, Inc. to Opposition of Sirius Satellite Radio Inc. to Petition to Dismiss or Deny, File No. SAT-STA-20060623-00067 (filed Oct. 16, 2006); Reply of NextWave Broadband Inc. to Opposition to Petition to Deny, File No. SAT-STA-20060623-00067 (filed Oct. 16, 2006); Reply of the WCS Coalition, File No. SAT-STA-20060623-00067 (filed Oct. 16, 2006); Comments of the WCS Coalition, IB Docket No. 95-91, at 14-15 (filed Dec. 14, 2001).

[90] *DARS Order and FNPRM*, 12 FCC Rcd at 5810-12. *See also 1997 Sirius Order*, 13 FCC Rcd at 7988 n.103 ("Terrestrial repeaters may be necessary to implement ('gap-fillers') in urban

Commission, however, concluded that it lacked sufficient information to craft technical rules governing such repeaters and issued a *Further Notice of Proposed Rulemaking* ("*Further DARS Repeater Notice*") soliciting information on a variety of issues associated with the deployment of such "gap fillers."[91]

Two years following the release of the *Further DARS Repeater Notice*, XM and Sirius provided the Commission with the first detailed technical parameters for their contemplated terrestrial repeater systems.[92] This technical information made clear for the first time that they planned to abandon the use of low-powered "gap fillers" for high-power transmitters that would blanket metropolitan areas and, in the process, pose a risk of harmful interference into the WCS bands. Although XM and Sirius would frequently thereafter alter their proposals (usually to the detriment of the WCS community),[93] the

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canyons and other areas where it may be difficult to receive SDARS signals transmitted by a satellite.").

[91] *See DARS Order and FNPRM*, 12 FCC Rcd at 5810.

[92] *See* Supplemental Comments of XM Radio Inc., IB Docket No. 95-91, GEN Docket No. 90-357 (filed Dec. 17, 1999); Supplemental Comments of Sirius Satellite Radio, IB Docket No. 95-91, GEN Docket No. 90-357 (filed Jan. 18, 2000). As WCS licensees have noted, however, much of the precise technical information contained in the initial filings by XM and Sirius has changed over the years, presenting the WCS community and the Commission with a "moving target" that has slowed Commission resolution of the issues. *See, e.g.*, Letter from Douglas I. Brandon, VP External Affairs and Law, AT&T Wireless Services, Inc. *et al.*, to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, RM 8610, DA No. 01-2570, at 2 (filed July 27, 2001) ("[T]he information finally revealed in the STA request is radically different from the most recent prior data provided by XM to the Commission and the WCS licensees at a meeting on January 11, 2001 []. At that time, XM represented that its nationwide network would make use of 150 high-power repeaters and that only three cities would have more than three such repeaters. In stark contrast, its recent STA request encompasses more than five times as many high-power repeaters and 50 cities with more than three such repeaters. Needless to say, these discrepancies have forced the WCS licensees to reexamine some of their analyses of SDARS terrestrial repeater deployment and its potential impact on WCS services. It has also led them to wonder what surprises may be in store when the other SDARS licensee, Sirius Satellite Radio, finally discloses the characteristics of the terrestrial repeater network it has been deploying under its own experimental authorization.").

[93] On January 11, 2001, for example, XM presented a summary hand-out at a meeting of Commission staff with WCS and DARS licensees in which it again confirmed that it would only

Commission immediately recognized that what XM and Sirius were contemplating was at material odds with prior expectations, and thus released a *Public Notice* soliciting comment.[94] In response, WCA (whose membership included a large number of those holding WCS licenses at the time) and a variety of other stakeholders all raised objections, demonstrating beyond doubt that the high power repeaters being proposed would cause harmful interference to WCS operations.[95] In subsequent filings, the WCS

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deploy 150 repeaters with an EIRP over 2 kW. *See* Attachment to Letter from William M. Wiltshire, Counsel to AT&T Wireless Services, Inc., to Thomas Sugrue, Chief, Wireless Telecommunications Bureau, Federal Communications Commission, IB Docket No. 95-91 (dated Aug. 9, 2001). The number of proposed repeaters, however, almost immediately began to increase dramatically. Later in January 2001, Sirius filed proposed rules under which each DARS licensee would be entitled to deploy approximately 577 repeaters nationwide with EIRP over 2 kW. *See* Letter from Carl R. Frank, Counsel to Sirius Satellite Radio, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Jan. 25, 2001). In April of that year, XM proposed a rule that would allow 250 repeaters operating between 10 kW and 40 kW EIRP as of right with the option for additional transmitters conditioned only upon provision of appropriate filters for WCS base stations. *See* Letter from Bruce D. Jacobs, Counsel to XM Radio Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed April 25, 2001). Indeed, in its response to the Commission's public notice offering suggested solutions to the DARS repeater problem (*Public Notice*, "Request for Further Comment on Selected Issues Regarding the Authorization of Satellite Digital Audio Radio Service Terrestrial Repeater Networks," Report No. SB-176 (rel. Nov. 1, 2001)), Sirius argued that it should be allowed to deploy an *unlimited* number of high power repeaters, without regard to the interference into the WCS band, under the guise of offering "solutions" and compromises. *See, e.g.,* Reply Comments of the WCS Coalition, IB Docket No. 95-91, at 21-22 (filed Dec. 21, 2001); Reply Comments of BeamReach Networks, IB Docket No. 95-91, at 3-6 (filed Dec. 21, 2001).

[94] *See* Public Notice, "Satellite Policy Branch Information," IB Docket No. 95-91, GEN Docket No. 90-357 (rel. Jan. 21, 2000).

[95] *See* Comments of BellSouth Corporation, IB Docket No. 95-91, GEN Docket No. 90-357 (filed Feb. 22, 2000); Comments of Wireless Communications Ass'n Int'l, Inc., IB Docket No. 95-91, GEN Docket No. 90-357 (filed Feb. 22, 2000); Reply Comments of Metricom, Inc., IB Docket No. 95-91, GEN Docket No. 90-357 (filed Mar. 8, 2000). WCS licensees continued to press these issues in *ex parte* filings. *See, e.g.,* Letter from Paul J. Sinderbrand, Counsel to Wireless Communications Ass'n Int'l, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 2 (filed Dec. 15, 2000) (the analysis of George W. Harter "concludes that the proposed deployment of numerous high-power terrestrial DARS repeaters poses a substantial threat of interference."); Letter from Karen Gulik, Counsel to AT&T Wireless, to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 1 (filed Feb. 1, 2001) ("Regardless of band emission limits, the brute force overload of such high-power transmissions would dramatically affect the integrity of the WCS licensees' services.

licensee community provided the Commission with extensive analysis of the potential for interference to WCS if DARS terrestrial repeaters are not appropriately regulated.[96]

Not long after disclosing for the first time that they contemplated deployment of high-powered terrestrial repeaters, XM and Sirius revealed that they had constructed extensive networks of such repeaters under experimental authorizations, and sought STAs to place those "experimental" networks into commercial operation. Not surprisingly, the WCS community objected to the grant of these STA applications

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AT&T Wireless, for example has calculated a 1 kilometer exclusion zone surrounding each transmitter where its fixed wireless access equipment would be rendered useless.").

[96] *See, e.g.*, Letter from Karen L. Gulik, Counsel to AT&T Wireless Services, Inc., to Thomas Sugrue, Chief, Wireless Telecommunications Bureau, Federal Communications Commission, IB Docket No. 95-91 (filed Aug. 9, 2001) ("As various WCS licensees have documented in this proceeding, the interference generated by high-power SDARS repeaters will create large exclusion zones within which WCS operators will effectively be precluded from offering their services.") (citation omitted); *accord* Letter from Karen L. Gulik, Counsel to AT&T Wireless Services, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 6 (filed Feb. 20, 2001); Letter from Karen L. Gulik, Counsel to AT&T Wireless Services, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed April 30, 2001); Comments of BellSouth Corporation, File Nos. SAT-STA-20010712-00063, SAT-STA-20010724-00064, at i (filed Aug. 21, 2001) ("operation of SDARS terrestrial repeater networks . . . poses the potential for interference in the WCS spectrum"); Letter from Karen B. Possner, BellSouth Corporation, to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed May 18, 2001); Opposition of WorldCom, Inc., to STA Request, File Nos. SAT-STA-20010712-00063, SAT-STA-20010724-00064, at 1 (filed Aug. 21, 2001) ("the power levels requested by XM and Sirius for their terrestrial repeaters will interfere with WorldCom's operating WCS system in Memphis, Tennessee and planned system in Dallas/Fort Worth, Texas"); Letter from Karen B. Possner, BellSouth Corporation, to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Aug. 28, 2001) (providing additional information on BellSouth's analysis of DARS interference requested by FCC staff); Letter from Paul J. Sinderbrand, Counsel to Wireless Communications Ass'n Int'l, Inc., to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Oct. 2, 2001); Letter from the WCS Coalition, to Magalie Roman Salas, Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Nov. 2, 2001); Comments of the WCS Coalition, IB Docket No. 95-91, RM 8610, DA No. 01-2570 (filed Dec. 14, 2001); Reply Comments of the WCS Coalition, IB Docket No. 95-91, RM 8610, DA No. 01-2570 (filed Dec. 21, 2001); Letter from the WCS Coalition, to William Caton, Acting Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Feb. 4, 2002); Letter from the WCS Coalition, to William Caton, Acting Secretary, Federal Communications Commission, IB Docket No. 95-91 (filed Feb. 19, 2002).

because of, among other things, the potential for interference to WCS operations. Suffice it to say that while the Commission ultimately granted the STA applications, it specifically acknowledged that "there are areas around terrestrial repeaters where [WCS] equipment may be susceptible to blanketing interference,"[97] and mandated that XM and Sirius cure any interference that they may cause in the future to WCS facilities.[98] Yet, XM and Sirius now seek to have the permanent benefit of their high-powered networks, without also accepting the obligation to cure any resulting interference that was the *quid pro quo* for the STA grants in the first place.

XM and Sirius cannot feign surprise that they would be required to comport with the new rules. In granting the STAs, the Commission explicitly warned Sirius and XM that any repeaters built pursuant to special temporary authority might have to be modified to comply with any final rules governing those facilities.[99] The *Notice* puts the matter succinctly: "[T]he [DARS] licensees deployed their repeaters pursuant to grants of special temporary authority that explicitly state that *any actions taken under the STAs are 'solely at [the licensee's] own risk*, and that the grant of the STAs '*shall not prejudice the outcome of any final repeater rules adopted by the Commission*.'"[100] Simply put, Sirius and XM constructed their temporary repeaters at their own peril, knowing full well that the power levels at which they could operate was a matter in controversy. Having

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[97] *Initial Sirius STA Order*, 16 FCC Rcd at 16777; *Initial XM STA Order*, 16 FCC Rcd at 16785.

[98] See Initial Sirius STA Order, 16 FCC Rcd at 16779; Initial XM STA Order, 16 FCC Rcd at 16787.

[99] See Initial Sirius STA Order, 16 FCC Rcd at 16777; Initial XM STA Order, FCC Rcd at 16787.

[100] *Notice* at ¶ 33, *quoting Initial Sirius STA Order*, 16 FCC Rcd at 16779, and *Initial XM STA Order*, 16 FCC Rcd at 16787 (emphasis added) (footnote omitted).

ignored the Commission's clear and unambiguous warning, they cannot be heard to claim financial hardship now that final rules are at hand.[101]

Insisting that XM and Sirius comport with the rules to be adopted in this proceeding would hardly be a departure from precedent. Recently, for example, the Commission issued a waiver to FiberTower, Inc. ("FiberTower") authorizing it to use smaller antennas in the 11 GHz band pending resolution of FiberTower's parallel request for a rulemaking on that issue.[102] As with Sirius and XM, the Commission emphasized that its issuance of the waiver "[did] not prejudge the action the Commission may take on FiberTower's petition for rulemaking."[103] And, as with Sirius and XM, the Commission made it clear that FiberTower assumed the risk of deploying smaller 11 GHz antennas under its waiver "because it will be required to comply with the outcome of the related rulemaking proceeding."[104] Upon its completion of the rulemaking, the Commission required FiberTower to bring any antennas deployed under the waiver into compliance with the Commission's new rules for those facilities.[105]

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[101] *See* SDARS Response to WCS Compromise Proposal at 9 (claiming that WCS Coalition proposal "would force satellite radio licensees to add hundreds of lower-power repeaters, rapidly and at huge expense").

[102] *See FiberTower, Inc.*, Order, 21 FCC Rcd 6386 (WTB 2006).

[103] *Id*. at 6396.

[104] *Id*.

[105] *See Amendment of Part 101 of the Commission's Rules to Modify Antenna Requirements for the 10.7-11.7 GHz Band*, Report and Order, 22 FCC Rcd 17153, 17183 (2007) (emphasis added) ("We will also terminate the waiver granted to FiberTower on the date the rules adopted herein become effective. To the extent FiberTower wishes to be authorized to use smaller antennas in the 11 GHz band after these rules become effective, it shall obtain such authorizations using the rules we adopt today. Any authorizations FiberTower received pursuant to the *FiberTower Waiver Order* shall be grandfathered, and FiberTower may continue to operate such facilities *pursuant to the rules we adopt today*."). *See Service Rules for the 698-746, 747-762 and 777-792 MHz Bands*, Second Report and Order, 22 FCC Rcd 15289, 15460 n.1023 (2007) (giving STA-authorized wideband 700 MHz public safety systems a six month grace period within which to bring their operations into compliance with the Commission's new 700 MHz rules).

Certainly, the potential for significant interference to WCS that would be caused by the high-powered terrestrial repeaters has not abated. To illustrate the implication that grandfathering would have on WCS base station deployment, Attachment F illustrates those areas in New York City, NY and Washington, DC where the WCS C and D block licensees will find their ability to deploy base stations severely constrained by the presence of high-powered SDARS terrestrial repeaters.[106]

Nor has there been any change in circumstances that would justify subjecting WCS licensees to such potential interference. While Sirius and XM argue that permanent authorization of their temporary repeaters (without an obligation to cure interference to WCS) is necessary to avoid additional expense, that is precisely the risk they assumed when they chose to construct those repeaters at power levels above what the WCS community was prepared to accept.[107] Certainly, XM and Sirius cannot be heard to argue that they cannot meet their needs with the power level proposed by the WCS Coalition -- the record reflects that Sirius and XM have deployed scores of repeaters at or below 2

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[106] Overload interference to WCS base stations results from close proximity to a SDARS terrestrial repeater and strong mutual antenna coupling to SDARS repeaters. Attachment F is modeled using performance and configuration values described in Report ITU-R M.2030 titled "Coexistence between IMT-2000 time division duplex and frequency duplex terrestrial radio interface technologies around 2600 MHz operating in adjacent bands and in the same geographic area." The red areas in the resulting plots indicate areas around existing SDARS terrestrial repeaters where WCS base stations operating on the indicated channels could experience performance degradation due to strong SDARS repeater signals. The receiver interference parameters used are those identified in Tables 8 and 13 for a macrocell WCDMA 5 MHz base station. C and D block impairment from Sirius and XM repeaters is modeled with a -40 dBm signal level threshold at the base station antenna, resulting from the 10 MHz adjacent channel selectivity (ACS) value of 58 dB assumed in the Report, a 17dBi Rx antenna at 30 meters, and an additional 40 dB of filtering at the BTS to improve selectivity. The simulation was performed with CelPlan software for 90% coverage probability.

