Technical Appendix in Support of Reply Comments
IB Docket No. 95-91 and ET Docket No. 07-293

Sirius Satellite Radio, Inc.

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Introduction

Sirius Satellite Radio, Inc. ("Sirius") has prepared this Technical Appendix in support of the attached reply comments submitted to the Federal Communications Commission in its proceeding to finalize rules for the deployment of satellite radio terrestrial repeaters authorized under Part 25 of the FCC's Rules and to support modifications to the technical rules governing the deployment of stations in the 2.3 GHz Wireless Communications Services ("WCS") defined in Part 27 of the FCC's Rules.

As indicated in the following declarations, the information and analysis presented in the text was conducted and approved under the supervision of Sirius employees and observed by independent engineering consultants.

The Appendix is structured into a series of technical exhibits addressing a variety of issues that are raised by the Commission's Notice of Proposed Rulemaking and the comments filed in response thereto.

Exhibit A

Repeater Coverage Maps for New York and Washington

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Executive Summary

The comments of the WCS Coalition provided an analysis of Sirius and XM repeater coverage for the markets of New York and Washington.[1] This analysis was used in an attempt to illustrate a variety of points regarding transmitter powers and out of band emissions (OOBE), namely that the availability of terrestrial based SDARS signals will, to a great degree, mask any interference caused by WCS transmitters to reception of SDARS satellite based signals and that SDARS repeaters will cause significant interference to WCS base station receivers.

To correct a number of significant errors and omissions in the analyses provided by the WCS Coalition, Sirius provides its own engineering analysis of the same markets along with details on the models and analysis used.

The WCS Coalition has suggested that the SDARS repeater coverage is sufficient in scope to permit unfettered mobile broadband service to be allowed within the entire repeater coverage contour. As shown in this exhibit, this is clearly not the case. Specifically, this Exhibit uses "real world" drive test calibrated and validated coverage predictions to demonstrate the following:

<u>Appendix A (Counterpoint to Coalition Attachment C):</u>

- The WCS Coalition based its coverage estimates on inaccurate assumptions regarding the number of repeaters Sirius operates in New York and Washington DC. Also, the Coalition used incorrect data for the operating power as several sites are operated at powers below the authorized STA values to reduce the potential for harmful interference. These errors, added to the theoretical modeling approach used, result in the WCS Coalition. overestimating even the basic (i.e. non-interference mitigating) repeater coverage for these markets by approximately a factor of 2 for the NY market and a factor of 3 for the Washington market.
- As established by Sirius' testing[2], a repeater signal level of -60 dBm or greater is required to mitigate the interference that would be generated from a 250 milliwatt WCS mobile terminal. Sirus shows that its existing repeater network provides a signal level exceeding -60 dBm in only 0.5 % of the area of the New York market. This is contrasted with the Coalition's estimate of 23%. For Washington DC, Sirius' analysis shows terrestrial signal levels exceeding -60 dBm to approximately 1% of the market area, which is contrasted to the Coalition's analysis showing 36% coverage.
- Designing a terrestrial repeater network to place -60 dBm across these two markets is neither technically nor financially feasible.[3] Even if Sirius could

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[1] Comments of the WCS Coalition, WT Docket No. 07-293, February 14 2008.

[2] See Exhibit C, Figure 4.

[3] The Sirius repeater waveform was designed to support the provision of a moderate amount of area coverage in targeted areas. The self interference generated from the deployment of thousands of closely

overcome the self-interference issues, the number of 2 kilowatt repeaters necessary to provide such coverage would be enormous. Sirius estimates that its number of repeaters needed in New York City would need to increase from 12 to approximately 4,850 and in Washington DC from 6 to approximately 965. Sirius' business model simply could not support the enormous capital and recurring operating costs of deploying and maintaining such a repeater network in all the various urban markets across the US.

Appendix B (Counterpoint to Coalition Attachment D):

- When appropriate realistic assumptions are used, no significant out of band (OOBE) interference is caused by SDARS repeaters to WCS base station receivers.

Appendix C (Counterpoint to Coalition Attachment E)

- The areas where the signal strength from SDARS terrestrial repeaters exceeds the the 100 dBµV/m ground based field strength (-44 dBm isotropic antenna equivalent) that was originally proposed by Sirius to protect WCS terminals is significantly smaller than the area estimated by the WCS Coalition. Similarly, the area where the signal strength from SDARS terrestrial repeaters exceeds Sirius' refined ground based protection proposal for mobile WCS terminals of 110 dBµV/m (-35 dBm isotropic equivalent) is exceedingly minute in both NY and Washington.

Appendix D (Counterpoint to Coalition Attachment F)

- When appropriate realistic assumptions are used, SDARS repeaters will not cause significant receiver overload interference to WCS base station receivers.

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spaced repeaters would cause significant service impairment and turn the Sirius network from a satellite based system into a terrestrial system.

Appendix A to Exhibit A
Base Repeater Coverage Maps

Prediction Information

Market Boundary for Statistics Aggregation

Urbanized areas, New York--Newark, NY--NJ--CT and Washington, DC--VA—MD[4]

Model Parameters

The model parameters used are shown in Table 1:

Table 1 Model Parameters Used for Repeater Coverage Prediction

Item	Value	WCS Coalition nearest equivalent[5]
Model type	CRC-Predict[6]	"Cellplan"
Terrain resolution	30 meters	Not specified
Clutter	12 categories, 30 meter resolution, 2005/7	Not specified
Coverage criteria	-95 dBm (edge of coverage boundary) -75 dBm (intermediate serving level boundary) -60 dBm level required to tolerate a WiMax 250 mW mobile at 3 m (*See* Exhibit C)	-95 dBm boundary
Location probability	50%	90%
Fade margin	n/a	7 dB
Receiver height	2 m Above Ground Level (AGL)	2 m AGL

Site Table

The WCS Coalition filing used the repeater configurations on file with the FCC as of Fall 2007.[7] The predictions in this appendix utilize the current Sirius operating sites. (*See* Table 2).

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[4] Although not explicitly stated, it appears that the geographic area used for statistics generation in the WCS filing (Comments of the WCS Coalition, WT Docket No. 07-293, February 14 2008, and Attachment C) is an "Urbanized Area". (http://www.census.gov/geo/www/ua/ua_2k.html). The actual geographic boundaries used by Sirius for the statistics calculation were obtained from http://www.census.gov/geo/www/ua/ua_bdfile.html

[5] The WCS Coalition filing did not disclose sufficient information to duplicate or confirm directly the modeling assumptions used. The information here is from Footnote 31.

[6] *See*, http://www.crc.ca/en/html/crc/home/tech_transfer/10171.

[7] Comments of the WCS Coalition, WT Docket No. 07-293, February 14 2008, Footnote 31, The WCS Coalition filing did not provide a specific list of sites used for the prediction and so Sirius has examined the plots provided and made a "best effort" at interpreting which sites were actually used.

The WCS Coalition predictions include a number of authorized STA sites that Sirius has not constructed. These sites have not been constructed in accordance with Sirius' previously described economic and technical requirements to minimize the amount of repeater infrastructure used in its network wherever possible. Additionally, certain of the sites used in this analysis are operated at powers below the authorized STA values. These power reductions were implemented for the purpose of reducing the potential for harmful interference.

Table 2 Sirius Prediction Site List and Parameters

Market	No Of Sectors	Antenna Type	Sector 1					Sector 2					Sector 3			
			Antenna Beamwidth	Orientation	Downtilt	EiRP (Watts)	Operating EIRP	Antenna Beamwidth	Orientation	Downtilt	EiRP (Watts)	Operating EIRP	Antenna Beamwidth	Orientation	Downtilt	EiRP (Watts)
New York, NY	2	EMS FR65-18-00NVL	65	30	0	7000.00	3550	65	330	0	7000.00	3550	-	-	-	-
New York, NY	3	EMS FR90-16-00NVL	90	30	6	2500	2500	90	195	0	2500	2500	90	110	0	2500
New York, NY	2	EMS FR90-17-00NVL, EMS FR65-18-00NVL	90	140	0	4900	4900	65	350	8	6200	6200	-	-	-	-
New York, NY	1	EMS FR65-18-00NVL	65	160	0	13800	1300	-	-	-	-	0	-	-	-	-
New York, NY	1	HMD8V360-R05-H	Omni	-	-	9000	9000	-	-	-	-	0	-	-	-	-
New York, NY	2	EMS FR90-17-00NVL, EMS FR65-18-00NVL	90	5	0	4900	1600	65	160	12	6200	2000	-	-	-	-
New York, NY	2	EMS FR90-17-00NVL	90	0	5	4900	4900	90	180	10	4900	4900	-	-	-	-
New York, NY	2	EMS FR65-18-00NVL	65	15	3	13800	13800	65	320	0	13800	0	-	-	-	-
New York, NY	2	HMD8PV180-R05-H	180	110	6	5500	500	180	110	6	5500	500	-	-	-	-
New York, NY	2	EMS FR90-17-00NVL, EMS FR65-18-00NVL	90	315	0	4900	4900	65	45	8	6200	6200	-	-	-	-
Newark, NJ	1	EMS FR65-18-00NVL	65	260	5	13800	1300	-	-	-	-	0	-	-	-	-
Paramus, NJ	2	EMS FR90-17-00NVL	90	160	0	800.00	360	90	315	0	800.00	360	-	-	-	-
Tyson's Corner, VA	2	EMS FR90-17-00NVL	90	100	0	7000.00	3550	90	290	0	7000.00	2850	-	-	-	-
Washington D.C.	2	Andrew HMD8V360-R05-H	Omni	-	-	3100	3100	Omni	-	-	3100	3100	-	-	-	-
Washington D.C.	2	EMS FR90-17-00NVL	90	90	0	4900	4900	90	250	0	4900	4900	-	-	-	-
Washington D.C.	1	EMS FR90-17-00NVL	90	240	0	11000	11000	-	-	-	-	0	-	-	-	-
Washington D.C.	3	EMS FR90-17-00NVL, EMS FR65-18-00NVL	90	90	7	3100	300	65	210	7	3900	380	90	330	0	3100
Washington D.C.	2	HMD8PV360-R05-H	Omni	-	-	3500.00	725	Omni	-	-	3500.00	725	-	-	-	-

Market Statistics

The WCS Coalition filing was unclear on how the tables of statistics shown in Attachment C of their comments were generated. The total area statistics put forward by the WCS Coalition align most closely with those for a market definition of an "Urbanized Area". The methodology Sirius used to calculate the relevant statistics was as follows;

1. Demographic data layers from the 2000 Census were used to provide a zip code boundary layer of population and household data.
2. Using the radio planning coverage predictions, the values of total population and households covered were calculated for three basic serving level conditions:
    a. At a signal level greater than -95 dBm, for the nominal case to allow for comparison of the base case with the WCS Coalition filing. The actual Sirius repeater signal service threshold is approximately -93 dBm.
    b. At a signal level greater than -75 dBm, for the case representing some impact of repeater coverage on the basic WCS terminal interference case.[8]
    c. At a signal level greater than -60 dBm. This is the average (unimpaired) repeater level above which a WCS 250 mW handset would actually be able to operate within 3 meters of an SDARS radio.[9]
3. The population and household counts were aggregated for those zip codes falling either partially or totally within the signal level boundary using a standard Geographic Information System (GIS) query available in Mapinfo™.

The calculated values are shown in Table 3 for New York and Table 4 for Washington.

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[8] *See* Exhibit C of this appendix, Figure 5

[9] *Id*. Figure 4

Table 3 NY Market Statistics

NYC Active sites	Area (Square miles)	% of Area covered	Population (2000 zip level)	Households (2003 zip level)
Total Urban Area	3,392.0	100%	17,495,925	6,489,692
> -95 dBm	673.5	20% (WCS est. =36%)	9,236,850	3,530,253
> -75 dBm	117.8	3%	2,419,499	1,078,998
> -60 dBm	16.5	0.5% (WCS "red area"= 23.5%)	210,878	108,960

Table 4 Washington Market Statistics

WDC Active sites	Area (Square miles)	% of Area Covered	Pop 2000 (zip level)	Households (2003 zip level)
Total Urban Area	1,159	100%	3,709,311	1,494,601
> -95 dBm	312	27% (WCS est. 65%)	1,499,076	645,078
> -75 dBm	66	6%	366,773	172,963
> -60 dBm	14	1% (WCS 'red area" 36%)	117,683	61,862

This data confirms two major points raised by Sirius throughout these proceedings. First, terrestrial coverage in major urban areas is neither ubiquitous nor contiguous. SDARS delivers is signal to subscribers primarily from its space-borne platforms and the FCC must therefore place the highest priority on protecting the satellite based signal. Second, the signal levels distributed by the terrestrial repeater networks are insufficient in most areas to overcome the interference generated by a WCS mobile transmitting device in close proximity. This point is further detailed in Exhibit C of the appendix.

Figure 1 New York Repeater Coverage Map

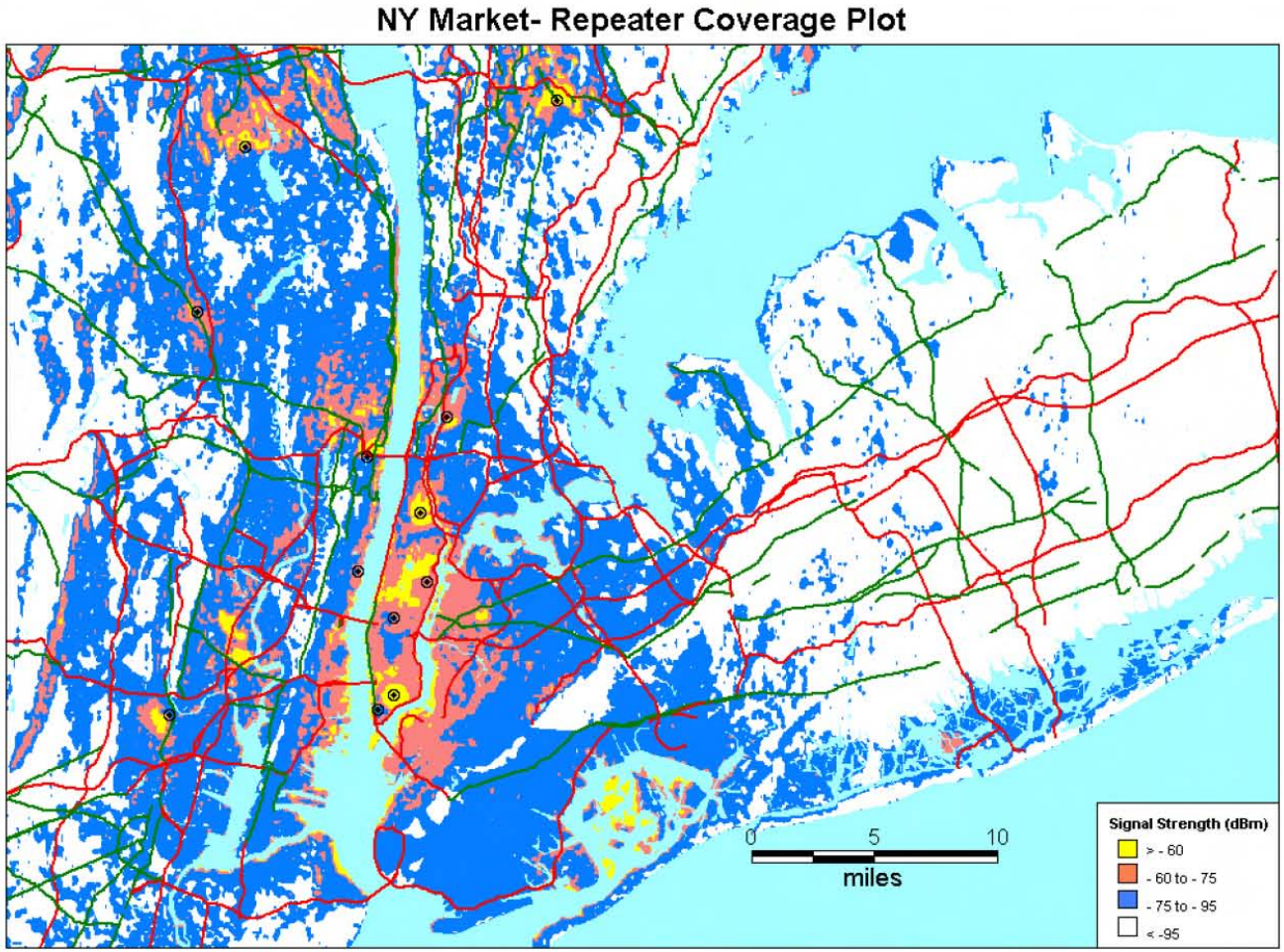
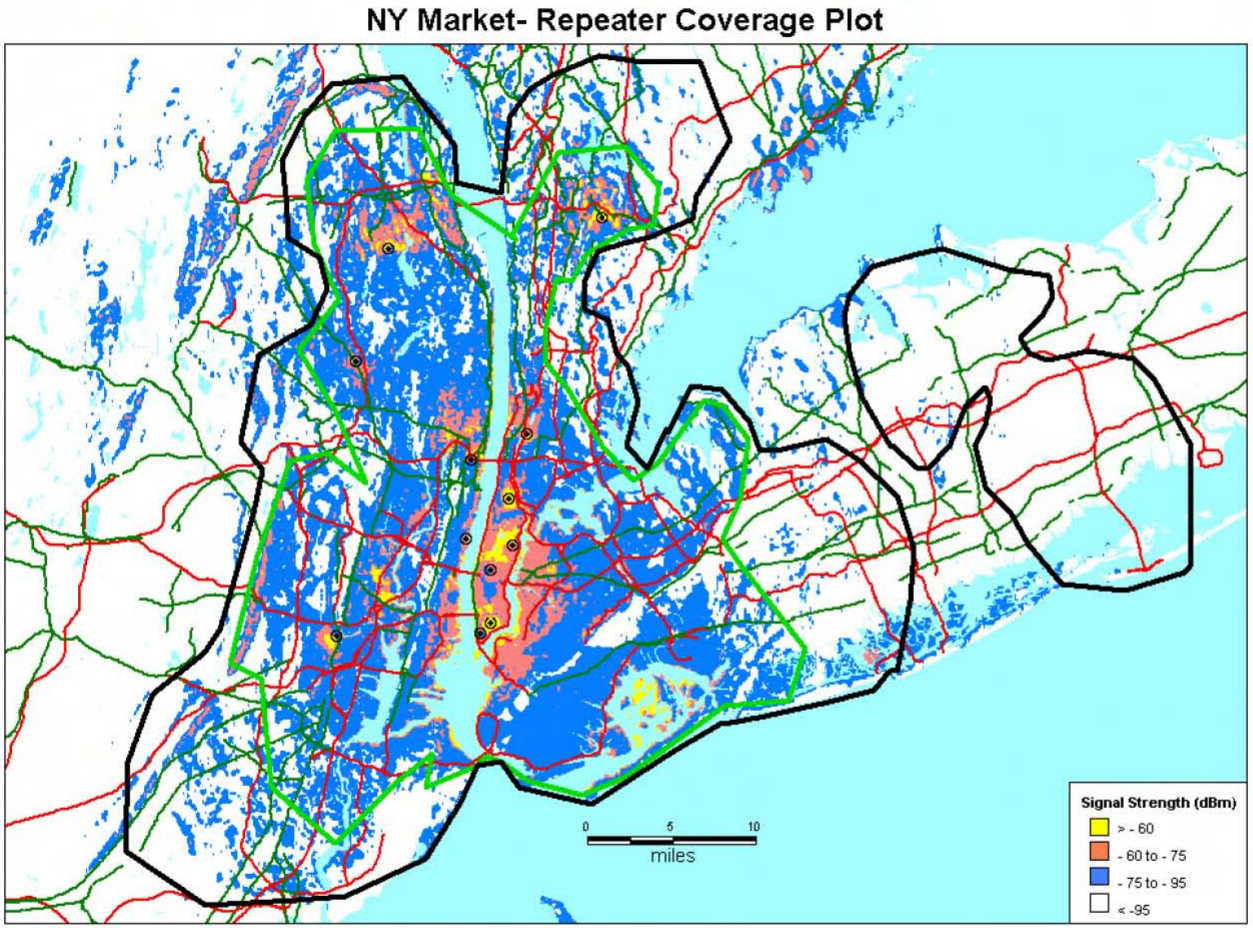


Figure 2 NY Market Coverage Comparison with WCS Coalition Plot



NYC Active sites	Area (Square miles)
WCS boundary (Black) (estimate)	1596.8
SSR boundary (Green) (estimate)	846.6