[107] *See* SDARS Response to WCS Compromise Proposal at 9.

kW EIRP throughout the country.[108] In fact, for the past year, Sirius and XM have been filing STA requests for new repeaters at or below 2 kW EIRP, demonstrating that the high-powered repeaters are not technologically necessary.[109] While, Sirius and XM may have to spend more than they would prefer to comport with the new rule there is no policy or technical reason why Sirius and XM should be allowed to continue operating the interfering, high-power repeaters they deployed at their own risk.

Finally, any grandfathering of Sirius/XM's temporary repeaters would create a hodge-podge regulatory framework under which some repeaters would be required to observe the Commission's power limits but others would not, regardless of the interference the latter will inflict on WCS operations. As previously observed by NextWave:

> Such a result would be impossible to administer and would impose unreasonable burdens upon WCS licensees. Deploying services on a hodge-podge, market-by-market basis, under which systems are custom-designed and deployed in response to unique interference phenomena presented by grandfathered SDARS terrestrial repeaters located within each market will preclude equipment standardization, economies of scale in equipment production, and the incremental software and hardware improvements that naturally grow out of standardized architectures. Grandfathering SDARS terrestrial repeaters will lead to piecemeal

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[108] *See, e.g.*, Letter from AT&T Wireless Services, Inc. *et al.*, IB Docket No. 95-91, at 3 (filed Feb. 4, 2002) ("In Greenville, South Carolina, XM has a total of 13 terrestrial repeaters, none of which operates at a power level greater than 1.43 kW EIRP"); Letter from Paul J. Sinderbrand, Counsel for the WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91, at 4 (filed Dec. 13, 2006) ("Given that XM has blanket authority to construct and operate repeaters operating at no more than 2,000 Watts peak EIRP, it is evident that XM lawfully can provide service to all of the areas it illegally served. This is readily demonstrated by reference to the Providence market, where XM is providing service through a single repeater constructed at an unauthorized location.").

[109] Sirius has applied for 54 new repeaters at or below 2 kW EIRP since November 11, 2006 (File No.s 20061107-00131, 20061207-00145, 20070719-00104, 20070828-00135, 20071213-00174). XM has applied for 6 new repeaters at or below 2 kW EIRP since March 30, 2007 (File No.s 20070330-00059, 20070628-00091, 2001105-00140, 20071115-00160, and 20071220-00179).

> deployment of non-standardized systems that would start the WCS service on an unstable footing that may not be sustainable over the long haul.[110]

In sum, Sirius and XM knew full well the risks they assumed when they deployed high-power terrestrial repeaters under their STAs, notwithstanding the well-documented objections of WCS licensees. Having accepted those risks, Sirius and XM should not be afforded grandfathering rights that effectively permit them to evade the regulatory obligations upon which their STAs were conditioned in the first place. Fundamental considerations of fairness and regulatory certainty mandate that the Commission require Sirius and XM conform their temporary repeaters to the Commission's final rules within the one-year grace period recommended by the WCS Coalition.

[110] NextWave Petition at 14.

III. CONCLUSION

Once again, the WCS Coalition applauds the Commission for releasing the *Notice* and moving closer to the day where WCS and SDARS will be able to both co-exist and provide their own set of valuable services to the public. Adoption of the proposed rules set forth in the WCS Compromise Proposal, with the minor modifications discussed above, will assure that WCS licensees can provide advanced wireless services, including WiMAX mobile services, without undue interference to or from SDARS. As such, the public interest will be better served by adoption of the WCS Coalition's proposals than adoption of the one-sided rules being advanced by the SDARS licensees.

THE WCS COALITION.

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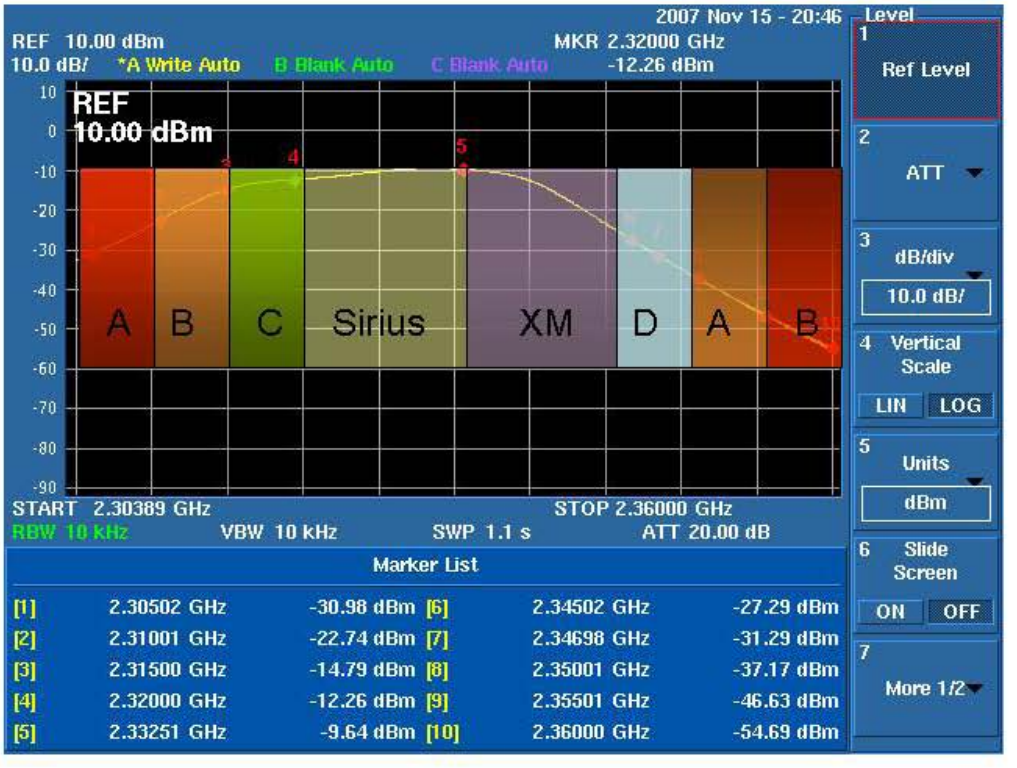
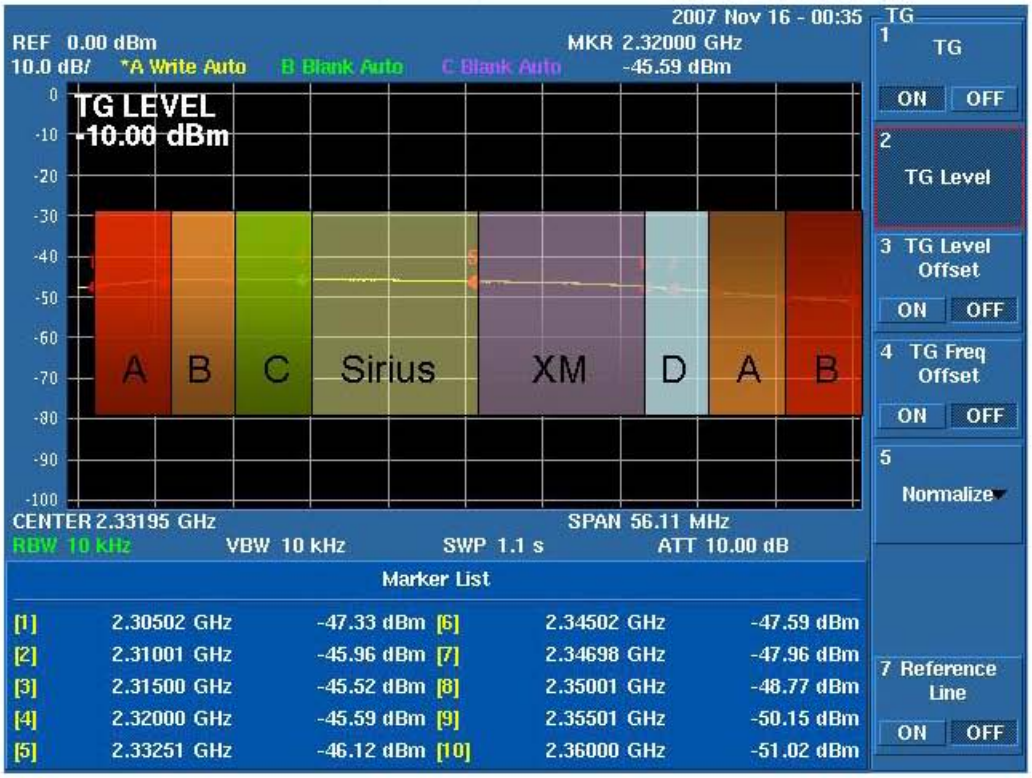
February 14, 2008

ATTACHMENT A

Measured Frequency Response Sirius Antenna #8772



Measured Frequency Response Standard XM Delphi



ATTACHMENT B

Interference to SDARS Receivers from WCS Subscriber Transmitters

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1 Executive summary

In this paper, the variable nature of the transmit power of a WCS mobile unit in a WiMAX deployment is analyzed to determine the interference impact to an SDARS receiver operating in the adjacent frequency band. The statistical nature of the transmit power of a mobile unit in a cellular network is an important, but frequently overlooked, factor in any interference analysis. "Worst case," static phenomena, such as the maximum allowable transmit power of the mobile, are typically considered in a computational analysis. Under real-world deployment conditions, however, the mobile transmit power varies dynamically over time and location, which has a direct impact on its interference potential to victim receivers.

For a cellular technology, such as WiMAX, a mobile station's transmit power level is a function of multiple algorithms and parameters, primarily designed to ensure that a mobile transmits at the lowest possible level to minimize intra-system interference and maximize battery life. In addition, a mobile station in a TDD system transmits only during the uplink portion of a frame and only when it has packets to transmit. The length of these packets (bursts) is a function of the application model (traffic pattern), which is commonly biased towards the downlink. The result of these factors is that the mobile in a typical WiMAX deployment is almost always operating at power levels well below its allowable maximum.

The path loss between a WCS mobile transmitter and an SDARS receiver is another important consideration in this type of interference analysis. First, both transmitter and receiver may be moving and, as such, the distance between them changes with time. Second, line-of-sight between the stations may or may not exist. Both of these phenomenon have a direct, but difficult to quantify, impact on the interference potential between the stations.

As described in greater detail in this paper, the inter-relationship of the algorithms affecting WCS mobile transmitter behavior, along with the variability of the location and speed of the mobile transmitter and the SDARS receiver, makes it impractical to evaluate this problem analytically. For this reason, simulations have been conducted that endeavor to account for the random nature of these parameters and provide a realistic picture of the interference potential.

The results of these simulations demonstrate that when the actual dynamics of WCS and SDARS operations are considered, the probability of WCS interference to SDARS is inconsequential. Specifically:

- 99% of the time, a WCS mobile transmits 3 dB below its allowable maximum, which has a significant impact on its interference potential to an adjacent band SDARS receiver.

- 99% of the time, the adjacent channel power originating from a typical WCS mobile is below -44 dBm at the SDARS receiver (the level at which an SDARS receiver would be blocked from receiving service).

- 94% of the time, the out-of-band emissions from a WCS device operating with a 55+10log(P) emissions mask in the SDARS band will have less than a 1 dB impact on the SDARS receiver noise floor.

2 Introduction

The purpose of this paper is to quantify the impact of interference caused by a WCS subscriber unit to an SDARS receiver operating in adjacent frequency bands. The analysis focuses on the statistical nature of the transmit power of a WCS subscriber unit operating under real-world conditions, as opposed to considering only the unit's maximum transmit power. The transmit power level of a subscriber unit in a cellular network is a function of multiple parameters; including link quality and application traffic pattern.

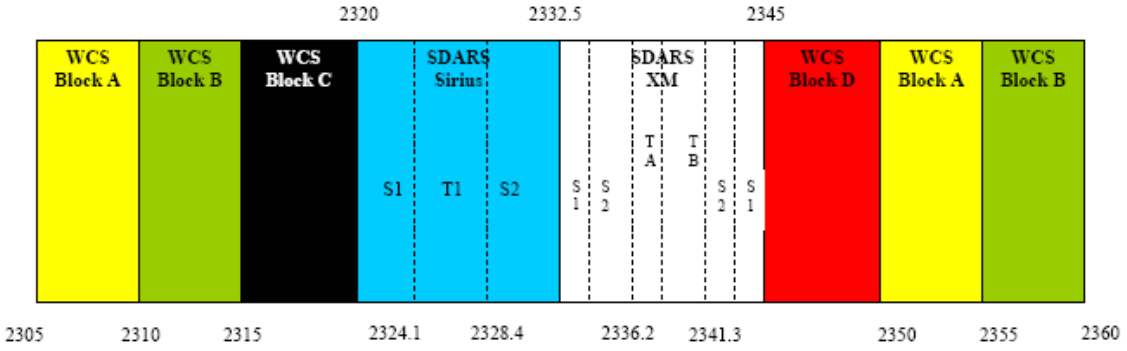
The analysis takes into account these factors in order to better characterize WCS transmit power variability over time. Once the transmit power statistics are known, a path loss model is applied to measure the received power at the SDARS receiver.

SDARS and WCS are authorized by Federal Communication Commission (FCC) to operate in adjacent frequency bands as shown in Table 1 and Figure 1 below.

Table 1: WCS and SDARS frequency bands

Service	Frequency (MHz)
WCS A Lower	2305 to 2310
WCS B Lower	2310 to 2315
WCS C	2315 to 2320
SDARS Sirius	2320 to 2332.5
SDARS XM	2332.5 to 2345
WCS D	2345 to 2350
WCS A Upper	2350 to 2355
WCS B Upper	2355 to 2360

Figure 1: WCS and SDARS spectrum



3 Adjacent Channel Coexistence Considerations

Adjacent channel interference occurs due to both transmitter imperfections (transmitter mask) and receiver imperfections (non-ideal receiver filter). Analysis of adjacent channel interference requires three terms to be defined: one for simulation use, one for transmitter performance requirements and one for receiver performance requirements. Each term can be defined for any frequency offset. Thus "Adjacent Channel" may refer to not only the channel closest to the baseline channel, but also the 2nd adjacent channel, etc.

Adjacent Channel Interference Ratio (ACIR) is the parameter that is determined in order to ensure the proper operation of both systems in adjacent bands. ACIR is expressed as the ratio of the total transmitted power to the interference power affecting the receiver. For the purpose of this paper, ACIR is the ratio of the total power transmitted from a source (WCS mobile) to the total interference power affecting a victim receiver (SDARS receiver), resulting from both transmitter and receiver imperfections.

ACIR is a function of Adjacent Channel Leakage Ratio (ACLR) and Adjacent Channel Selectivity (ACS)[1]. ACS is a function of the selectivity of the victim station's receiver, whereas ACLR is a function of the interfering station's transmitter. The relationship between ACIR, ACLR and ACS is as follows:

$$ACIR = [1/(1/ACLR + 1/ACS)]$$

This formula is similar to the formula for two resistors in parallel. The two interference modes of ACLR and ACS therefore can be thought of in terms of two parallel resistors. That is, if you have a 100 kohm resistor in parallel with a 10-megohm resistor, the total resistance of 99.0 kohms is mostly a function of the 100 kohm resistor and less a function of the 10-megohm resistor. But, if you have two 100 kohm resistors in parallel, both resistors contribute equally to the aggregate resistance of 50 kohms.