Figure 3 Washington Repeater Coverage Map

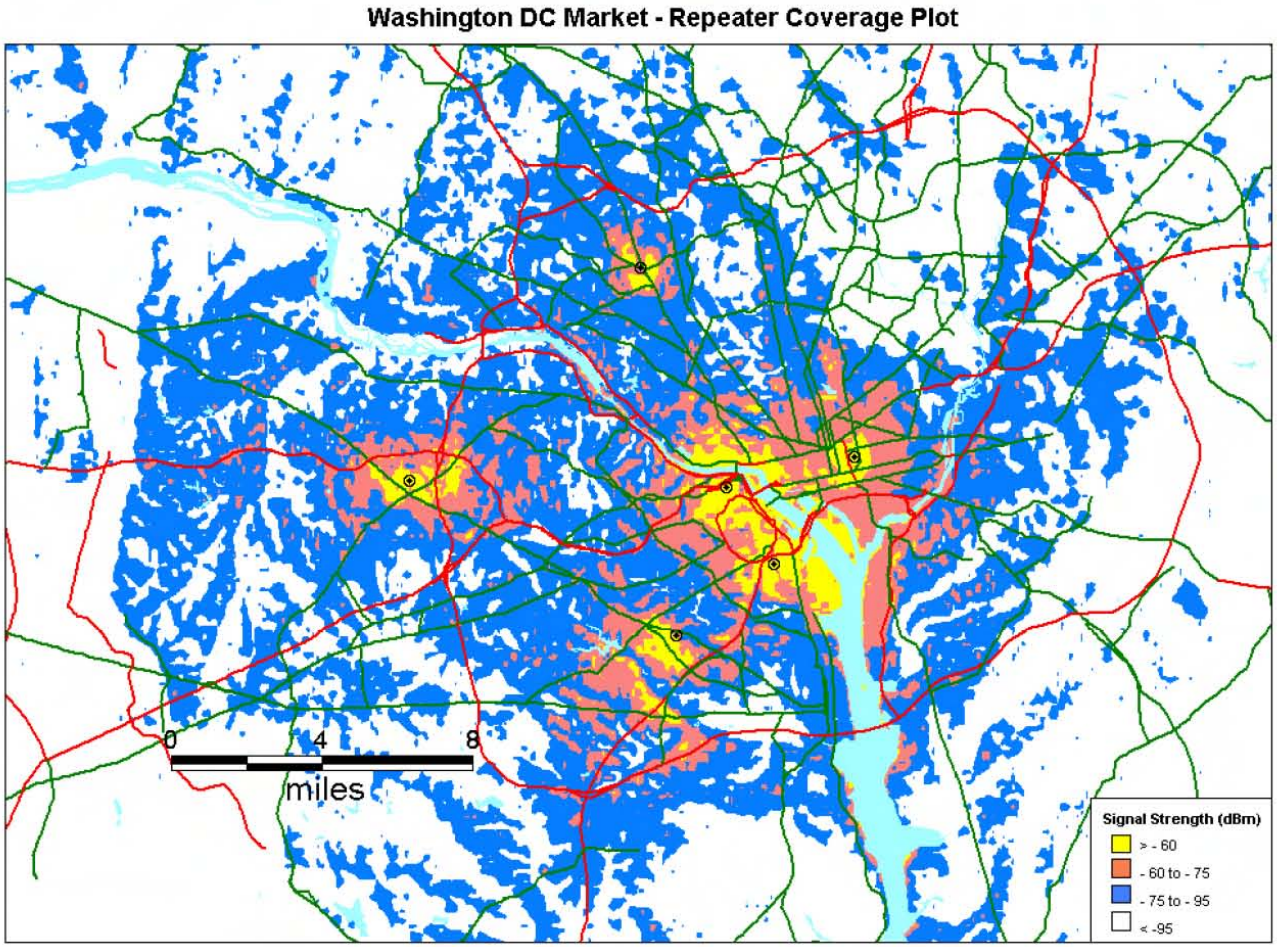
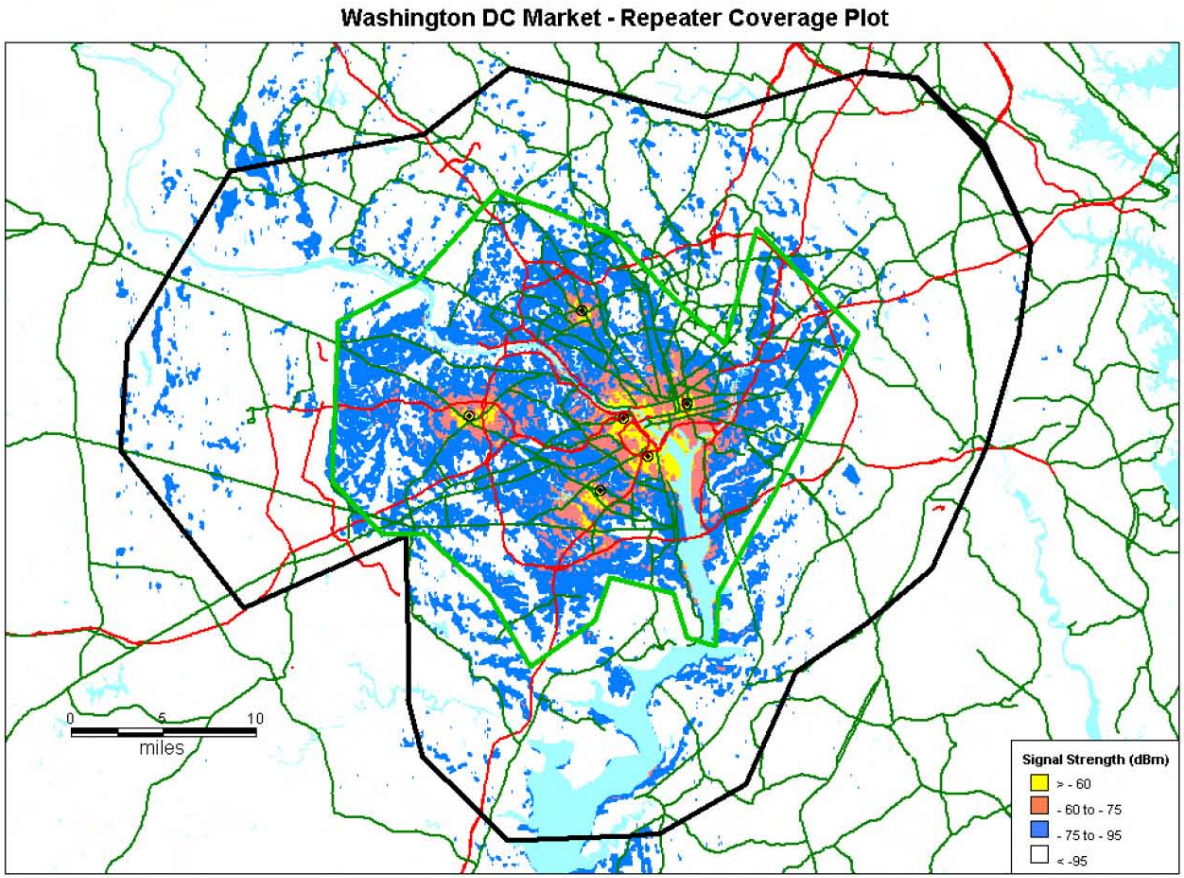


Figure 4 Washington Market Coverage Comparison with WCS Coalition Plot



WDC Active sites	Area (Square miles)
WCS boundary (Black) (estimate)	1420
SSR boundary (Green) (estimate)	450.2

Appendix B to Exhibit A
Sirius OOBE Impact on WCS Base Station Receivers

SDARS Repeater Out of Band Emission Limits

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

The out of band emissions in a 1 MHz bandwidth outside of the range 2320 to 2332.5 MHz shall be attenuated by 75+10log(P) dB with respect to the Effective Isotropic Radiated Power (EIRP) P, in watts.

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

This industry leading performance ensures that Sirius transmitters easily comply with the agreement with AFTRCC to reduce or eliminate any potential interference to AFTRCC telemetry operations. However Sirius cautions that a large scale deployment of WCS base stations meeting the Coalitions Base Station transmitter OOBE proposal (which Sirius is willing to agree to in the context of protecting its own operations) would dramatically increase the potential for interference to these telemetry operations.

WCS OOBE Impairment Criteria

The WCS Coalition comments describe an area surrounding each SDARS terrestrial repeater in New York and Washington DC 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.[11]

The exact analysis used by the WCS Coalition to arrive at OOBE impairment criteria is somewhat unclear; Sirius has made the following assumptions of the analysis:

A 1 dB rise in the receiver noise floor is the stated impairment criterion.[12] The relevant noise floor is calculated as follows:

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10 Comments of the WCS Coalition, WT 07-293, February 14 2008, II(A)(2).

11 *Id.* note 41. *See also*, Attachment D.

12 *Id.*

The base receiver noise floor is stated as -114 dBm/MHz. This is assumed to be the nominal thermal noise floor in a 1MHz bandwidth (BW), (i.e. -174 + 10log (10^6)).

The WCS Coalition applies a 4dB receiver noise figure, which produces an input referenced noise power of -110 dBm/MHz.

The 1 dB rise is applied by subtracting 6 dB from this value to give -116 dBm/MHz (-109 dBm/5 MHz BW) as the receiver input referenced OOBE impairment criterion.

The WCS receiver antenna is stated to have a gain of 17 dBi, no downtilt with respect to the line of sight from the SDARS repeater and zero cable loss.[13]

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

SDARS Repeater Exclusion Zone Calculation

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

Using a simple free space model this corresponds to a zone of less than 300 meters around an SDARS repeater. This is less than ¼ of the WCS Coalition claim of 1,400 meters (and, obviously, 1/16 of the impact area).

In addition, even small amounts of WCS base station receive antenna downtilt, which is almost certainly an element of any deployment consistent with the WCS Coalitions' proposals,[14] for this gain of antenna will introduce significant additional attenuation of the OOBE signal from the SDARS repeater due to mismatches in the boresight alignment of the WCS receive and SDARS transmit antennas. For example, 5 degrees of downtilt for a 17 dBi gain sector antenna will introduce more than 20 dB of additional attenuation (Figure 5). Assuming even 6 dB of additional attenuation due to receive antenna downtilt, leads to an exclusion zone of less than 130 m. All of Sirius' Washington sites and all but one of the NY sites are above the 30 meters in height stated as the nominal WCS base station receiving antenna height.

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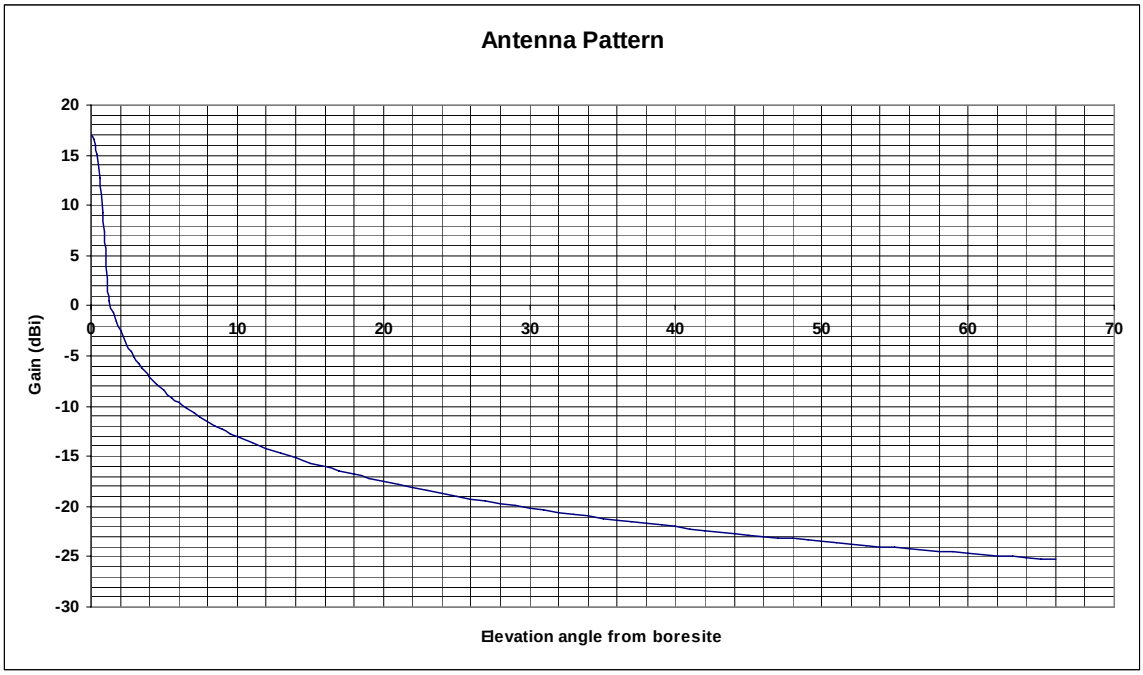
[13] Sirius notes that these assumptions represent poor modeling; base receive antenna for mobile services typically employ downtilt and cable loss must always be factored.