Similarly, the aggregate interference from adjacent channel operations (ACIR) is a function both of the selectivity of the victim receiver and the out-of-band energy emitted by the interfering transmitter. That is, ACS enables a receiver to reject undesired out-of-band or out-of-channel signals, but is of no help if the interfering transmitter radiates spurious energy that falls in the pass band (i.e., channel) of the victim station. Requiring an adjacent band transmitter to meet a high ACLR is wasted if the victim receiver has a poor ACS. Again using the example of parallel resistors, both the ACLR and ACS need to act like co-equal "100 kohm" resistors, not one a 100 kohm resistor and the other a 10 megohm resistor, if the two systems are to co-exist effectively.

In the case of WCS interference to SDARS, ACS or the rejection ratio of the filter at the SDARS receiver directly relates to the overload level that would cause impairment to the SDARS device. Similarly, ACLR is a measure of the out–of-band emissions from a WCS device that falls into

[1] ACIR, ACLR and ACS are terms used in the report issued by the International Telecommunications Union (ITU): ITU 8F/587 ("Coexistence Between IMT-2000 TDD and FCC Radio Interface Technologies Operating in Adjacent Bands and in the Same Geographical Area").

the pass band of the SDARS receiver. In order to facilitate coexistence between the two services, the ACLR of a WCS transmitter should be a reasonable match to the ACS of an SDARS receiver. However, there are practical limitations on the amount of filtering that can be implemented in a handheld WCS device, given size, weight, and cost constraints. Therefore, a reasonable ACLR requirement for both WCS and SDARS depends on: 1) WCS mobile EIRP, 2) the SDARS receiver noise floor, 3) the assumed gain of the received antenna, and 4) the minimum distance between and the relative positions of the transmitter and receiver.

4 WCS and SDARS Metrics

In this section the SDARS receiver overload and WCS out-of-band emissions metrics that will be applied in the simulation analysis are established.

Adjacent channel selectivity or receiver overload is governed by a number of factors, including the amount of front end filtering available at the receiver, the performance of the automatic gain control of the amplifier, and the front end low noise amplifier performance. As such, it is difficult to derive analytically. In most cases, the ACS for a receiver is a measured value.

For the purpose of the simulations described herein, empirical data documented in the Sirius white paper entitled, "Interference to the SDARS Service from WCS Transmitters"[2] and summarized in Table 2 below will be applied. Sirius later concluded from data that "where the level of interference exceeded -44 dBm, both satellite channels likely would be blocked, preventing satellite service to satellite DARS subscribers."[3] For this reason, a level of -44 dBm was selected as the receiver overload metric in the simulations and analysis.

Table 2: Measured overload interference powers

Onset of muting	WCS C-Block (dBm)	XM Terrestrial (dBm)	WCS D-Block (dBm)
Sirius TDM1 satellite band	-57.0	-29.7	-24.5
Sirius TDM2 satellite band	-42.9	-36.9	-24.8

As Adjacent Channel Leakage Ratio or out-of-band emissions of the WCS device is effectively a measurement of the conducted noise power, this metric can be derived analytically.

The WCS Coalition has proposed a 55+10log(P) mobile emissions mask at the edge of WCS band.[4] While additional attenuation of out-of-band emissions is also specified in the WCS

[2] *See* Letter from Carl R. Frank, Counsel to Sirius Satellite Radio Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91, WT Docket No. 03-264, File No. 0002240823, DA 05-1662, WT Docket No. 05-256, Attachment, "White Paper: Interference to the SDARS Service from WCS Transmitters," at 14 (filed Mar. 29, 2006) ["Sirius White Paper"].
[3] Petition of Sirius Satellite Radio Inc. for Rulemaking, and Comments, IB Docket No. 95-91 at 5 (filed Oct. 17, 2006).
[4] Letter from Paul J. Sinderbrand, Counsel to WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91 at 9 (filed July 9, 2007).

Coalition's proposed rules, for simplicity it is assumed in this analysis that the WCS device emissions are a uniform -25 dBm/MHz across the entire SDARS band.

Using the WCS Coalition's proposed mobile emissions mask, the out-of-band-emission impact at the SDARS receiver is computed below. Table 3 demonstrates that an out-of-band emissions level of -116 dB/MHz will raise the SDARS receiver noise floor by 1dB. Below this level, the out-of-band emissions appear not to cause impairment to the SDARS receiver.

Table 3: WCS OOBE level that raises the SDARS receiver noise floor by 1dB

	Value	Unit
WCS emissions mask	55 + 10log(P)	
Resulting OOBE noise power	- 25	dBm/MHz
Thermal noise	- 114	dBm/MHz
SDARS receiver noise figure[5]	3	dB
1 dB noise rise impact (delta)[6]	- 6	dB
Maximum noise level contribution from WCS OOBE before impairment	-117	dBm/MHz

To analyze the impact of WCS out-of-band-emission on SDARS receivers, the emission mask of 55 + 10log(P) is applied to the WCS transmitter. Furthermore, when operating at the maximum transmit power level (e.g., +24 dBm EIRP), the WCS device power amplifier operates close to its compression point and in its non-linear region. In the non-linear region, for every 1 dB reduction in fundamental output signal level, out-of-band emissions are reduced by 2 to 3 dB.[7] When the output power is reduced further, the amplifier operates in its linear region and the out-of-band emissions are reduced 1 dB for each 1 dB reduction in output fundamental signal power.

[5] *See* Sirius White Paper at 17. The Sirius claim that "the common Sirius SDARS receiver's noise floor for its satellite signals of about -111 dBm" is ambiguous. The interpretation used here is that the noise floor is -111 dBm/MHz resulting in a receiver noise figure of 3 dB.
[6] In Paragraph 29 of the Amendment of the Communications Rules to Establish Part 27, the Wireless Communications Service, Memorandum Opinion and Order, 12 FCC Rcd 3977, 3992 (1997) the Commission uses a 1 dB allowable noise floor rise in its calculations.
[7] In Appendix C, it is shown theoretically that for each 1 dB reduction in fundamental signal, out-of-band emissions are decreased by 3 dB. In practice, this figure is somewhere between 1 dB and 3 dB.

5 Path loss model

To assess the impact area of a WCS subscriber transmitter in the simulations, an empirical propagation path loss model was applied.

Due to the interaction of the RF signal with nearby clutter, propagation loss between a WCS device and an SDARS receiver decays more rapidly than it would in free space, even when the propagation path is unobstructed.

The path loss model used in the analysis is derived from measurements performed in the 2.3 GHz band. For these measurements, the path loss between the simulated WCS transmitter and SDARS receiver was measured under unobstructed (line-of-sight) conditions. To determine the path loss equation, a minimum mean square error (MMSE) curve was fit to the data.

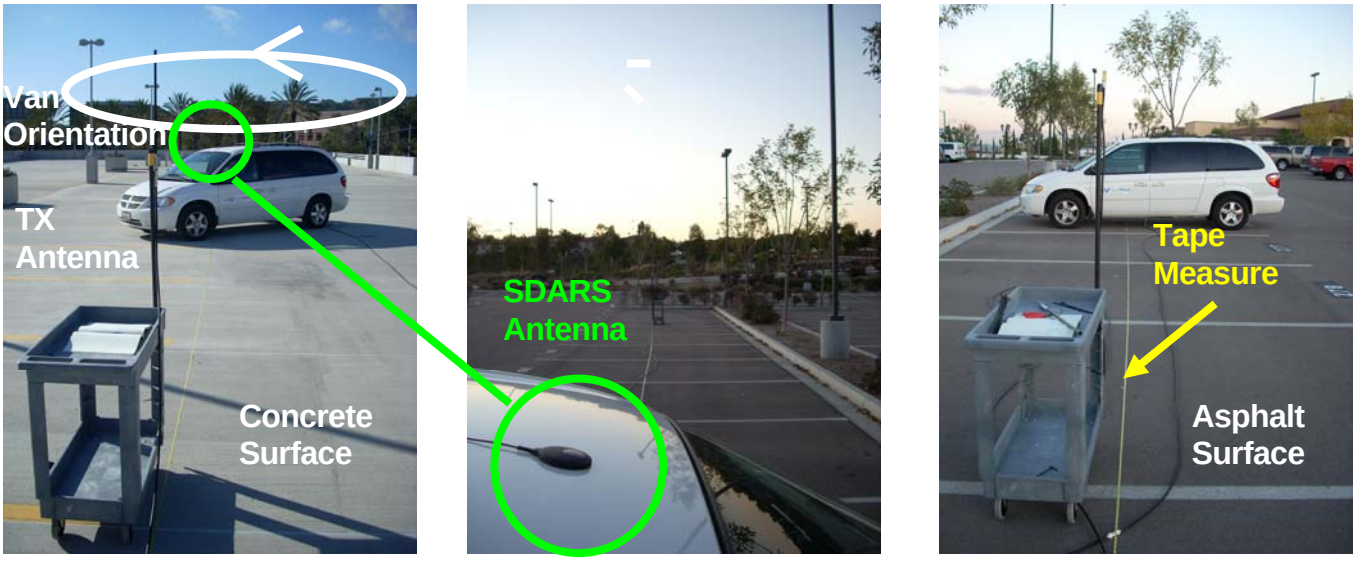
The measurements and analysis show that the path loss can be expressed by:

$$path\,loss(dB) = 52 + 22\log(D)$$

where D is the distance in meters.

For this test, a standard Sirius magnetic mount antenna was placed on the rooftop of the test vehicle, centered, and positioned a few inches rearward from the windshield as depicted in Figure 2 below to mimic a typical OEM or consumer installation and avoid shadowing from roof racks or other obstructions.

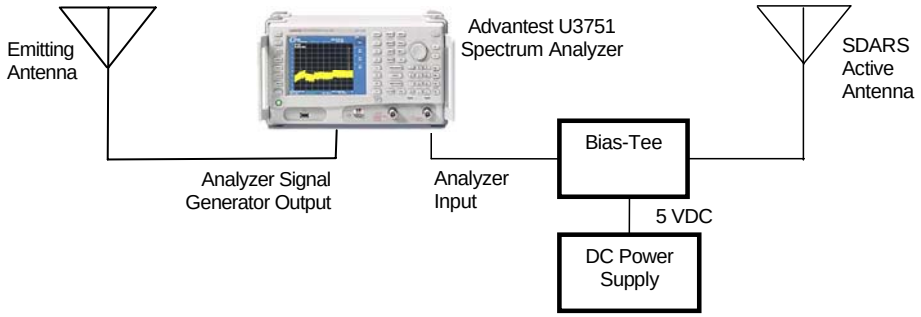
Figure 2: Pictures of the test vehicle



A CW signal in WCS C-Block (2315-2320 MHz) band was generated. The effective radiated power level was -2.4 dBm.

The transmitter and receiver configurations are shown in Figure 3 below. 120 feet of LMR-400 coaxial cable was used to allow repositioning of the transmitting antenna to test locations outside the vehicle. The WCS transmitting antenna was mounted 6 feet above the ground to a plastic pole on a rolling plastic cart, however, it was stationary when operational. The test was performed on two surfaces, concrete and asphalt. The tests were conducted with the WCS transmitting antenna oriented at 0, 45 and 90 degrees relative to the vehicle with 0 degrees corresponding to the front of the vehicle, 90 degrees corresponding to the side of the vehicle, and 45 degrees corresponding to an angle between these two positions (outward from the front quarter-panel).

Figure 3: Test Transmitter and Receiver Configuration



The receive power at the SDARS receiver was measured per the configuration shown in Figure 3. The Sirius antenna was energized at 5 VDC using a bias-tee. The gain of this antenna is known to be essentially flat from 2305 MHz through 2332 MHz.

At each test location, the received channel signal power and distance between the WCS transmitter and SDARS receiver was recorded. The distance and power measurements were used to compute the propagation path loss between the transmitter and receiver.

Table 4 below shows the received power measurement results, corrected by subtracting the measured 27 dB of SDARS active antenna gain (LNA gain minus cable loss).

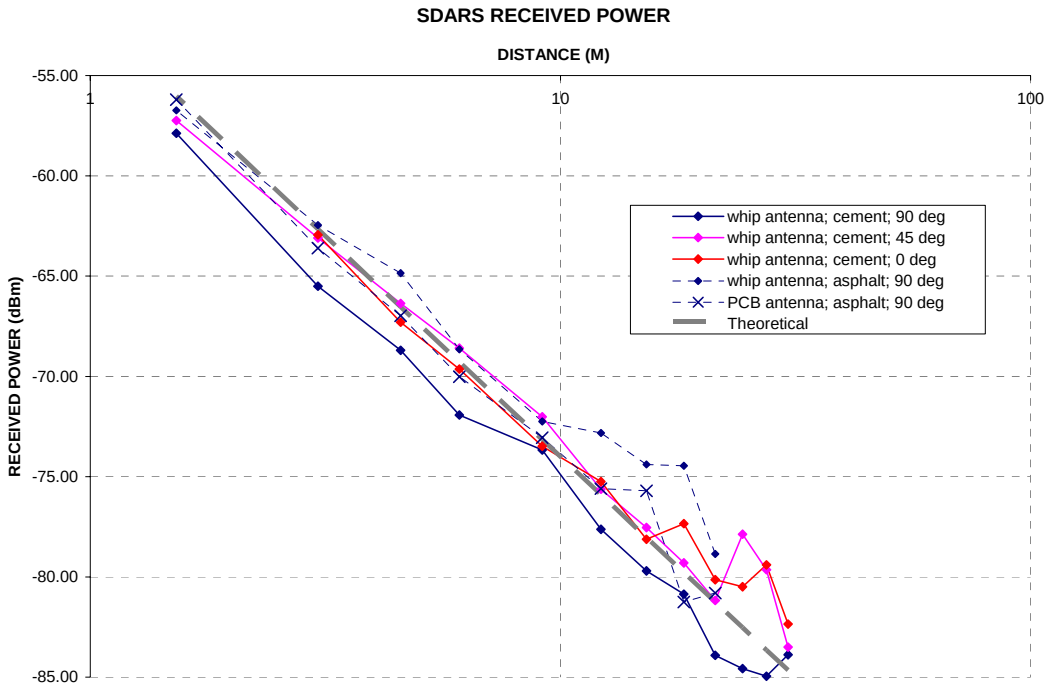
Table 4: Interference power at SDARS receiver from WCS transmitter

Corrected SDARS Antenna Received Power in dBm

	Whip Antenna				PCB Ant.
	Cement			Asphalt	
Distance in Feet	Van Orientation in Degrees				
	90	45	0	90	90
100	-83.88	-83.50	-82.35		
90	-84.95	-79.64	-79.40		
80	-84.57	-77.87	-80.49		
70	-83.91	-81.17	-80.14	-78.85	-80.80
60	-80.86	-79.30	-77.34	-74.46	-81.25
50	-79.70	-77.54	-78.12	-74.39	-75.70
40	-77.62	-75.63	-75.25	-72.82	-75.60
30	-73.67	-72.01	-73.48	-72.25	-73.05
20	-71.92	-68.59	-69.63	-68.65	-70.01
15	-68.70	-66.36	-67.30	-64.85	-66.97
10	-65.50	-63.10	-62.94	-62.45	-63.60
5	-57.87	-57.24	NA	-56.73	-56.20

MMSE calculations were performed for a range of values of parameters A and B in the path loss formula, *Path Loss = A + B*log(D)*. The results of A = 53 and B = 22 were those that corresponded to the minimum MMSE value. Figure 4 below provides a visual confirmation that the 52 + 22*log10(D) (shown as the grey line labeled as "theoretical" in the legend) relationship fits the measured data.