[14] Comments of the WCS Coalition, WT 07-239, II(B)(1) ("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")

The size of these predicted exclusions zones lend themselves well to coordination among adjacent band licensees. This is especially true for the limited number of repeaters that Sirius deploys in a metropolitan area. For these reasons, Sirius believes that this interference mechanism is of little relevance to the discussions in these proceedings.

Figure 5 From ITU F1336, 90 degree 17 dBi gain



Appendix C Repeater Coverage >-44 dBm and >-35 dBm

Introduction

Sirius has proposed that all SDARS repeaters would meet a ground based limit of 110 dBµV/m (-35 dBm equivalent isotropic received power), which would be sufficient protection for mobile WCS terminals based on Sirius current understanding of the likely characteristics of such devices.[15] The WCS Coalition filing used the original Sirius proposal of 100 dBµV/m, made before sufficient information on the characteristics of likely WCS mobile terminals were known. To allow an appropriate comparison both values are examined here.

Even at the previously proposed limit the area where the SDARS signal is greater than -44 dBm is much smaller than the Coalition's prediction indicates. Figure 6 shows the predicted area in the NY market (note area is zoomed in as this is the only area within the NY market where the levels are greater than -44 dBm.). Figure 9 shows the same for the Washington market. To further illustrate these issues, actual drive test data is provided also showing the small areas where signal levels greater than -44 dBm exist.

Prediction Information

Model Parameters

The model parameters used are shown in Table 5.:

Table 5 Model Parameters Used for -44 dBm Prediction

Item	Value	WCA Filing Nearest Equivalent
Model type	CRC-Predict	"DVB-H"
Terrain resolution	30 meters	Not specified
Clutter	12 categories, 30 meter resolution, 2005/7	Not specified
Coverage criteria	Received signal >=-44 dBm Received signal >=-35 dBm	Received signal >-44 dBm
Receiver height	2 m AGL	2 m
Location probability	50%	90%
Fading margin	n/a dB	7 dB

[15] Comments of Sirius Satellite Radio Inc., WT 07-293, V(A)(2)

Figure 6 NY Coverage Map Showing Ground Based Levels >=-44 dBm

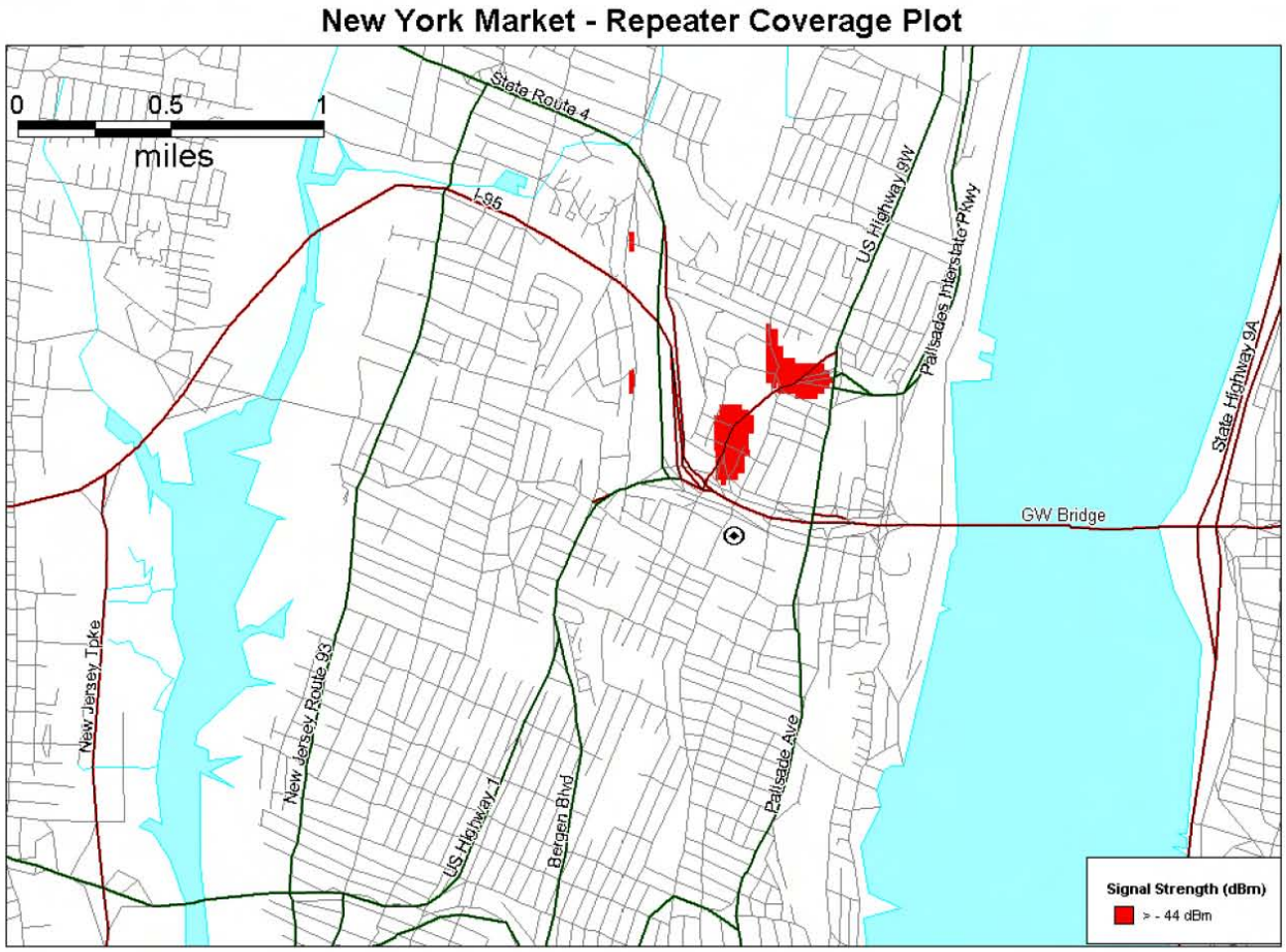


Figure 7 New York Drive Test Measurements

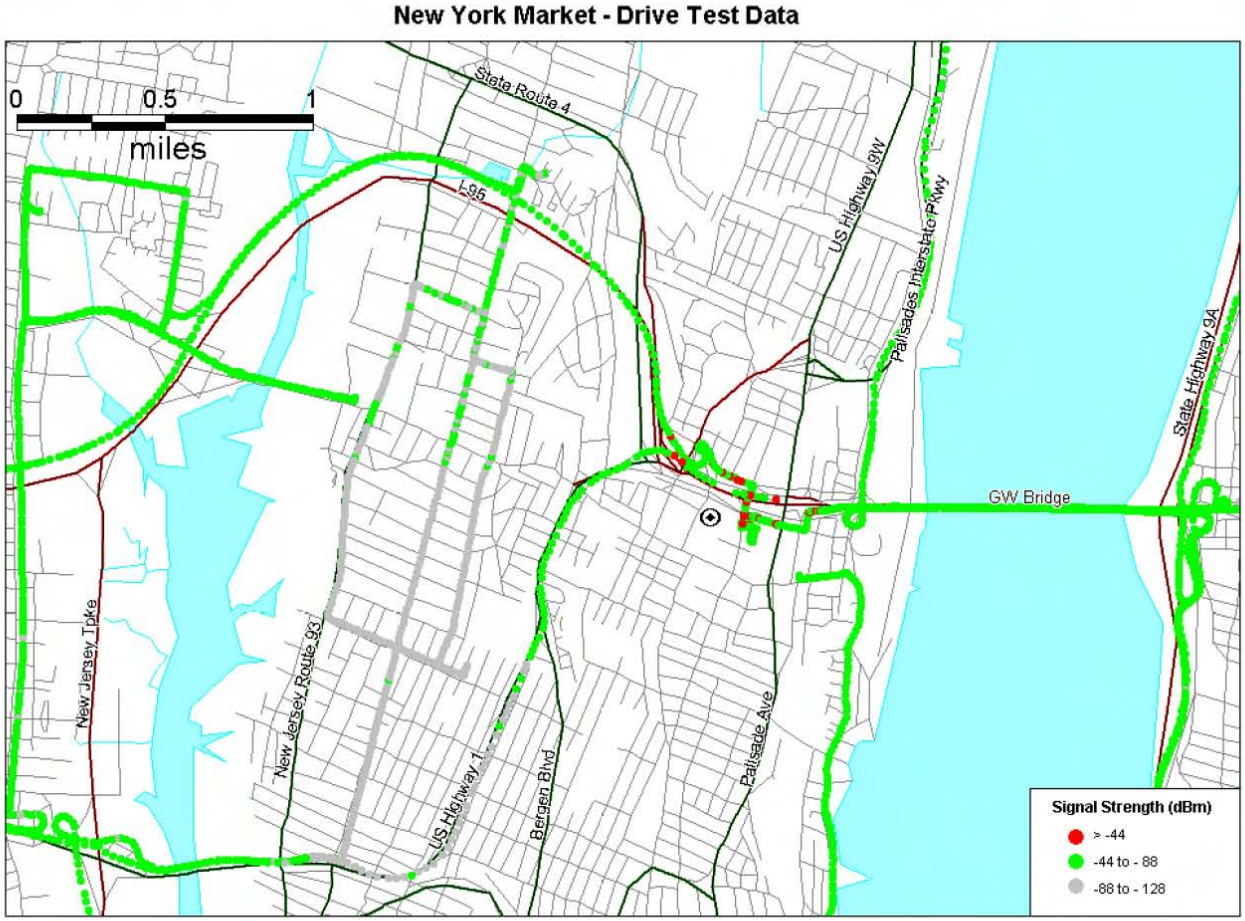


Figure 8 NY Coverage Map Showing Ground Based Levels >=-35 dBm

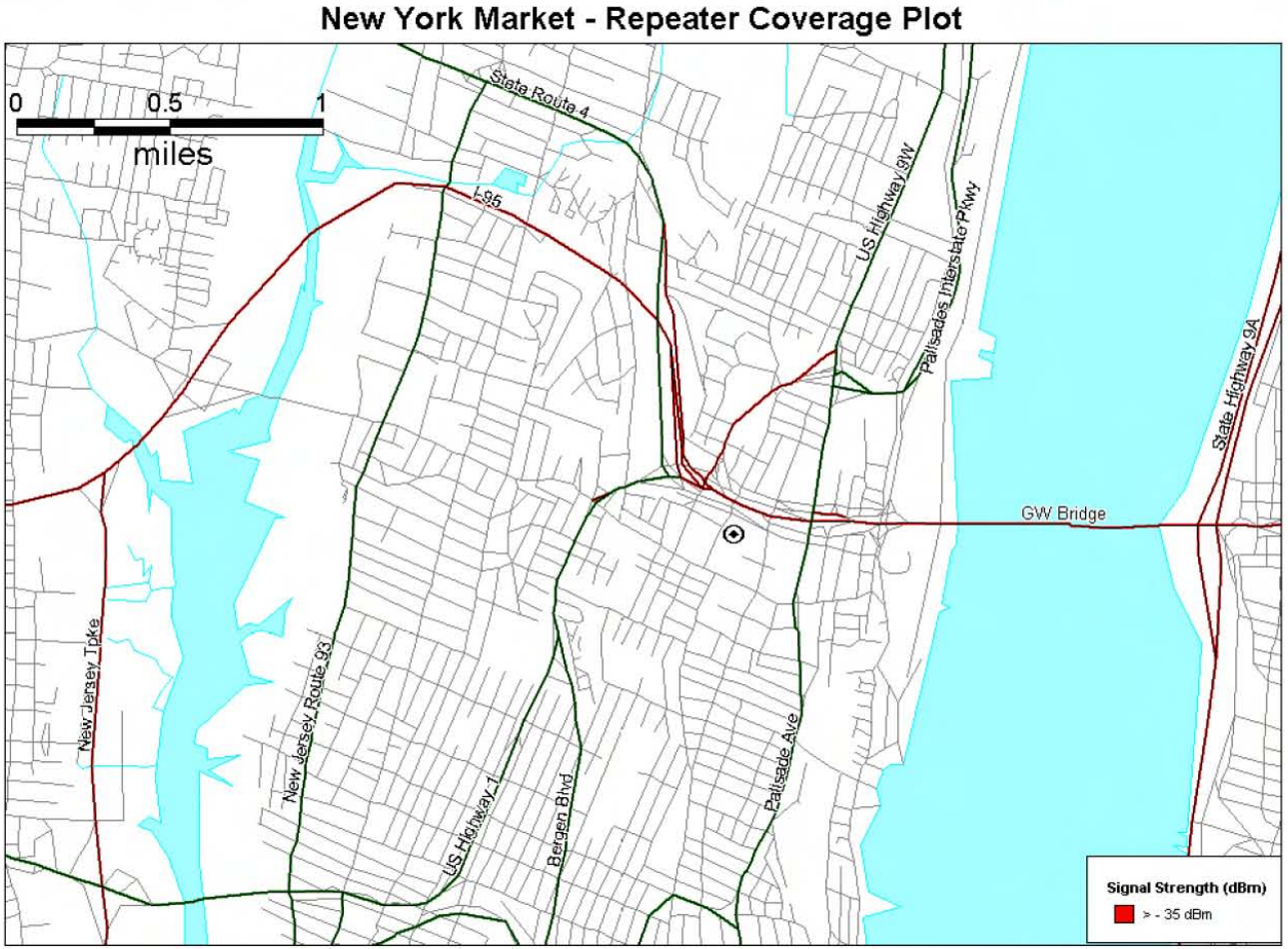


Figure 9 Washington Coverage Map Showing Ground Based Levels >=-44 dBm

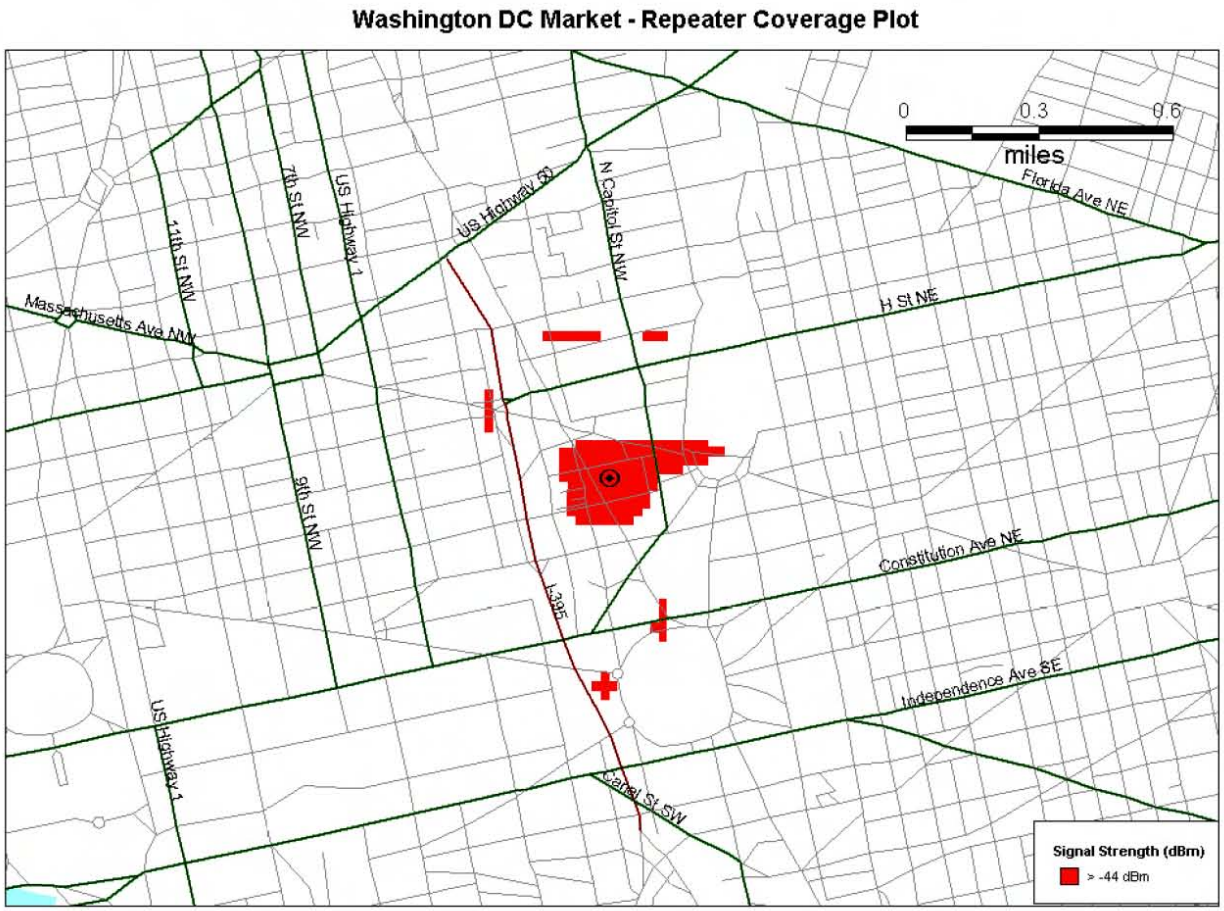


Figure 10 Washington Drive Test Measurements

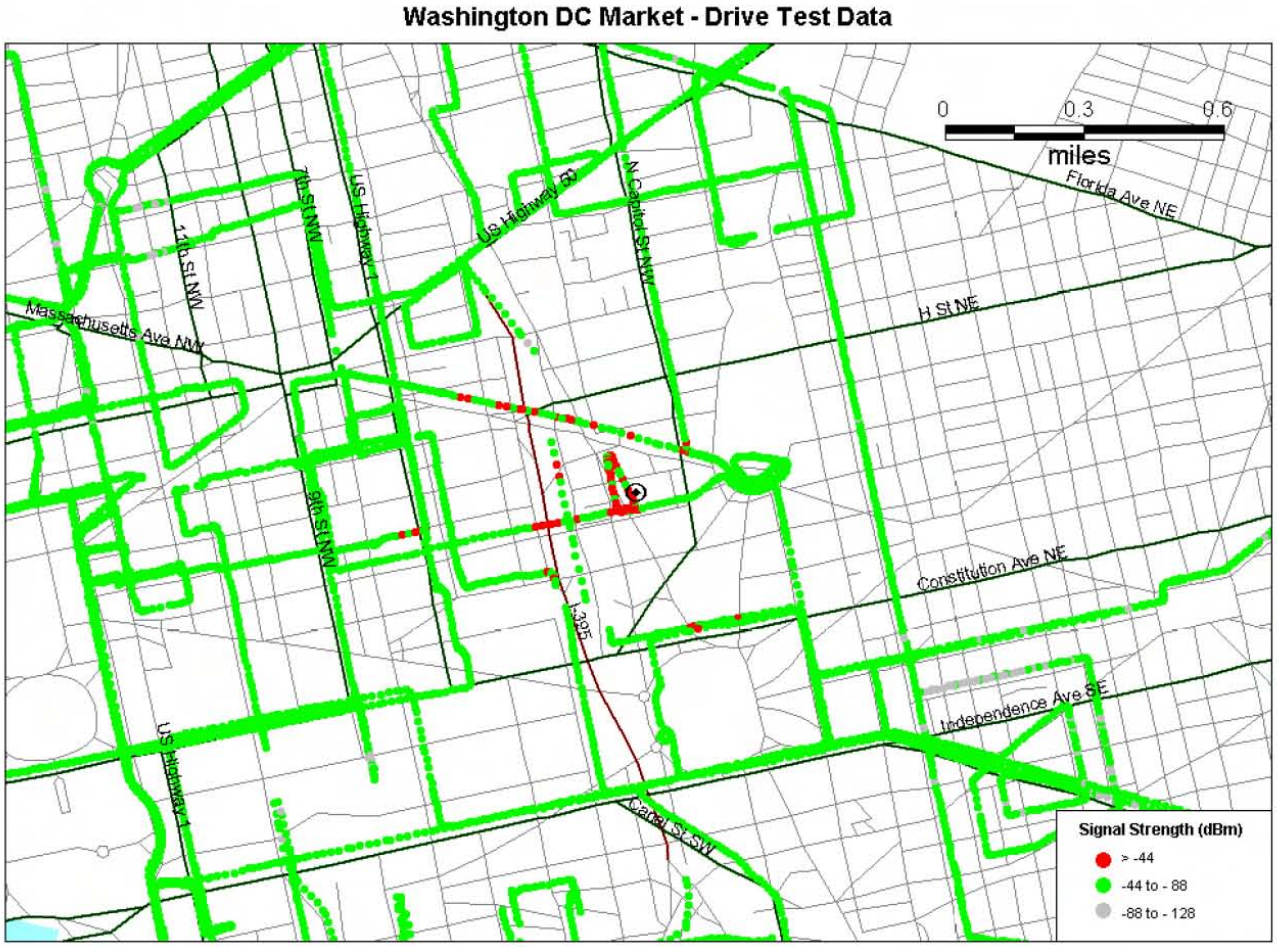
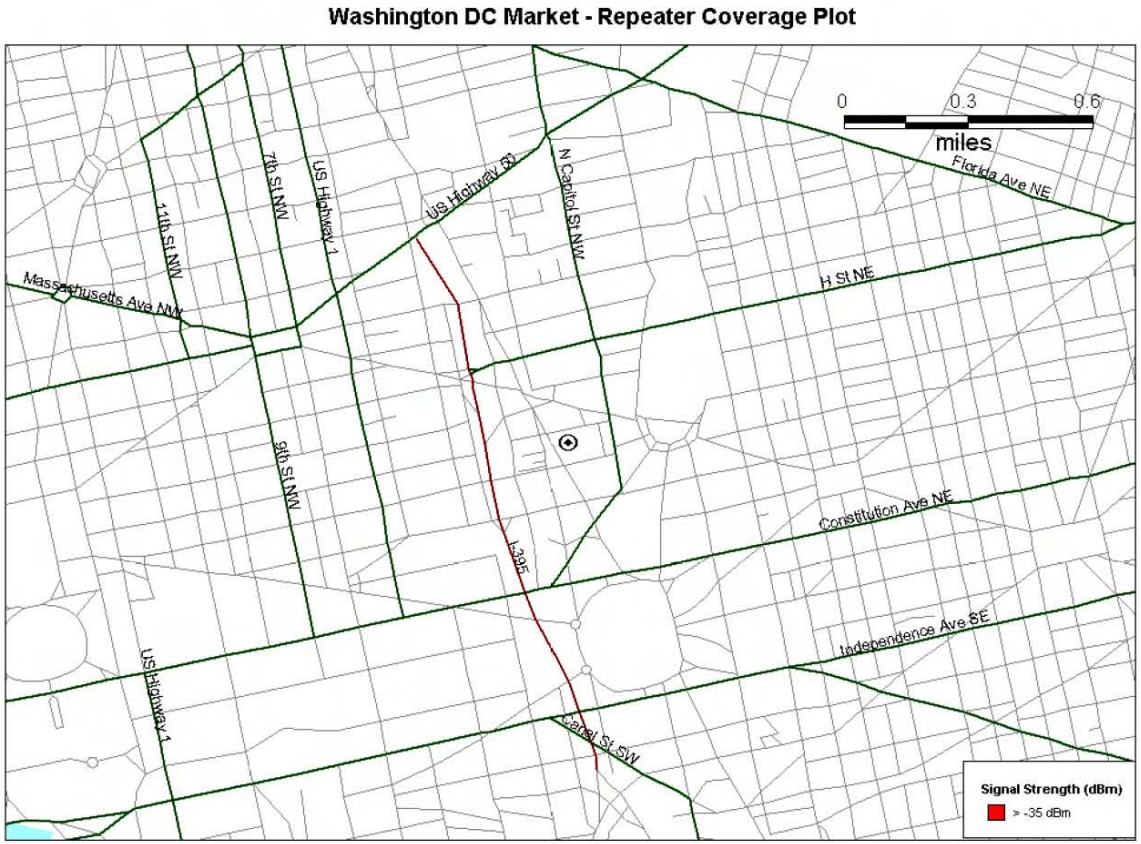


Figure 11 Washington Coverage Map Showing Ground Based Levels >=-35 dBm



Appendix D Sirius Repeater Coverage Maps Showing WCS Base Station Receive Overload Levels

Introduction

In the WCS Coalition filing an attempt was made to illustrate the impact of repeater signal levels on WCS base station receive overload.[16] The WCS Coalition position was that this interference mechanism was not constrained by a purely ground based limit proposal. The analysis presented here consists of the following:

- Evidence is presented that the assumed parameters for this interference model are in error. The calculation is inconsistent with the WCS Coalition's base station OOBE analysis. Additionally, the WCS Coalition's analysis does not take into account other factors that significantly reduce any perceived or real impact.

- A more accurate base prediction is made for each market using the original parameters supplied by the WCS Coalition, which claim that a -40 dBm overload level is appropriate for a typical WCS base station.[17] Predictions are also made based on these more realistic assumptions

.

The results clearly indicate that the market areas even potentially impacted by this interference mechanism are insignificant, even with the WCS Coalition's unrealistic assumptions. For the realistic case presented by Sirius, the results are (for the NY market) 0.01%, (for the Washington market) 0.03%. At any reasonable value of SDARS repeater power, there is therefore no need for the ground based limits proposal to be modified to account for this interference model. Normal site specific engineering practices that are used when either co-locating a new transmitter in a location with multiple radio services or introducing a new transmitter into a market are all that is required.

Calculation Method for WCS BTS Receiver Overload ParametersError! Bookmark not defined.

Sirius is not entirely confident that it understands how the WCS Coalition arrived at the -40 dBm value used for its. Our attempt to replicate the analysis is as follows. The comments of the WCS Coalition state the following:

> *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*
> *BTS ACS 10 MHz sep. 58.0 dB*

---

16 Comments of the WCS Coalition, WT 07-293, II(B)(3)(b)

17 *Id.* at note 60 and note 106.

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.[18]

And also,

> *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*[19]

Reference Sensitivity= -121 dBm.
As stated in footnote 106 of the WCS Coalition comments, this reference value (which defines the effective overload impairment criteria) comes from Table 8 of ITU-R M.2030. This is reproduced here:

> *ITU-R M.2030, Table 8*
> *The BS reference sensitivity levels in Table 8 (specified for a 12.2 kbit/s service, BER must not exceed 0.001) are taken from [1] and [2].*

---

18 Comments of the WCS Coalition at note 60.

19 *Id*. at note 106.

TABLE 8

BS reference sensitivity for FDD and TDD BSs