Figure 4: Path loss measured data and the MMSE curve fit



6 WiMAX Mobile Transmit Algorithms

The ACIR requirement for WCS and SDARS coexistence scenarios is a function of the mobile transmit power statistics. In a cellular system, maximum transmit power of a subscriber unit is not representative of its statistical nature operating under "real-world" conditions. Hence, it cannot predict the impact the transmit power of the mobile in any practical coexistence scenario.

In a cellular system, the quality of the wireless link from the base station to the mobile and vice versa are affected by many parameters including:

- Distance from the serving base station
- Antenna direction
- Shadowing
- Fast fading

For these reasons, mobile transmit power control is considered a crucial algorithm in many cellular technologies, such as WiMAX. It ensures that mobiles with advantageous locations do not transmit more power than needed, which minimizes intra-system interference and maximizes battery life.

"Link adaptation" is another important algorithm that deals with the temporal changes of the link quality in a mobile. This algorithm determines the modulation/coding scheme (MCS) level of the mobile. Mobile transmit power control and link adaptation jointly, in effect, control the mobile transmit power level. Furthermore, they also ensure that the mobiles in locations that could cause much interference to the neighboring cells are transmitting at lower levels.

In addition to transmit power control and link adaptation, the overall statistics of mobile station transmit power are also influenced by the scheduling or allocation of radio resources, also known as the multiuser diversity, and the application level model, which defined the periodicity and data throughput rate for individual users.

The intricacy of the interaction between different algorithms; multiple stochastic processes, such as fast fading and traffic patterns; and multiple random factors such as user location, geometry, and data application makes it impractical to compute the potential interference impact of mobile transmitters on SDARS receivers. Simulations that account for these critical variables were therefore conducted to better predict interference potential.

7 WCS-SDARS Coexistence Simulation

This section outlines the simulation set-up. Assumptions and parameters are described in detail in Appendix A.

A 7-cell topology hexagonal cell, surrounded by 6 other cells, is assumed and shown in Figure 5 below.

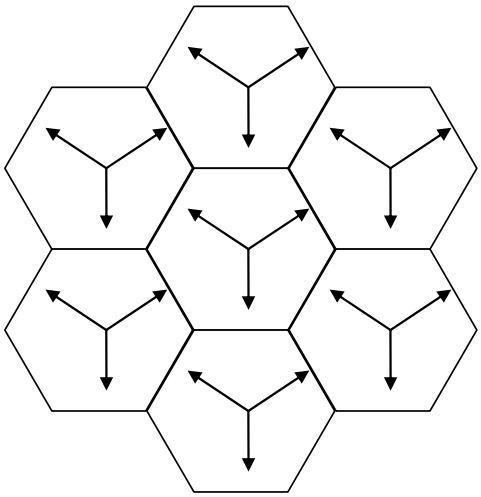


Figure 5: 7-cell Topology

The cells can be rotated by 30 degrees clockwise without any loss of generality. The antenna pattern is described in Appendix A.

A number of users (e.g. 10 users) are randomly positioned over the coverage area of the three central sectors (e.g. Sector 0). As described in previous sections, in a practical system the scheduler attempts to schedule the users with good links. This accounts for multi-user gain in cellular systems. However, for purposes of this simulation all users have been scheduled during each frame regardless of their link quality. This causes users with poor link quality to be scheduled and potentially transmit at higher power levels than would normally occur. Therefore, these simulation results present a worst case scenario as far as multi-user multiplexing is concerned.

For each user in Sector 0, one interfering user is located in each neighboring sector in a completely random location. It is assumed all users interfere with each other as well as with the corresponding user in Sector 0.

Link adaptation is performed for each mobile including the interfering mobiles. Note that the maximum power for 16QAM modulation is assumed to be +21 dBm and +24 dBm for QPSK.

Transmit power of all mobiles is controlled on a frame-by-frame basis by applying mobile transmit power control.

For simulating the interference signal levels, SDARS receivers are randomly positioned in the coverage area of Sector 0.[8] The distance between WCS mobiles and SDARS receivers is calculated. Based on the distance, the path loss and the received power levels are estimated.

In WiMAX, subchannels form the minimum frequency resource unit allocated by the base station for both downlink and uplink transmissions and so different subchannels may be allocated to different users as a multiple access mechanism. WiMAX defines several subchannelization permutations where subchannels are a collection of orthogonal frequency division multiplexed subcarriers (e.g., OFDM tones).[9] The simulation results below are based on the partial use of subchannel (PUSC) permutation. Results for both PUSC-1/3 and PUSC-1 permutations are provided. A PUSC-1/3 permutation corresponds to an N=3 frequency reuse pattern as only one third of the available subchannels are allocated per sector. A PUSC-1 permutation corresponds to an N=1 frequency reuse pattern as all of the available subchannels (i.e., OFDM tones) are allocated to every sector. The subchannelzation scheme is a consideration as a WiMAX network deployed with PUSC-1 is anticipated to result in a higher average mobile transmit power level. Given the effective frequency reuse of N=1, mobile stations need to overcome additional noise rise generated by users transmitting in other sectors and cells on the same subcarriers.

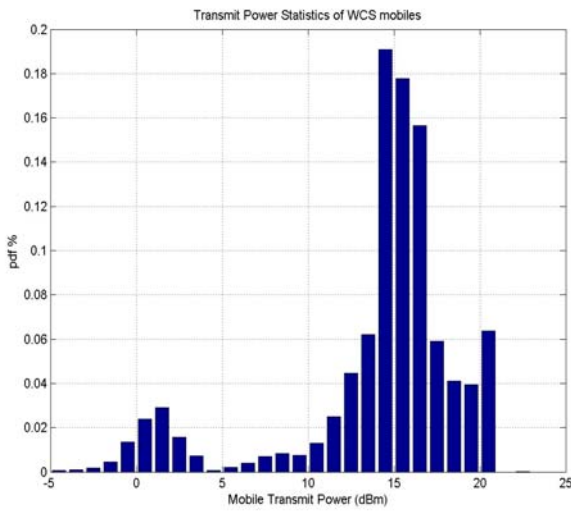
Simulations were performed on a frame-by-frame basis. To generate mobile transmit power statistics, simulations were conducted over thousands of radio frame transmissions to ensure reliable results. For each simulated WiMAX radio frame, the transmit power for each mobile was computed based on its location in the cell, the radio link quality in terms of slow and fast fading, the system noise rise due to other user transmissions, the modulation and coding scheme assigned to the mobile, and the transmit power control.

[8] For example, the results provided in Figure 7 are based on the random placement of 30 SDARS receivers. Simulations were performed with higher concentrations of SDARS receivers, e.g., 40, but did not result in any noticeable change in the interference probabilities.
[9] *See* "IEEE Standard for Local and Metropolitan Area Networks, Part 16: Air Interface for Fixed Broadband Wireless Access Systems," IEEE P802.16e-2005, February 2006.

7.1 Permutation PUSC, Frequency Reuse 3, 7-Cell, Cell Distance = 1600m

7.1.1 Simulation Results for WCS Mobile Transmit Power

WCS Transmit Power pdf **WCS Transmit Power CDF**



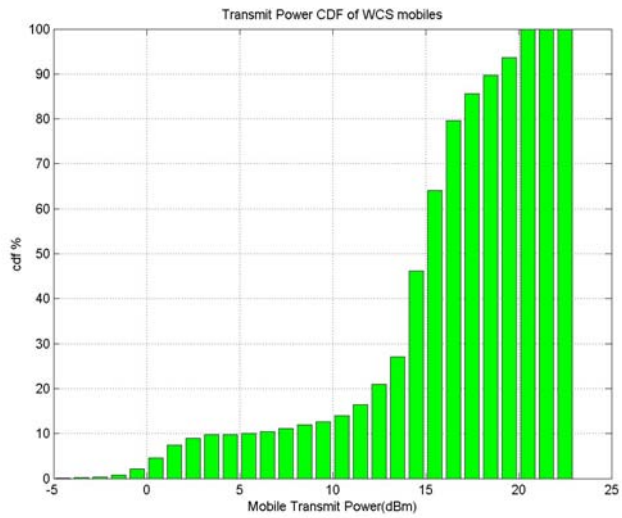


Figure 6: pdf and CDF of the mobile transmit power; PUSC frequency reuse 3

Transmit power values were collected for each mobile and during each and every simulated frame. The probability density function (pdf) and CDF of the mobile transmit power values were analyzed. The CDF 68, 95 and 99% (1-sigma, 2-sigma, and 3-sigma) points are listed in Table 5 below. As shown, 99% of the time the mobile is transmitting below +20.3 dBm, which almost 4 dB below its maximum allowable power.

Table 5: Transmit power CDF results

Permutation	68% CDF point (dBm)	95% CDF point (dBm)	99% CDF point (dBm)
PUSC	15.5	19.7	20.3

7.1.2 Simulation Results for Power Incident at SDARS Receiver

Once the mobile transmit power is estimated for the duration of each frame, the distance of the WCS mobile to the closest SDARS receiver is calculated and the path loss formula is applied in order to find the received power at the SDARS receiver. Pdf and CDF of the interference power level to SDARS receivers are depicted in Figure 7 below.

Received Power at SDARS (pdf) **Received Power at SDARS (CDF)**

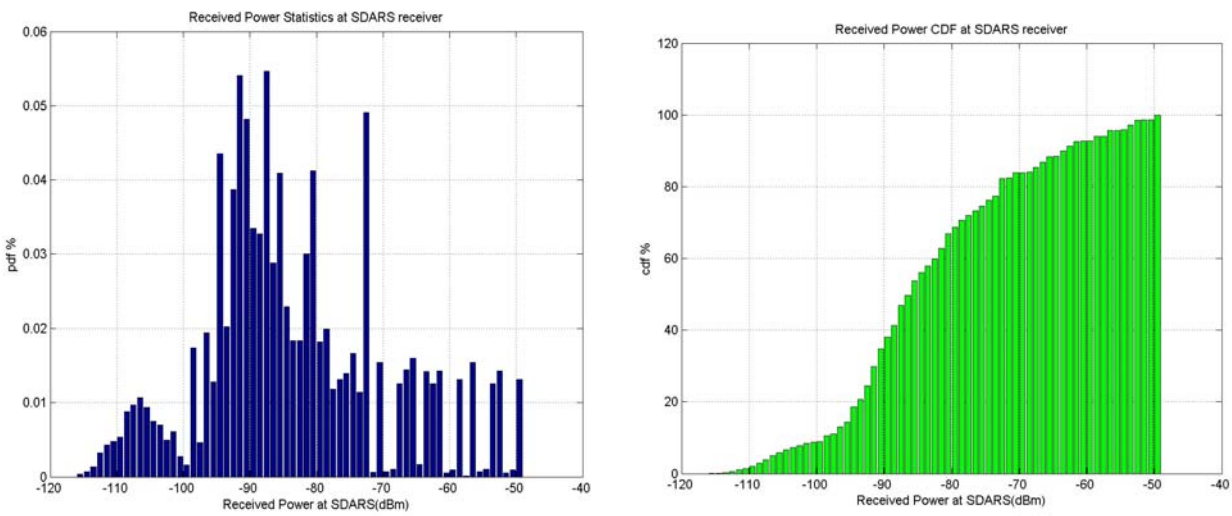


Figure 7: pdf and CDF of the received power at SDARS receiver; PUSC frequency reuse 3

As shown below in Table 6, 99% of the time the received power level is below the -44 dBm overload threshold identified by Sirius (see Table 3 above).

Table 6: Received power CDF results

Permutation	68% CDF point (dBm)	95% CDF point (dBm)	99% CDF point (dBm)
PUSC	-80.0	-56.6	-50.2

In the following section, the statistical property of the interfering signal at the receiver for PUSC frequency reuse of N=1 is examined.

Using the 55+10log(P) emission mask for the transmitter of the WCS device, the statistics of the out-of-band emission levels incident at the SDARS receiver can be determined. The results are captured in Table 7. The relationship of out-of-band emissions to in-band fundamental signal power is assumed to be a 2 dB out-of-band emission reduction for every 1 dB reduction of the in-band signal power for first 5 dB reduction (+24 dBm to +19 dBm transmit levels), and a 1 dB out-of-band emission reduction for each dB reduction for transmit powers less than +19 dBm.

Table 7: Received OOBE CDF results (OOBE analysis)

Permutation	**68% CDF point (dBm/MHz)**	**95% CDF point (dBm/MHz)**	**99% CDF point (dBm/MHz)**
PUSC N=1 frequency reuse	-143.5	-119.2	-111.2

We can interpolate between the 95% and 99% point on the CDF to show that 96% of the time the out-of-band emission level is below the computed -117 dBm/MHz level that would raise the SDARS receiver noise floor by 1 dB approximately (see Table 3 above).

7.2 Permutation PUSC, Frequency Reuse 1, 7-Cell, Cell Distance = 1600m

7.2.1 Simulation Results for WCS Mobile Transmit Power

WCS Transmit Power pdf

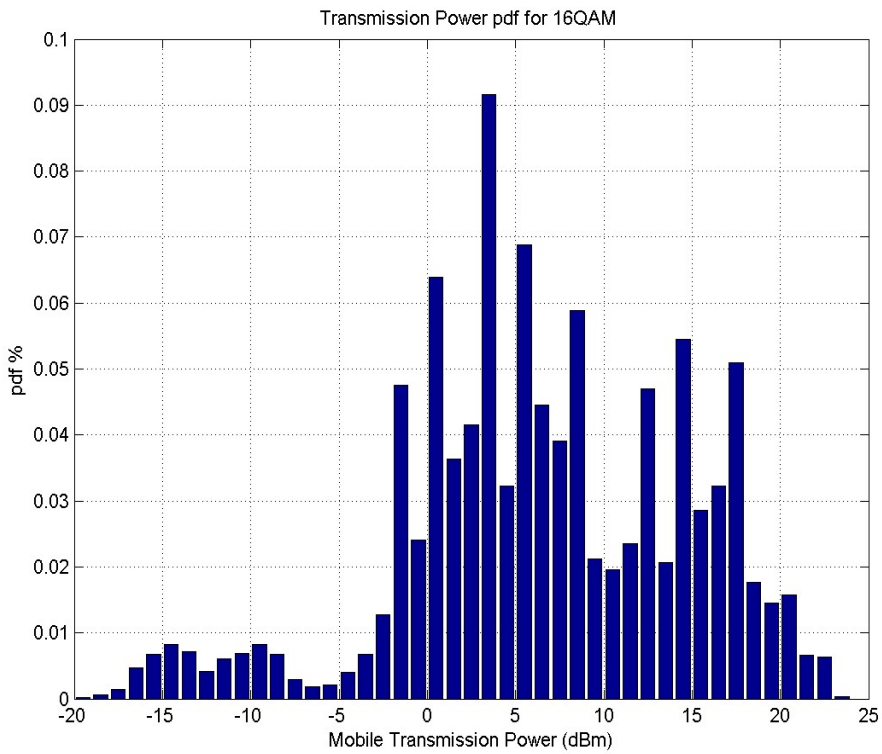


Figure 8: pdf of the mobile transmit power; PUSC frequency reuse 1

The CDF 68, 95 and 99% points are listed in Table 8 below. As shown, 99% of the time the mobile is transmitting below +20.3 dBm.