BS type	***BS reference sensitivity level (dBm)***
FDD macro	*–121*
FDD micro	*–121*
FDD pico	*–121*
3.84 Mchip/s TDD macro	*–109*
3.84 Mchip/s TDD micro	*–109*
3.84 Mchip/s TDD pico	*–109*

The value of -121 dBm chosen is for FDD base stations operating WCDMA and refers to impairing a 12.2 kbit/s data sub-channel (*see* ETSI TS 125 104 V8.1.0 (2008-01), sect 7.1). As this refers to a WCDMA system, as opposed to a mobile WiMAX™ system, this protection level is actually below the thermal noise floor for the associated base station receiver. This is straightforward to see by comparing to the 1 dB noise rise base station receiver impairment criteria used elsewhere in the WCS Coalition's filing for OOBE, namely 109 dBm/5 MHz,[20] which is 12 dB more. In other words, for base station overload, the WCS coalition is using a specification that is 12 dB more stringent than that used for OOBE and refers to an airlink system it doesn't appear to plan to use. In addition, this specification is for an FDD implementation when in fact, according the WiMAX Forum™, such mobile deployments are unlikely to be in this or any other band.[21] The -109 dBm value is more consistent with the TDD base station entries in the ITU-R M.2030.

So, in examining the WCS Coalition's overload model, it should be made clear that it is based on the Coalition assuming that WCS base station receivers are entitled to unprecedented protection levels that are 12 dB below thermal noise. Obviously, should SDARS receivers be viewed as entitled to the same protection levels, Sirius would have to drastically revise its proposed allowed mobile and fixed EIRP levels and OOBE levels downwards.

BTS ACS = 58 dB

This is the receiver adjacent channel selectivity (ACS) as defined by Table 10 of the ITU-R M.2030 specification used by the WCS Coalition. This table is repeated here:

---

[20] Comments of the WCS Coalition, note 41.

[21] *See* "A Comparative Analysis of Mobile WiMAX™ Deployment Alternatives in the Access Network" May 2007, *available at* http://www.wimaxforum.org/technology/downloads/mobile_wimax_deployment_alternatives.pdf.

TABLE 10

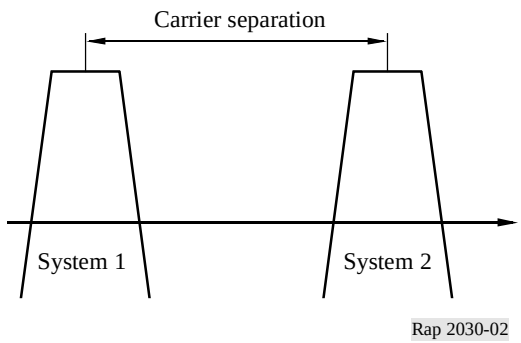
FDD and TDD BS ACS

Carrier separation (MHz)	**FDD BS ACS (dB)**	**TDD BS ACS (dB)**
5	46	46
10	58	58
15	66	66

The definition of "carrier separation" is given in ITU-R M.2030 section 2.3.1, Figure 2, also repeated here:

FIGURE 2

Carrier separation



Using this definition, the relevant carrier separation is 6.25 +2.5 (9.75) MHz for the C,D blocks, 6.25+7.5 (13.75) MHz for the Bl and Au blocks and 6.25+12.5 (18.75) MHz for the Al and Bu blocks. Therefore the use of 58 dB is an overly conservative view and, in practice the more relevant carrier offsets are larger than 10 MHz. with larger associated ACS.

RX Impairment level for jammer= -63 dBm

Sirius assumption: this is the interference level, in a 1 MHz bandwidth, referenced before the adjacent channel filtering, that would lead to the -121 dBm impairment level (=-121+58 dB).

Filter Attenuation=40 dB

Sirius assumption: This is the receiver adjacent channel rejection produced by a separate receive filter, ahead of the LNA, appropriate to the frequency separation between the WCS channel being received and the location of the nearest repeater signal (this separation would have a minimum value of approximately 4MHz for the adjacent blocks and up to 14 MHz for the A blocks). As a comparative benchmark, Sirius low loss transmit filters routinely achieve 20 dB more attenuation (60+ dB) than this at 4 MHz offset.

RX antenna Gain= 17 dBi
Sirius assumption: This is the antenna sector gain. Unrealistically, no cable loss has been included in this number (ITU-R M.2030, Table 6 utilizes a receive antenna gain of 15 dBi as an example).. No downtilt is specified which is at variance with the WCS Coalition's description of the anticipated network deployment configuration, i.e. mobile broadband service.[22]

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

Impairment = -63 +40 -17 dBm referenced to the antenna input = -40 dBm

Sirius notes that this value is based on erroneous protection levels, does not include allowances for cable loss and antenna downtilt attenuation and uses worst case performance in terms of filtering and ACS. Each of these factors increases the realistic overload level of the WCS base station. Conservative estimates of these factors are:

1. Appropriate protection level (equivalent to 1 dB noise floor rise) =-110 dBm (4 MHz). This raises the realistic protection level to -29 dBm.
2. Downtilt attenuation. At 17 dBi antenna gain with even a small downtilt this could easily exceed 10 dB due to boresight misalignment.
3. High quality filtering could easily add 20 dB.

Accordingly Sirius has evaluated each of the markets for two values, the WCS Coalitions -40 dBm and a more realistic -30 dBm level.

Model Parameters

The model parameters used are shown in Table 6 for the base comparison case and in Table 7 for what Sirius believes to be the realistic case.

Table 6 Model Parameters Used for Comparison with WCS Coalition Prediction

Item	Value
Model type	CRC-Predict
Terrain resolution	30 meters
Clutter	Landsat based, 12 categories, 30 meter resolution, 2005/7
Coverage criteria	Signal level > -40 dBm
Receiver height	30 m
Location probability	50%
Fading margin	n/a dB
WCS Base Station Antenna Gain	17 dBi
WCS Base Station Antenna Downtilt	0 degrees

[22] Comments of the WCS Coalition, II(B)(1) ("*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*")

Reference sensitivity	-121 dBm
BTS ACS 10 MHz	58 dB
Rx Filter attenuation	40 dB
WCS base Station Antenna Pattern	Not specified,

Table 7 Model Parameters Used for Realistic WCS Basestation Receiver Overload Prediction

Item	Value
Model type	CRC-Predict
Terrain resolution	30 meters
Clutter	Landsat based, 12 categories, 30 meter resolution, 2005/7
Coverage criteria	Signal level > -30 dBm
Receiver height	30 m
Location probability	50%
Fading margin	n/a dB
WCS Base Station Antenna Gain	17 dBi
WCS Base Station Antenna Downtilt	>3 degrees
Reference sensitivity	> -115 dBm
BTS ACS 10 MHz	58 dB
Rx Filter attenuation	>45 dB
WCS base Station Antenna Pattern	17 dBi ITU or equivalent

. The potential impact areas as a percentage of the market are:

- For the WCS Coalition published base case
  - For the NY market 0.2%
  - , For the Washington market 1.4%
- For the realistic case presented by Sirius:
  - For the NY market 0.01%
  - For the Washington market 0.03%

A comparison of the potential impact areas is given in Table 8

Table 8 Potential WCS Base Station Receiver Overload Impact Areas

30m Receive Height	NYC Area (Square miles)	WDC Area (Square miles)
> -40 dBm	7.55	15.88
> -30 dBm	0.29	0.38

Figure 12 and Figure 13 show coverage maps in the Washington and New York markets using the *unverifiable* overload levels proposed by the WCS coalition. Figure 14 and Figure 15 show coverage maps in the Washington and New York markets using the *realistic* overload levels using the procedure documented above.

These impact areas are well all within those that would be expected to be managed through routine site selection and site specific engineering rather being indicative of a systemic problem.

Figure 12 New York WCS Comparison Base Station Receive Levels Coverage Map

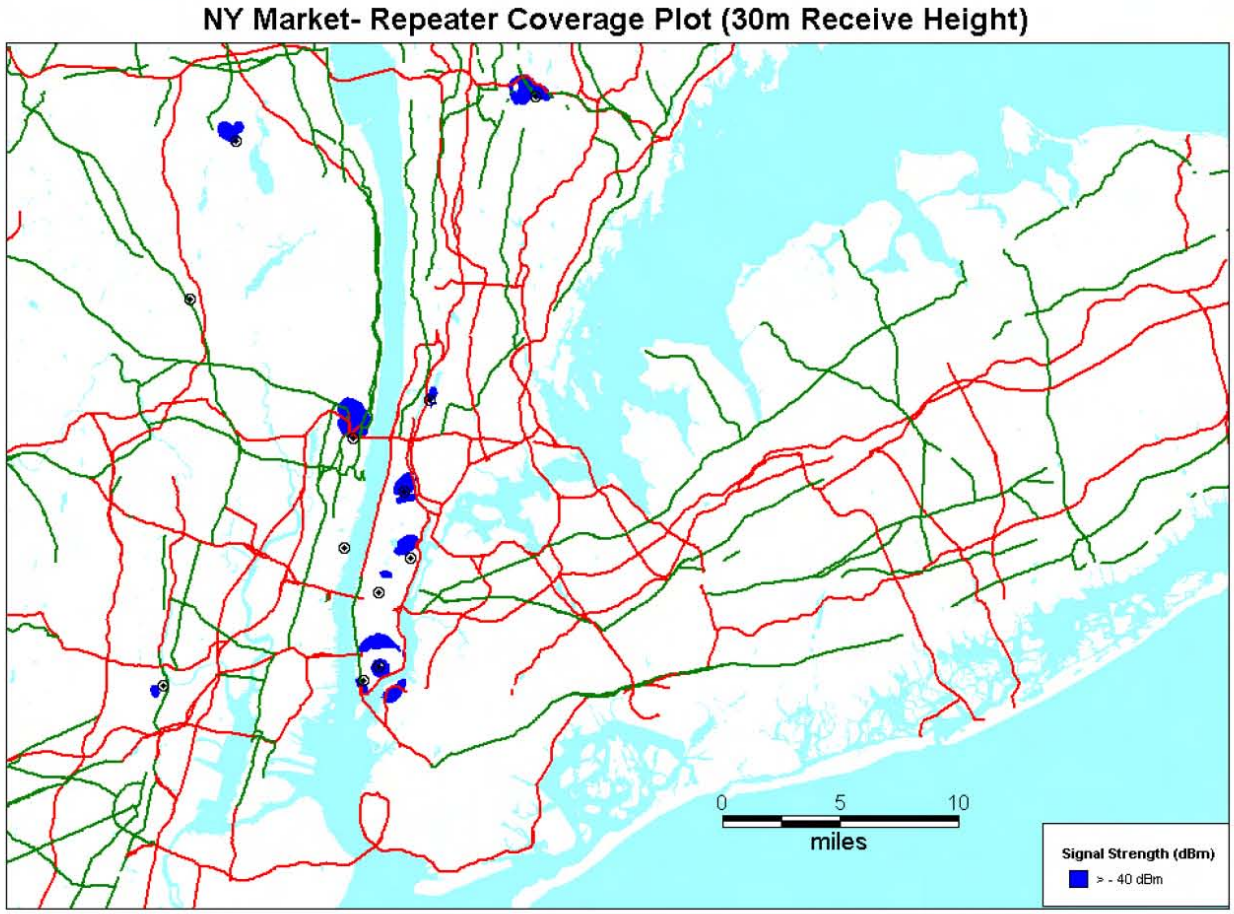


Figure 13 Washington WCS Comparison Base Station Receive Levels Coverage Map

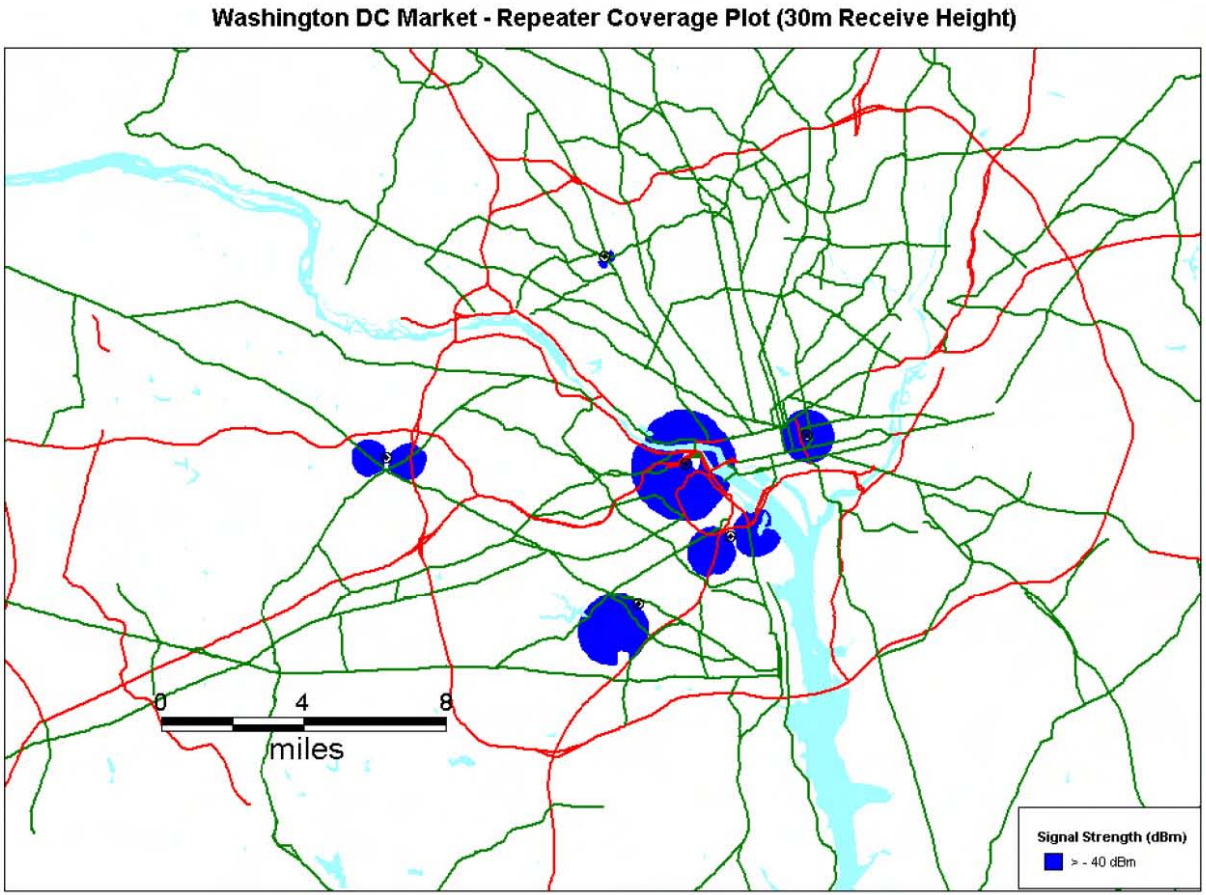


Figure 14 Realistic Coverage Map of WCS Base Station Receive Levels in the New York Market