Table 8: Transmit power CDF results

Permutation	68% CDF point (dB)	95% CDF point (dB)	99% CDF point (dB)
PUSC N=1 frequency reuse	16.6	20.3	22.0

The results illustrate that for the PUSC-1 permutation the mobile is generally transmitting at slightly higher power levels as compared with the PUSC-1/3 permutation. As described previously, this is a direct result of the N=1 reuse of the available subcarriers.

7.2.2 Simulation Results for Power Incident at SDARS receiver

In these simulations, once the mobile transmit power is simulated, the distance to the closest SDARS receiver is calculated and the path loss formula is applied to determine the received power.

Received Power at SDARS (pdf) **Received Power at SDARS (CDF)**

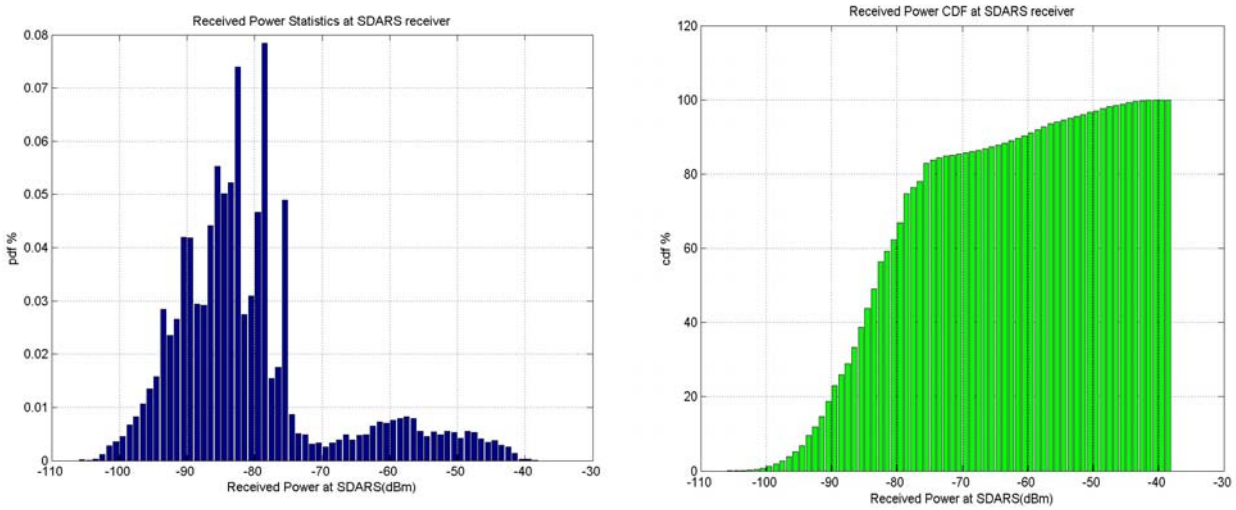


Figure 9: pdf and CDF of the received power at SDARS receiver; PUSC frequency reuse 1

Table 9: Received power CDF results (overload analysis)

Permutation	68% CDF point (dBm)	95% CDF point (dBm)	99% CDF point (dBm)
PUSC N=1 frequency reuse	-79.5	-53.6	-45.2

Using the 55+10log(P) emission mask for the transmitter of the WCS device, the statistics of the out-of-band emission levels incident at the SDARS receiver can be determined. The relationship of out-of-band emissions to in-band fundamental signal power is assumed to be a 2 dB out-of-band emission reduction for every 1 dB reduction of the in-band signal power for first 5 dB reduction (+24 dBm to +19 dBm transmit levels), and a 1 dB out-of-band emission reduction for each dB reduction for transmit powers less than +19 dBm.

Table 10: Received OOBE CDF results (OOBE analysis)

Permutation	68% CDF point (dBm/MHz)	95% CDF point (dBm/MHz)	99% CDF point (dBm/MHz)
PUSC N=1 frequency reuse	-142.5	-116.2	-106.2

We can interpolate from the CDF to show that 94% of the time the out-of-band emission level is below the computed -117 dBm/MHz level that would raise the SDARS receiver noise floor by 1 dB (see Table 3 above).

8 Summary

The results presented in this paper demonstrate a low probability of interference to an SDARS receiver when the statistical performance of a typical WCS mobile is considered. Under the "real-world" conditions of an operational cellular network, the mobile transmit power level varies dynamically over time and location, which has a direct impact on its interference potential to victim receivers.

The simulations demonstrate that when the actual dynamics of WCS and SDARS network operations are considered, the probability of WCS induced interference to SDARS is inconsequential. Specifically:

- ***99% of the time, a WCS mobile is transmitting 3 dB below its allowable maximum***, which has a significant impact on its interference potential to an adjacent band SDARS receiver.

- ***99% of the time the adjacent channel power*** originating from a typical WCS mobile ***is below -44 dBm at the SDARS receiver*** (the level at which an SDARS receiver would be blocked from receiving service).

- ***94% of the time, the out of band emissions from a WCS device operating with a 55+10log(P) emissions mask*** in the SDARS band will have less than a 1 dB impact on the SDARS receiver noise floor.

These results show a low probability of both overload and out-of-band emission interference despite the fact that several conservative assumptions were applied in the simulations, such as:

Line of site propagation: The path loss computations assume that an unobstructed propagation path always exists between the WCS transmitters and SDARS receivers. In reality, a certain percentage of propagation paths will be partially or fully obstructed, leading to greater path loss than was computed, and thus less probability of interference with SDARS receivers.

Full buffer traffic model: The simulations were performed using a full-buffer traffic assumption, which assumes that the WCS devices always have data to send (i.e., data is transmitted in every available radio frame). In reality users would have more periodic data transmission which would further reduce the probability of interference.

Radio resource scheduling: The simulations have not taken advantage of multi-user multiplexing which a WiMAX, or other mobile wireless broadband technology, radio resource scheduler will exploit. The scheduler will attempt to organize mobile transmissions according to the reported link quality for the mobile, avoiding transmission when more power is required to overcome radio link impairments. In the simulations, the mobiles were forced to transmit during each frame, thus maximizing the probability of interference. Yet the simulations still yielded a low instance of actual interference.

9 Appendix A

OFDMA parameters are a set of common simulation parameters that are shared amongst all simulated scenarios. The values of these parameters are listed in Table 11 below.

Table 11: OFDMA Numerology

Parameter	Description	Value
f_c	Carrier frequency	2.3 GHz
BW	Total bandwidth	10 MHz
N_{FFT}	Number of points in full FFT	1024
F_S	Sampling frequency	11.2 MHz
Δ_f	Subcarrier spacing	10.9375 kHz
$T_0 = \frac{1}{\Delta_f}$	OFDMA symbol duration without cyclic prefix	91.43 us
CP	Cyclic prefix length (fraction of T_0)	1/8
T_s	OFDMA symbol duration with cyclic prefix	102.86 us for CP=1/8
T_F	Frame length	5 ms
N_F	Number of OFDMA symbol in frame	47
R_{DL-UL}	Ratio of DL to UL (TDD mode)	38 symbols: 9 symbols
T_{duplex}	Duplex time	TTG: 296 PS for 10 MHz RTG: 168 PS for 10 MHz PS = 4 / FS

UL_{perm}	UL permutation type	PUSC w/ all subcarriers PUSC w/o all subcarriers

Noise floor is assumed to be at -174 dBm/Hz level which corresponds to -129.61 dBm/tone in uplink.

The noise floor per tone can be calculated by assuming a noise floor of -174 dBm/Hz as,

$$Noise\ floor[dBm/tone] = 10 * \log 10[(Noise(mW/Hz)) \times BW \times OSF \times 1/(number\ of\ tones)] + Rx\ NF[dB]$$

where BW=10MHz, oversampling factor=28/25, number of tones = 1024 and receiver noise figure=6 dB. This gives the noise floor per tone of -129.61 dBm/tone.

Base station directional antenna gain is calculated according to Equation 1. In this equation, the antenna beam width is assumed to be 70 degrees and the maximum antenna gain is set to 15dB.

$$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right] + 15, \quad \textbf{where } -\pi \le \theta \le \pi.$$

Equation 1

The base station and mobile characteristics are summarized in Table 12 and Table 13, respectively.

Table 12: Base Station Characteristics

Parameter	Description	Value
P_{BS}	Max transmit power per sector/carrier	43 dBm @10 MHz bandwidth
H_{BS}	Base station height	30m
G_{BS}	Gain (boresight)	17 dBi
S	Number of Sectors	3
θ_{BS}	3-dB beamwidth	S =3: θ_{BS} = 70°
G_{FB}	Front-to-back power ration	20 dB
M_{TX}	Number of transmit antennas	1

M_{RX}	Number of receive antennas	2
NF_{BS}	Noise figure (transmit & receive)	5 dB
HW_{BS}	Hardware loss (cable, implementation, etc.)	2 dB

Table 13: Mobile Station Characteristics

Parameter	Description	Value
P_{SS}	RMS transmit power/per Ss	24 dBm
H_{SS}	Subscriber station height	1.5m
G_{SS}	Gain (boresight)	0 dBi
$\{\theta_{SS}\}, G(\{\theta_{SS}\})$	Gain as a function of Angle-of-arrival	Omni
N_{TX}	Number of transmit antennas	1
N_{RX}	Number of receive antennas	1
NF_{SS}	Noise figure (transmit & receive)	7 dB
HW_{SS}	Hardware loss (cable, implementation, etc.)	2 dB

10 Appendix B

Non-omni directional Antenna Pattern

The antenna pattern used for each sector is plotted in Figure 10, and is specified by

$$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2,\ A_m\right],\quad \text{where}\quad -180 \le \theta \le 180.$$

Equation 2

θ_{3dB} is the 3 dB beamwidth, and $A_m = 20dB$ is the maximum attenuation.

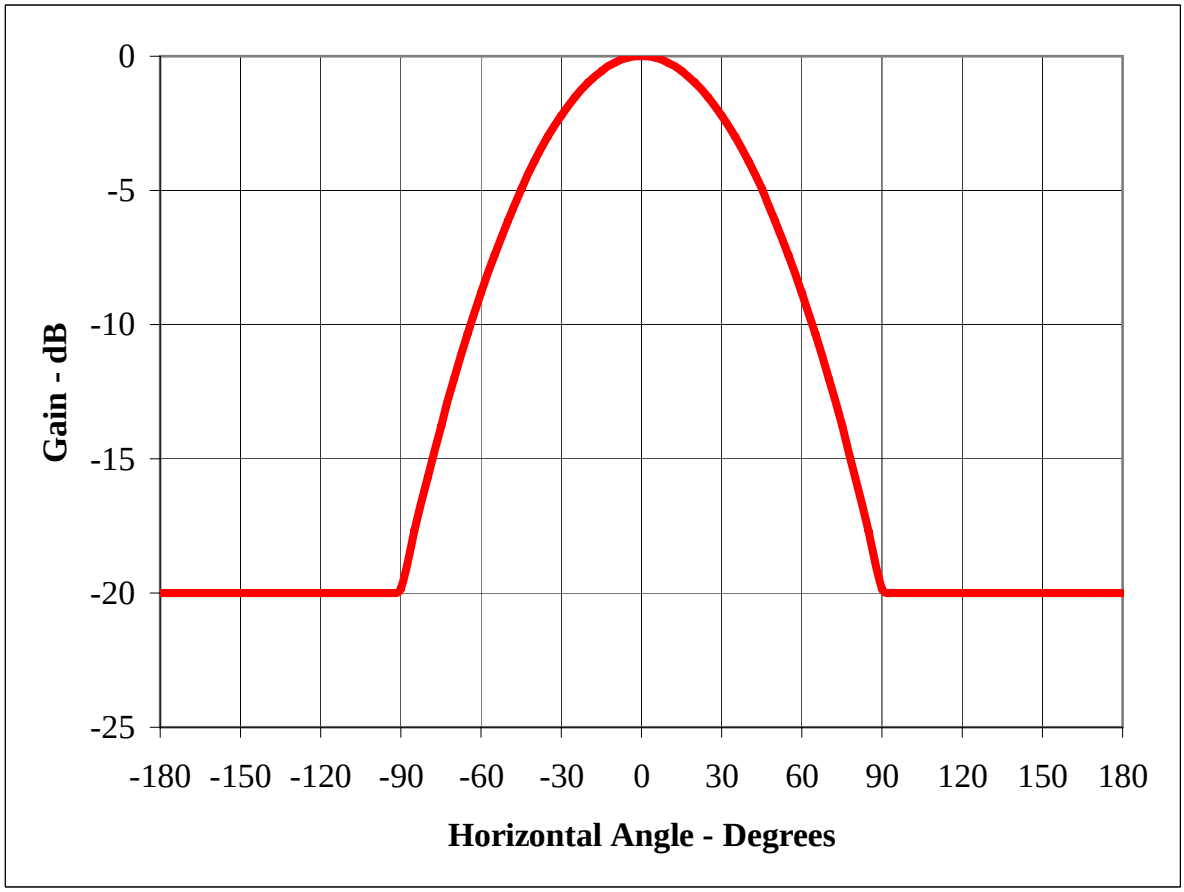


Figure 10. Antenna Pattern for 3-Sector Cells

11 Appendix C

Theoretical relationship between fundamental signal and OOBE reduction

The following baseband PA model has been frequently used in the literature.

$$y(t) = \sum_{k=0}^{K} a_{2k+1} \left| x(t) \right|^{2k} x(t)$$

where x(t) is the baseband PA input signal, y(t) is the baseband PA output signal, and a_{2k+1} coefficients are complex-valued coefficients that can be extracted from standard characterizations such as amplitude-to-amplitude (AM/AM) and amplitude-to-phase (AM/PM) conversions of the PA. The highest nonlinearity order is 2K + 1.

Although the analysis on spectral regrowth can be generalized to accommodate higher-order nonlinearities, for simplicity, we illustrate the spectral density of the output signal using a 3rd-order nonlinear model:

$$\begin{aligned} y(t) &= a_1 x(t) + a_3 \left| x(t) \right|^2 x(t) \\ &= a_1 x(t) + a_3 x^2(t) x^*(t) \end{aligned}$$

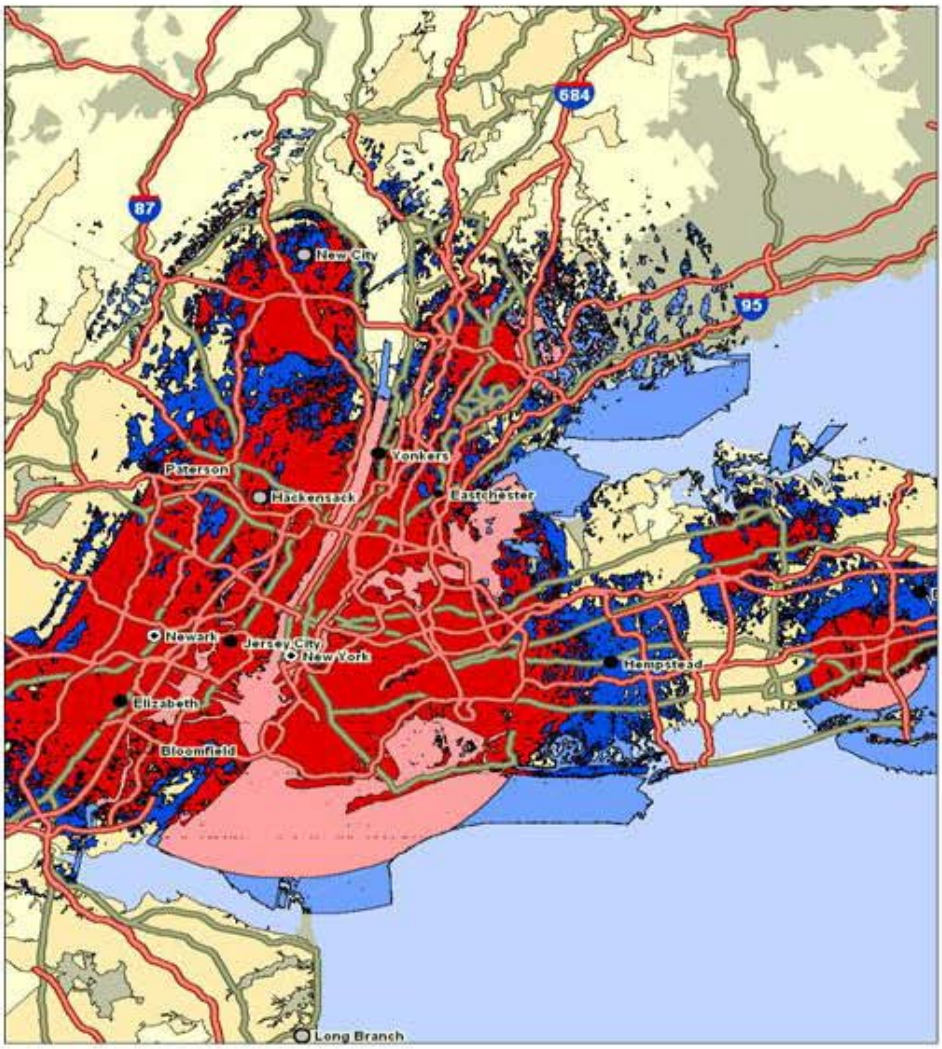
Since y(t) has normally a zero mean, its covariance coincides with its autocorrelation. Using autocorrelation the spectral density function (SPD) can be computed.
The SPD is often a function of pulse shaping filter h(t). When h(t) is real valued and symmetric, a surprisingly simple expression can be found for the PSD of y(t):

$$S_{2y}(f) = \left| a_1 \right|^2 A^2 \frac{1}{T} \left| H(f) + \frac{a_3}{a_1} A^2 H_3(f) \right|^2$$

where H(f) is the Fourier transform of h(t), and $H_3(f) = H(f) \otimes H(f) \otimes H(f)$ and $\otimes$ is the convolution operator.
It is easy to see that for every 1dB reduction in the input signal value (A^2), a 3 dB reduction is expected for out-of-band emission values.

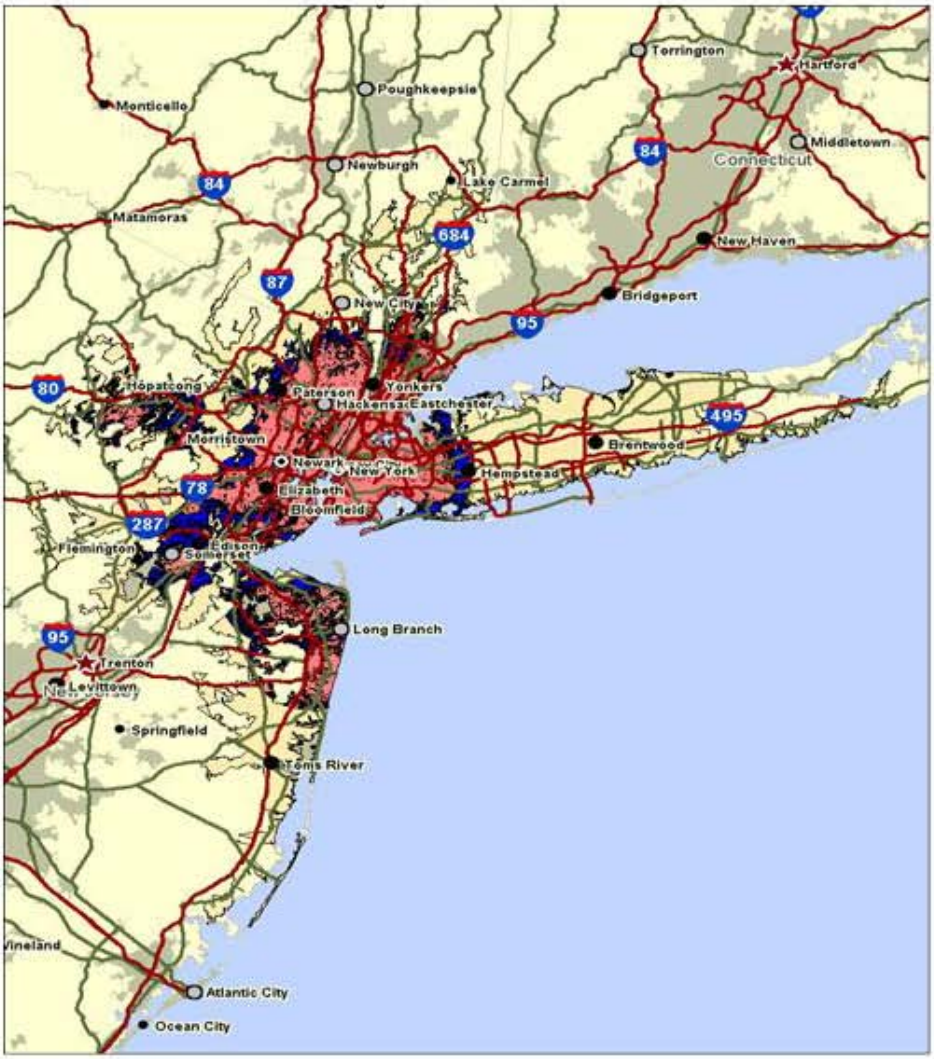
ATTACHMENT C

Sirius New York City Coverage



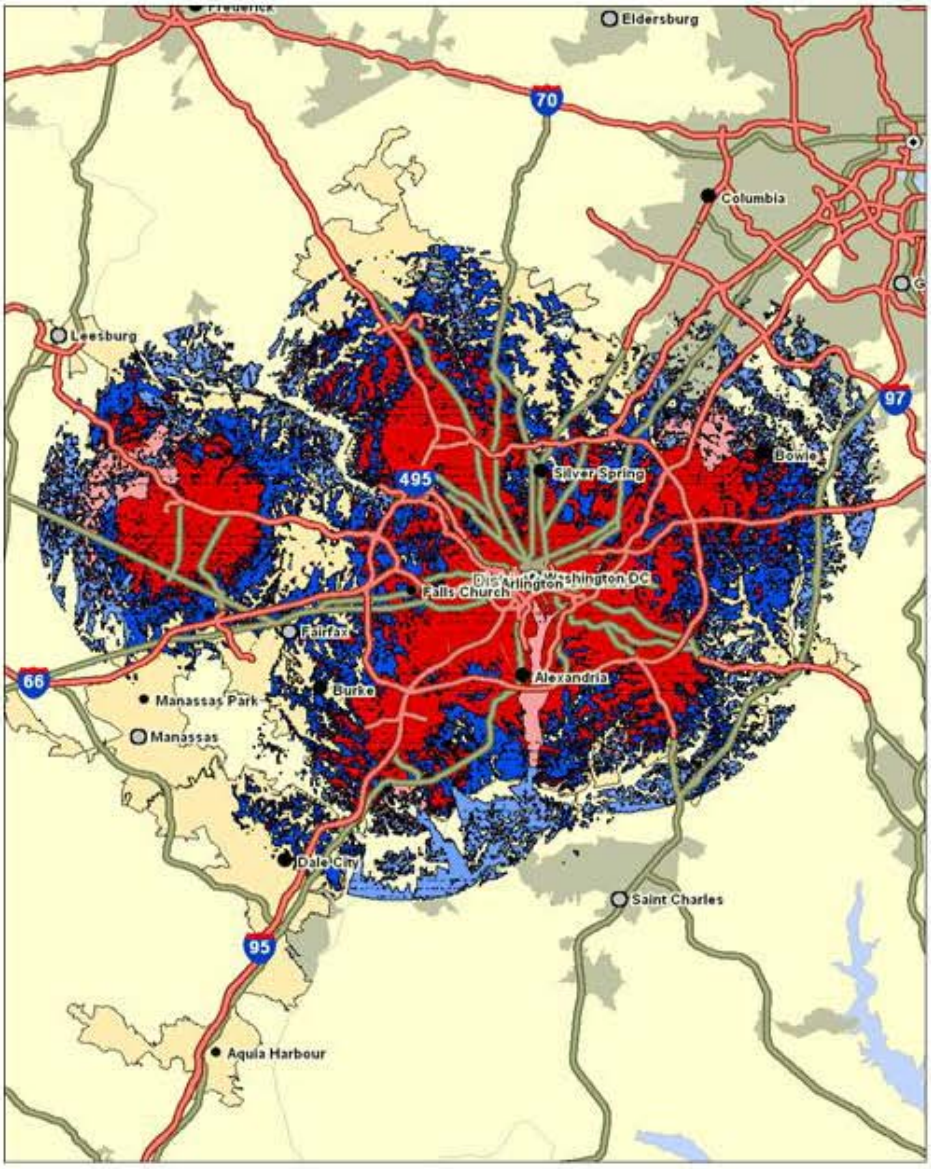
Area_sq_mi	Population	Households	Percent_ua	Category
3,396.00	18,375,033	6,681,576	100.0%	Total Urban Area
1,226.36	13,519,963	4,985,992	36.0%	Covered area in UA
442.98	1,998,058	680,946	13.0%	-85 to -95 in UA (Blue)
791.79	11,522,085	4,285,090	23.5%	-20 to -85 in UA (Red)

XM New York City Coverage



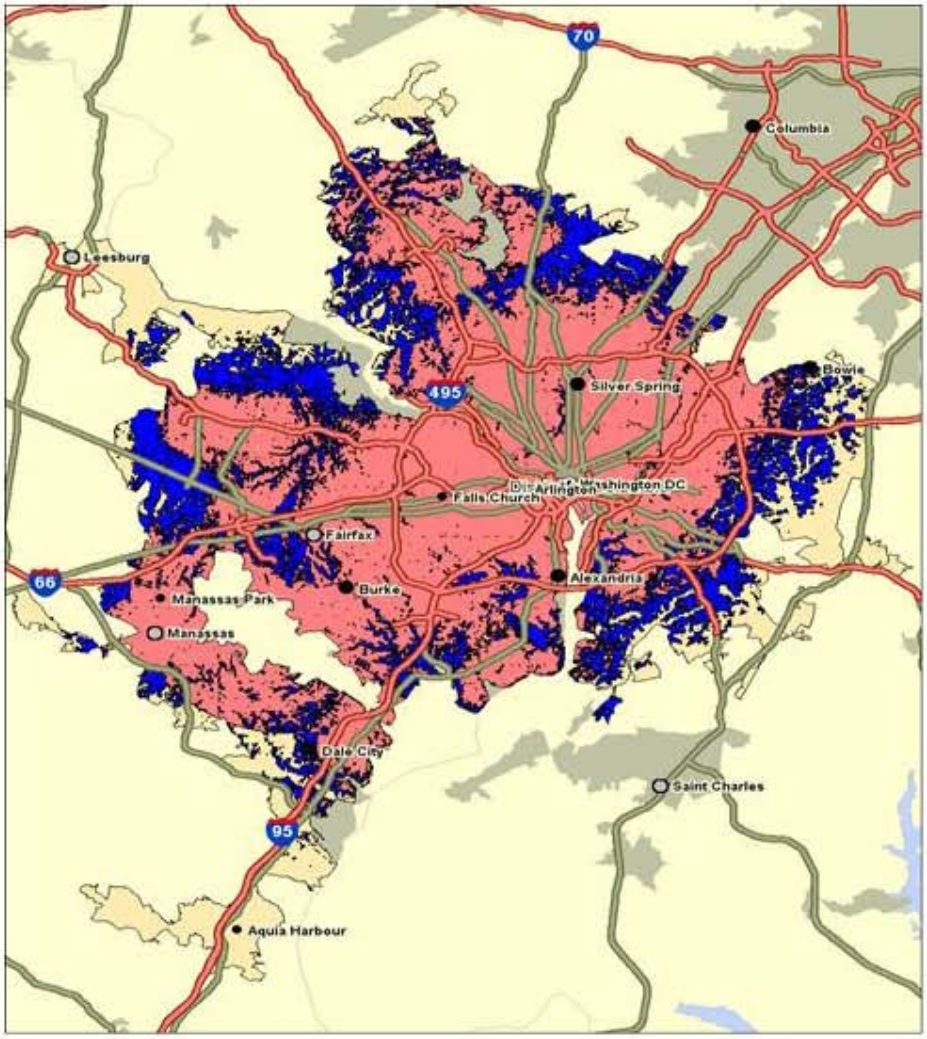
New York City 90%				
Area - Sq Miles	Population	Households	Percent UA	Category
3,396.0	18,375,033	6,681,576	100%	Total Urban Area
1,424.9	13,746,524	5,093,588	42%	Covered area in UA
415.9	1,427,254	497,817	12%	-85 to -95 in UA
1,009.0	12,319,270.0	4,595,771.0	30%	-20 to -85 dB in UA

Sirius Washington DC Coverage



Area_sq_mi	Population	Households	Percent_ua	Category
1,159.57	4,257,405	1,613,729	100.0%	Total Urban Area
751.67	3,181,545	1,243,577	65.0%	Covered area in UA
336.41	1,131,881	407,882	29.0%	-85 to -95 in UA (Blue)
420.30	2,053,822	837,207	36.0%	-20 to -85 in UA (Red)

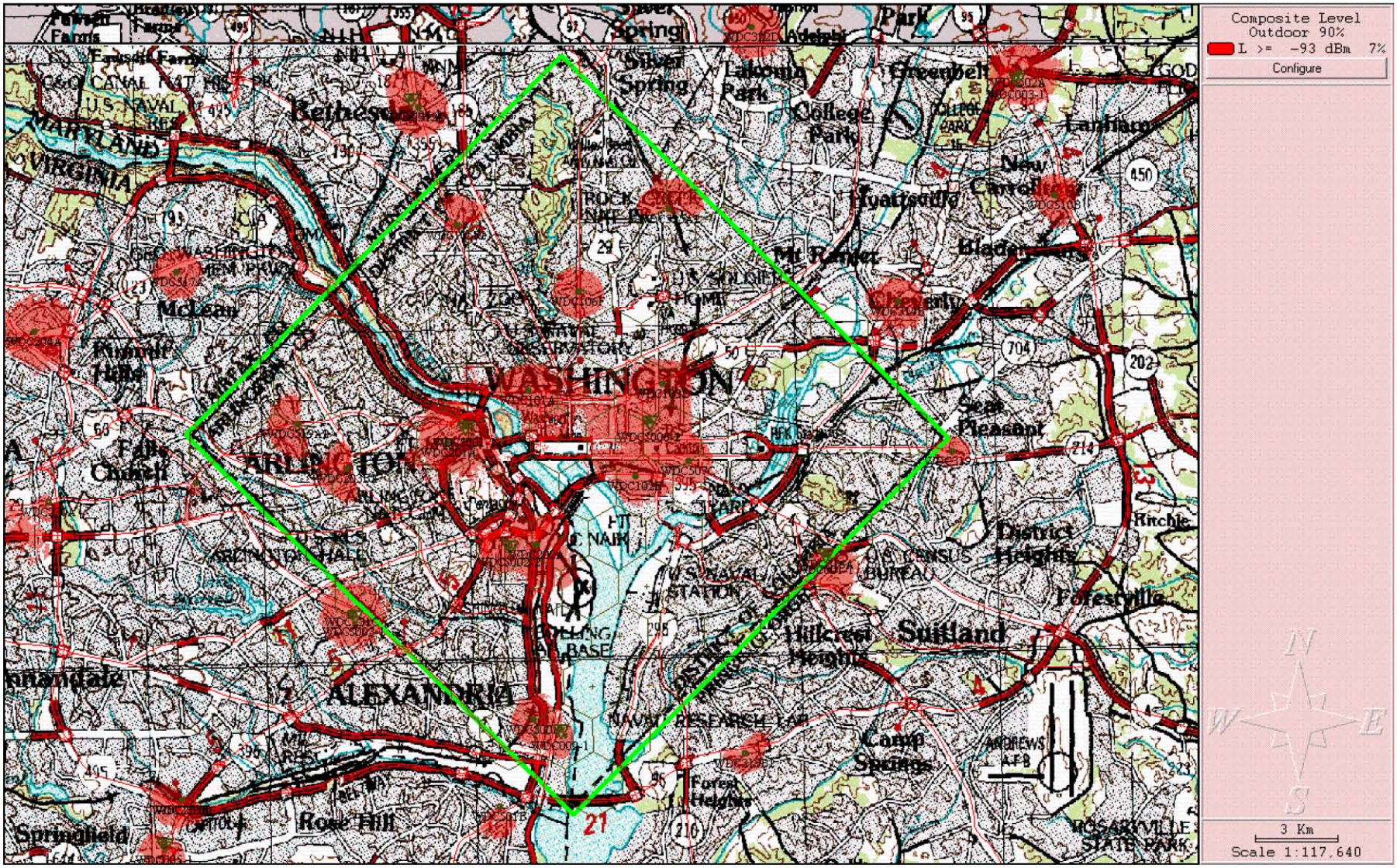
XM Washington DC Coverage



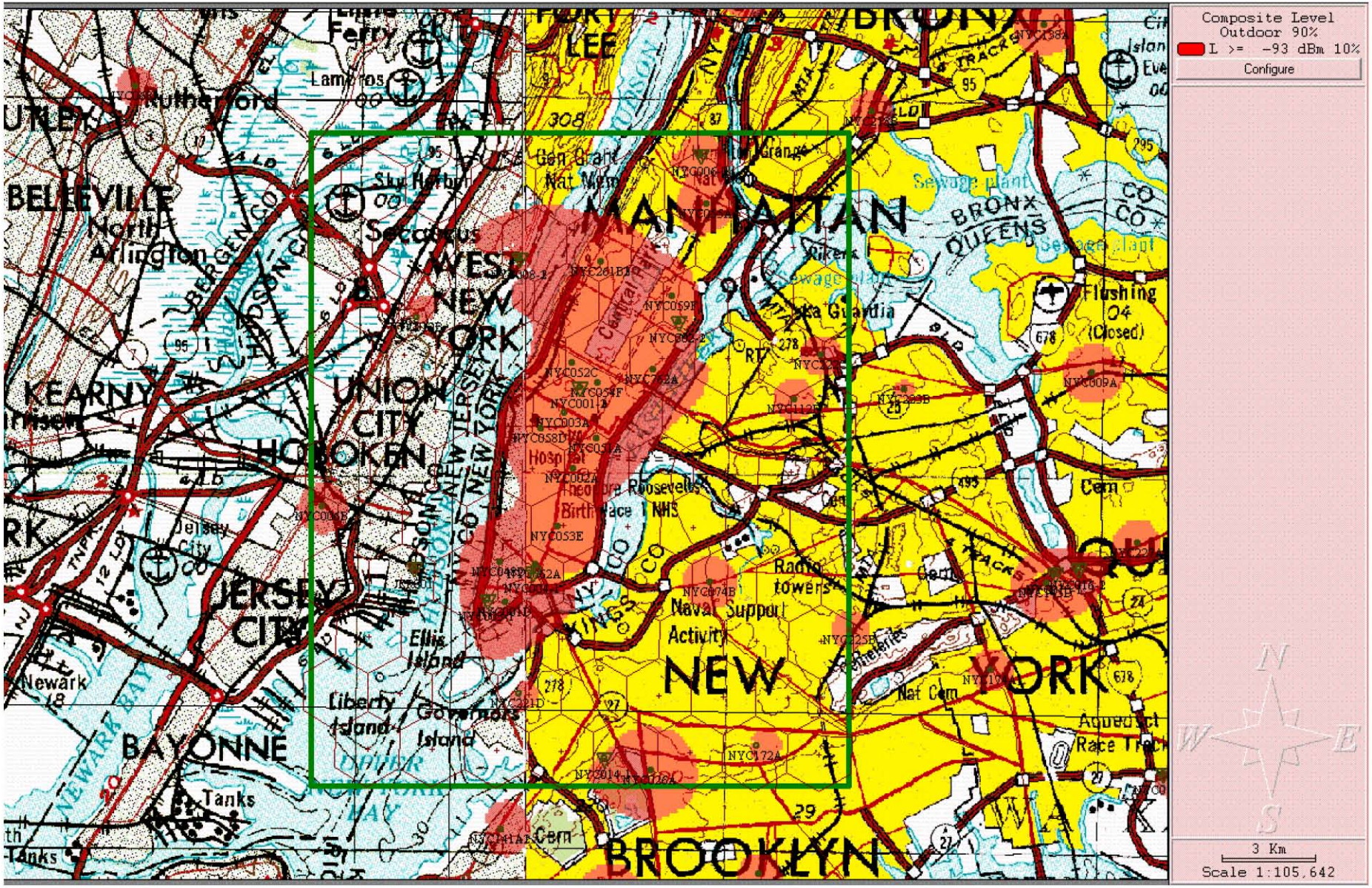
Washington DC 90%				
Area - Sq Miles	Population	Households	Percent UA	Category
1,159.6	4,257,405	1,613,729	100%	Total Urban Area
931.6	3,748,128	1,442,345	80%	Covered area in UA
258.4	679,445	241,903	22%	-85 to -95 in UA
673.2	3,068,683.0	1,200,442.0	58%	-20 to -85 dB in UA

ATTACHMENT D

WDC-M-XM&Sirius Repeater Ntwk
OOBE-Covg - LCity-90%-7.0dB FM
CPE@30m & 17 dBi Rx Ant Gain



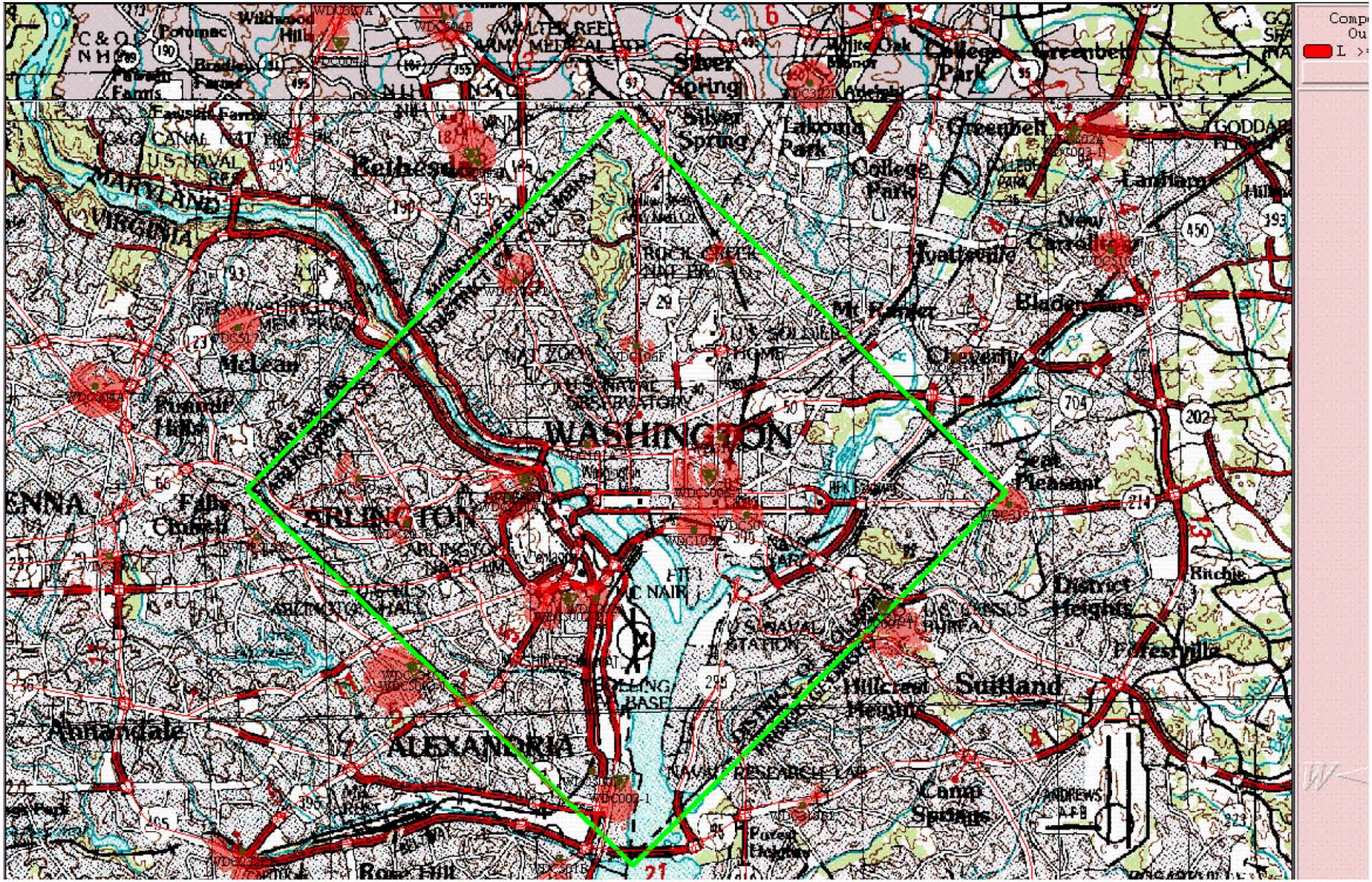
NYC-L-XM&Sirius Repeater Netks
OOBE-93dBm-Sub-90%-7.0dBFM
CPE@30m- 17dBi Rx Ant-+5dBm



ATTACHMENT E

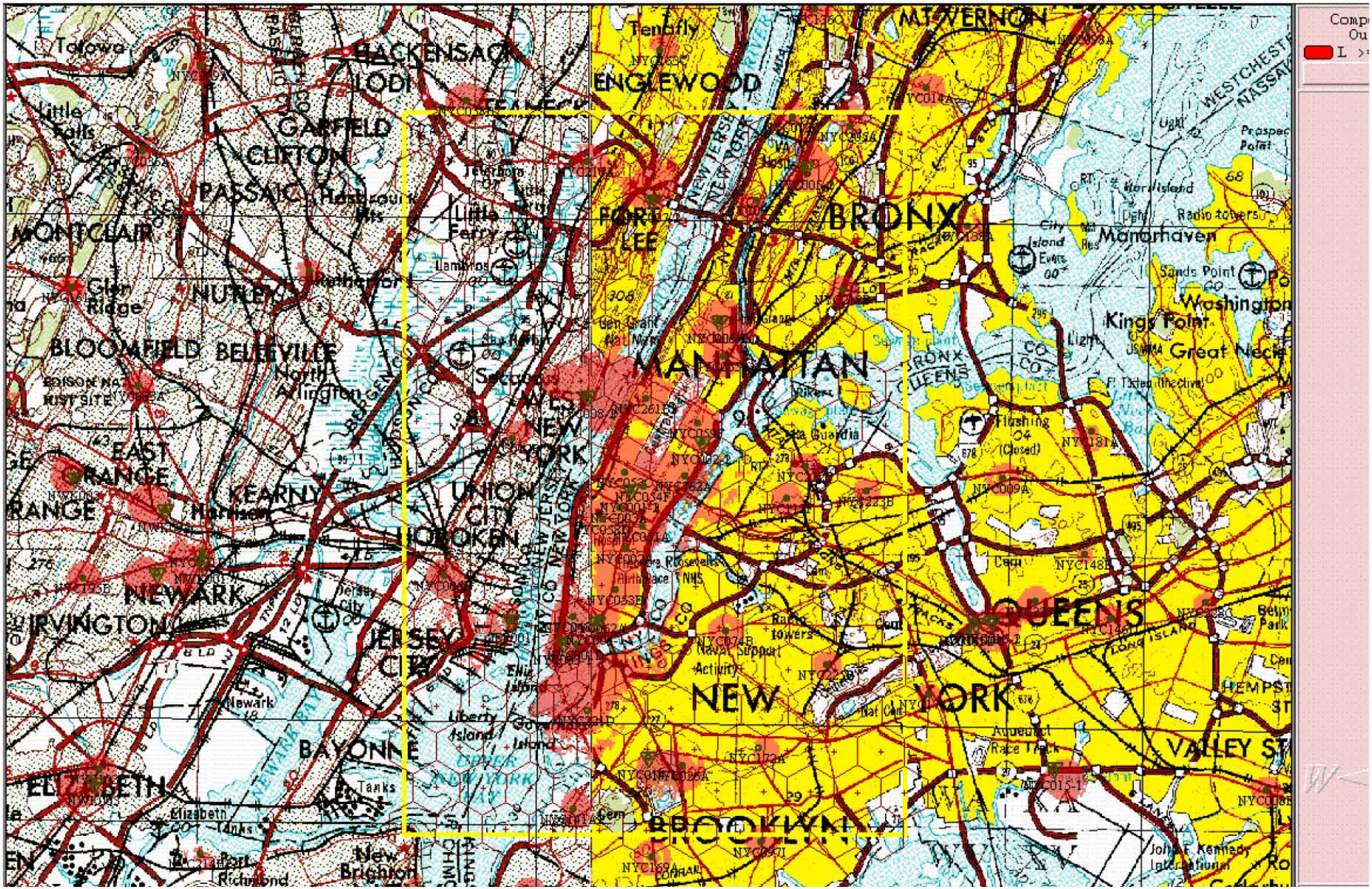
Combined Sirius+XM DC

WDC-Mt-XM&Sirius Repeater Net
-44 dBm Covg -Sub-90%-7.0dB FM
DVB-H Model - CPE@ 2m



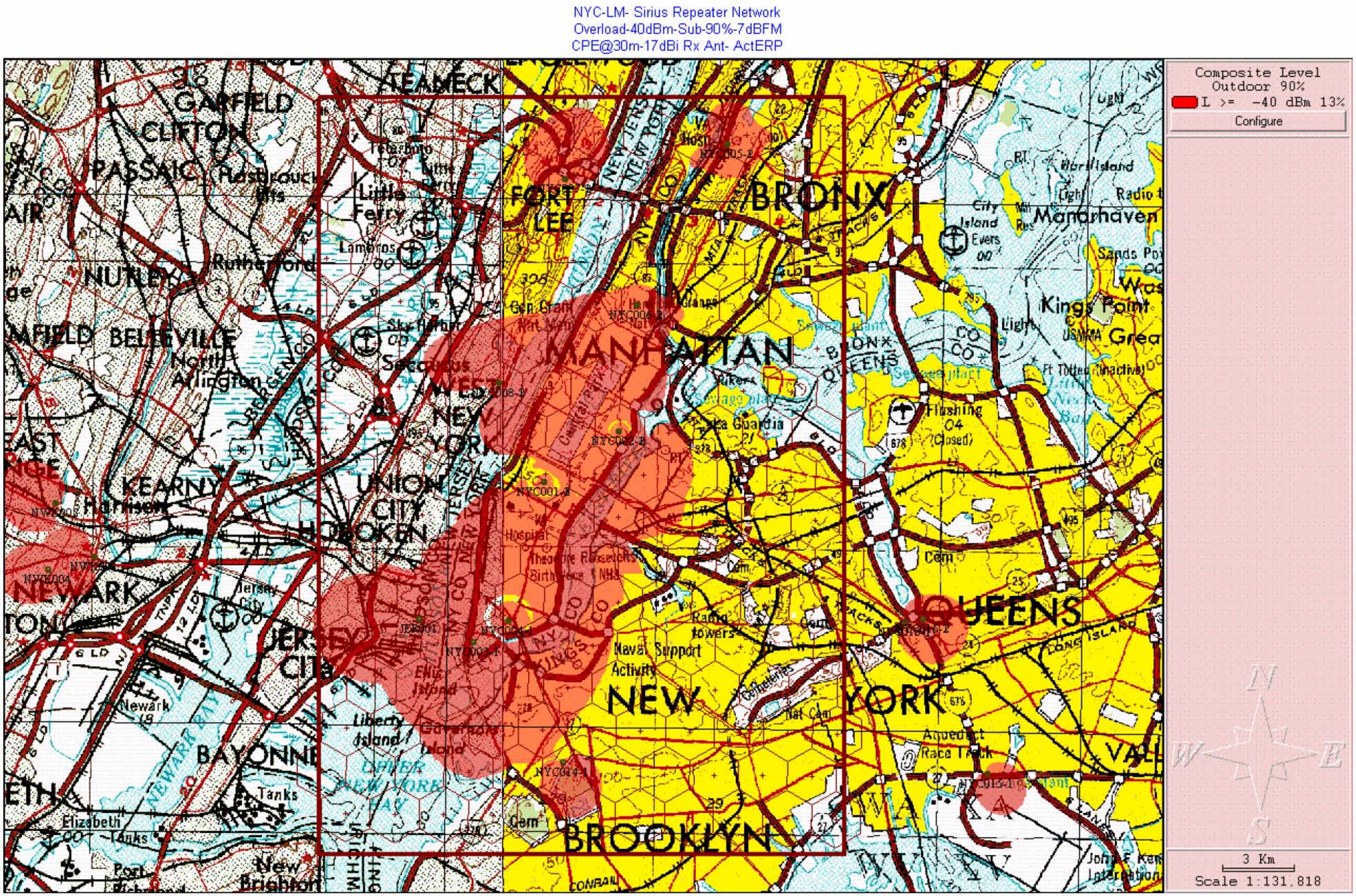
Combined Sirius+XM NYC

NYC-LM-XM&Sirius Network-Comb
-44 dBm Covg-Sub-90%-7.0dBFM
CPE@2m-DVB-H Model-Act ERP



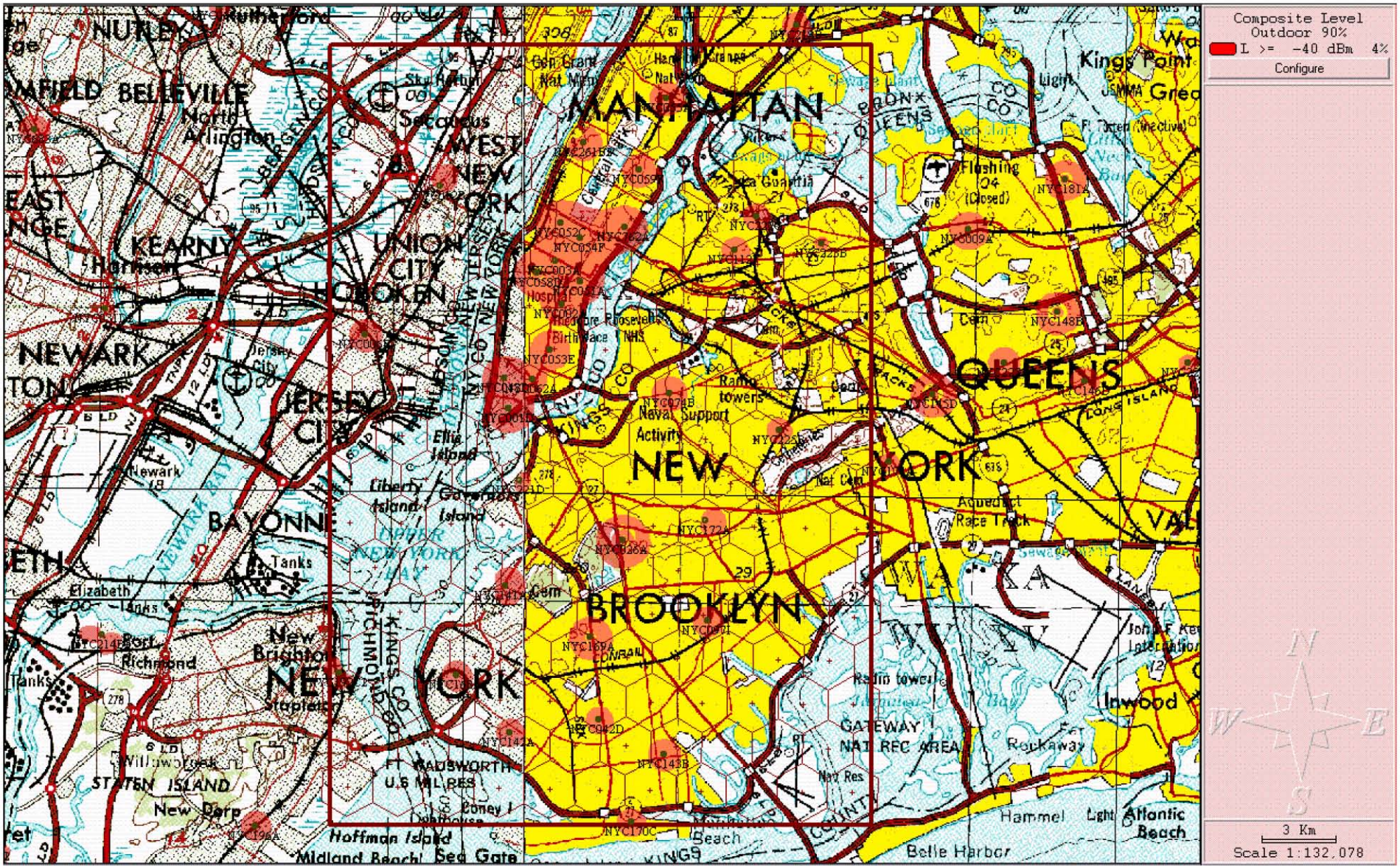
ATTACHMENT F

Sirius Full Power Overload C block



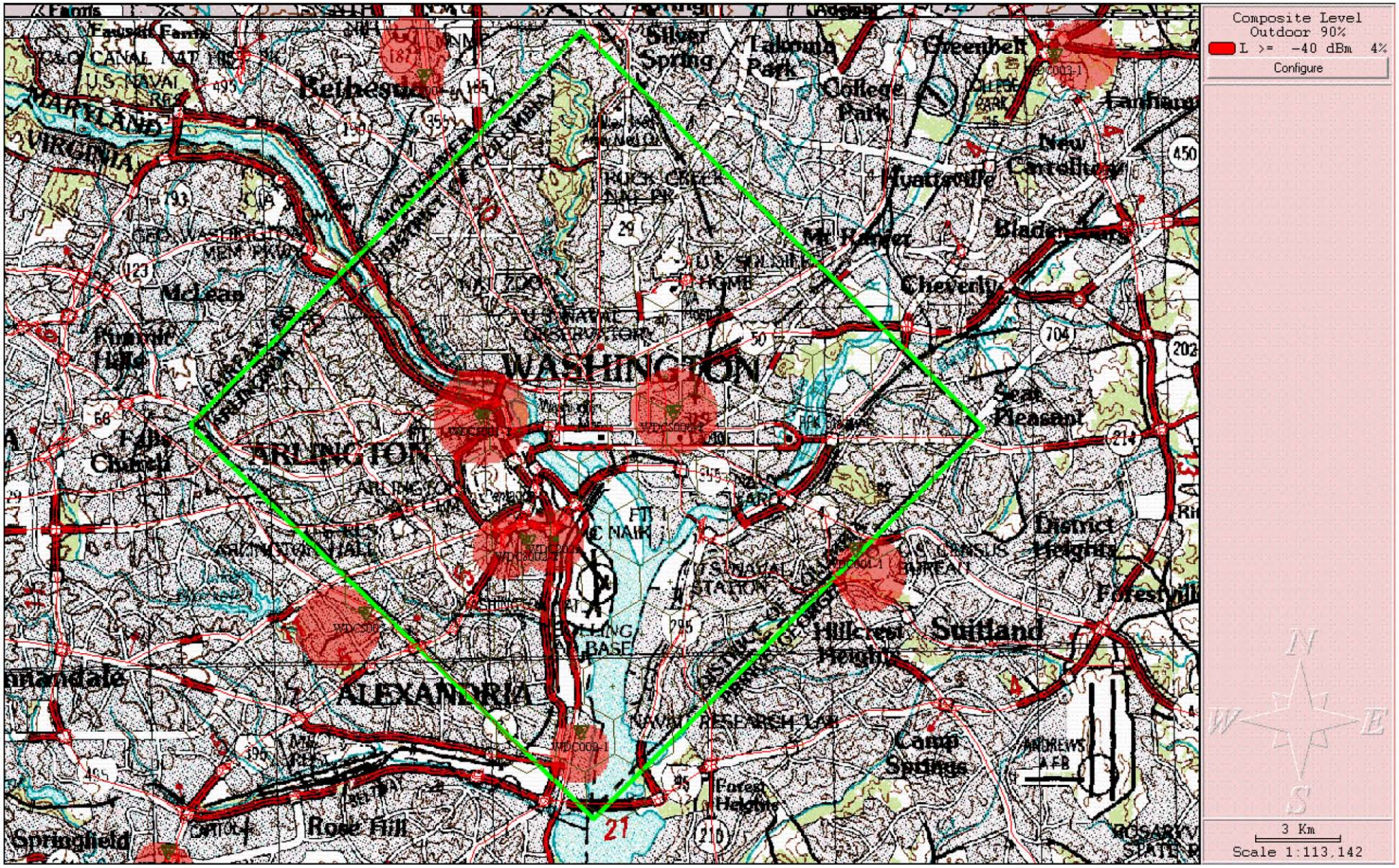
XM Full Power Overload D block

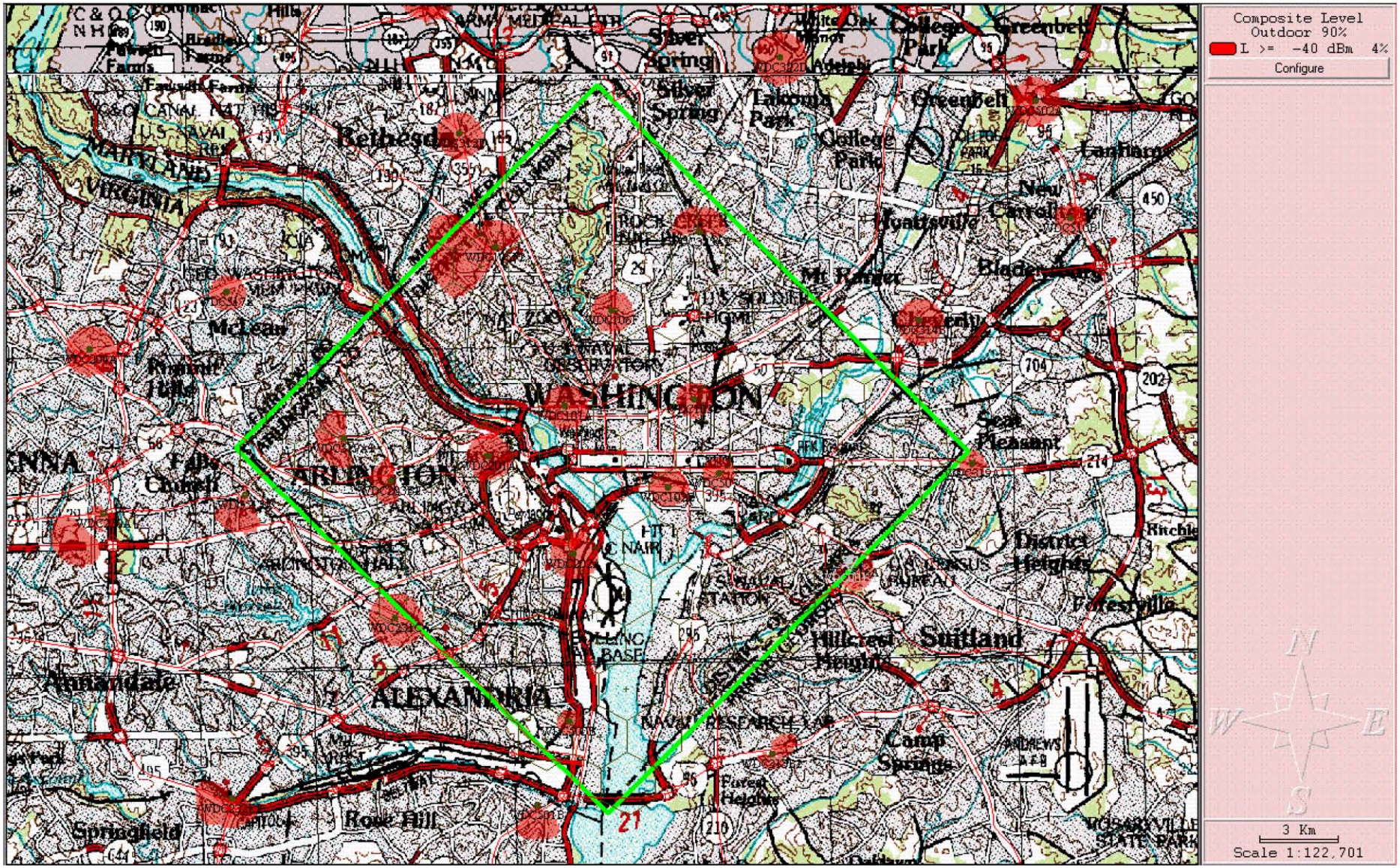
NYC- XM Repeater Network
Overload-40dBm-Sub-90%-7dBFM
CPE@30m-17dBi Rx Ant- ActERP



Sirius Full Power Overload C block

WDC-Mt-Sirius Repeater Network
Overload-40dBm-Sub-90%-7dBFM
CPE@30m- 17dBi Rx Ant- ActERP



XM Full Power Overload D block

WDC-Metr-XM Repeater Network
Overload-40dBm-Sub-90%-7dBFM
CPE@30m- 17dBi Rx Ant- ActERP