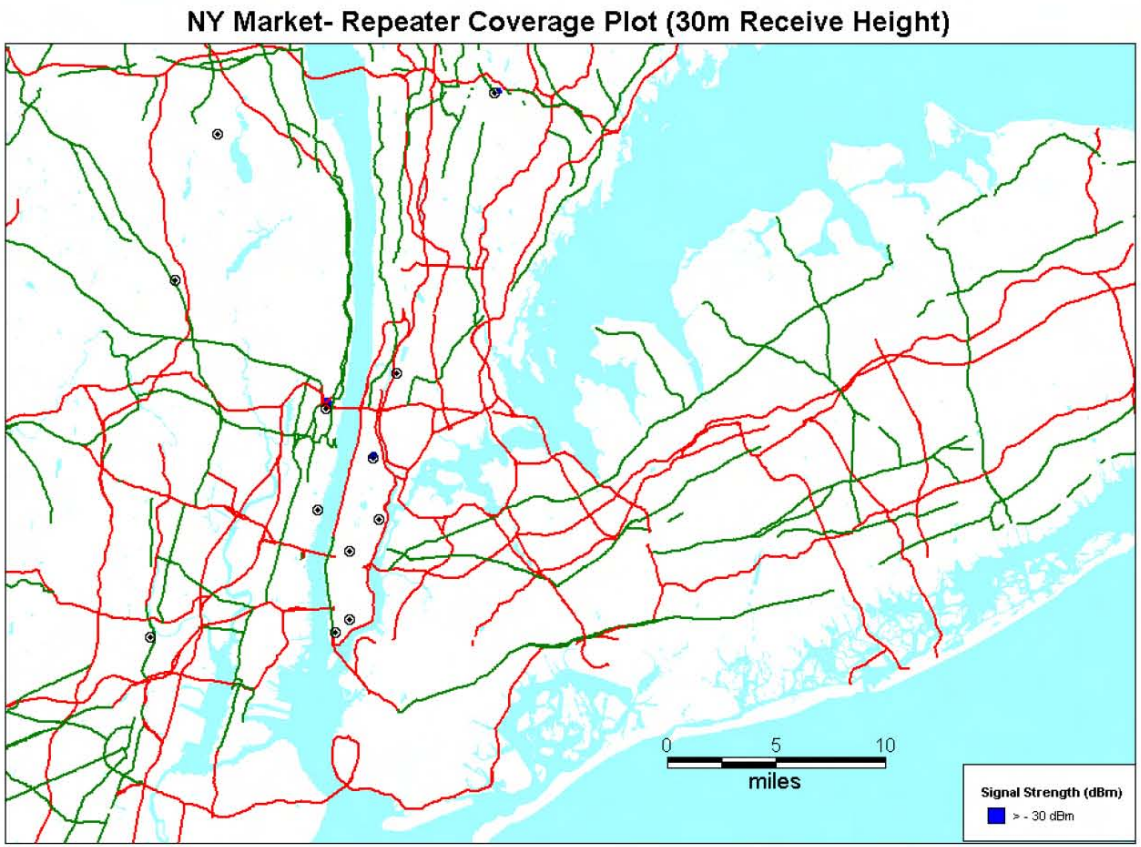


Figure 15 Realistic Coverage Map of WCS Base Station Receive Levels in the Washington Market

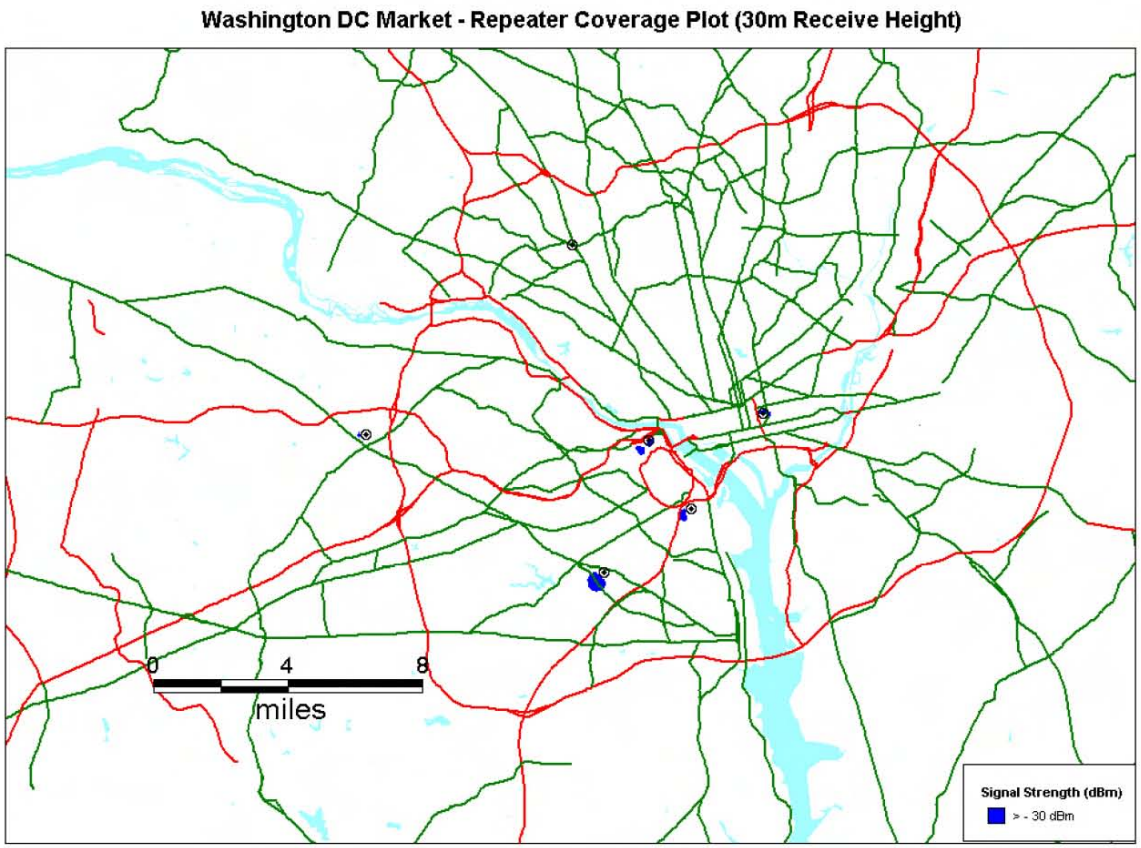


Exhibit B

Interference Modeling for WCS Mobile Terminals and SDARS Receivers

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Executive Summary

This exhibit addresses multiple areas related to improving the modeling of potential interference between WCS and SDARS systems. Four areas are analyzed:

- The estimation of the path loss that would exist between mobile WCS terminals and SDARS receivers in common use cases. A variety of experimental and theoretical materials are considered. As demonstrated herein, these materials support the recommendations submitted by Sirius in its previously filed comments and contradict the analysis presented by the WCS Coalition in previously filed comments.

- The linkage between the WCS terminal power and the WCS terminal out-of-band emissions (OOBE) limits in causing interference to SDARS receivers. It is shown that overload and OOBE need to be considered together and not separately when balancing the establishment of appropriate WCS mobile terminal specifications with the need to protect adjacent band satellite receivers.

- The frequency of occurrence of interference given the most likely use cases of the two services. It is shown that the probability of interference for typical use case scenarios for the two adjacent services is extremely high under the WCS Coalition's proposed rules.

- The performance of SDARS receivers in comparison to other, similar, broadcast receivers. It is shown that the performance of SDARS receivers compares favorably with specifications for other contemporary broadcast services, even though a large fraction of SDARS receivers currently in use were designed more than 5 years ago.

Estimation of Path Loss

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

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

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

While it is common practice in the cellular industry to look at distances of 1 meter when evaluating mobile to mobile interference, Sirius believes a distance of 3 meter is more relevant to its vehicle dominated user base.

Interference Model Use Cases and Associated Path Losses

The anticipated use cases for the type of WCS mobile/portable services that would be enabled by the proposed rule changes are similar to existing cellular service, encompassing a wide range of potential voice and data services used almost anywhere with almost any kind of terminal. In the case of SDARS, the main focus is on customers listening in vehicles

The use cases considered are given in Table 1.

Table 1 WCS/SDARS Example Use Cases

	Interferer	**Victim**	**Applicable distance range (meters)**	**Description**
1	WCS handheld or nomadic terminal in a car	SDARS Receiver in a separate car	3	See **Error! Reference source not found.**, **Error! Reference source not found.**
2	WCS handheld or nomadic terminal not in a car	SDARS Receiver in a separate car	1-3	e.g. Pedestrian using WCS portable terminal on sidewalk

[1] NTIA Report TR-07-449, Propagation Loss Prediction Considerations for Close-In Distances and Low-Antenna Height Applications, Nicholas DeMinco, July 2007.

[2] Propagation Studies For Mobile-To-Mobile Communications", Harold, T.J.; Nix, A.R.; Beach, M.A.; Vehicular Technology Conference, 2001. VTC 2001 Fall. IEEE VTS 54th, Volume 3, 7-11 Oct. 2001 (1251 – 1255).

Distances Relevant for WCS Mobile to SDARS Vehicular Reception Interference Models

The use model here is interference from either a nomadic terminal (e.g. smart phone or laptop) or a handset (e.g. VOIP) user in the passenger or back seat of a car to an SDARS receiver located in a nearby car. We can estimate lane widths from the Bureau of Transportation Statistics. Average lane widths and spacing are given in Table 2[3].

Table 2 Lane Widths

Description	Min	Max
Average lane width on major road (m)	3.30	4.00
Number of lanes on major road (lanes/traffic direction)	2	5

From this information it can be seen that a separation distance of 3 meters is appropriate to this analysis.

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

[3] *See* Description, Factor Levels, Coding System, and Basic Statistics of the Explanatory Variables, Department of Transportation Statistics, *available at* http://www.bts.gov/publications/journal_of_transportation_and_statistics/volume_07_number_23/html/paper_03/table_03_01.html.

Figure 2 Vehicular Use Case

Path Loss Estimation

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

The two graphs that are reprised in Figure 3 show measurements made at 2.1 GHz under a variety of conditions (line of site and non line of sight) for a transmitter and a receiver at low heights and separated by distances up to 25 meters. Only a small difference in path loss would be expected between this data and that at 2.3 GHz. It is clear that, at 3 meters, a path loss of 50 dB or less is involved under these types of circumstances.

One of the results from the recent comprehensive NTIA evaluation of mobile to mobile propagation loss modeling[1] is shown in Figure 4. This too, allowing for the slightly different frequencies puts the expected path loss at 3 meters at approximately 50 dB.

These measurements and estimates of path loss that are provided in these two independent source validate and confirm the analysis presented by Sirius in its initial comments, which recommended a "Free Space + 3dB" methodology for estimating path loss between WCS transmitters and nearby SDARS receivers.[4] As detailed in Exhibit C of this appendix, Sirius undertook additional measurements to confirm its initial recommendation.[5]. As pointed out in Exhibit C and expounded on in Exhibit E of this appendix, the path loss assumptions recommended by Sirius are also consistent with the recommendations submitted by other

4 Comments of Sirius Satellite Radio Inc., Docket WT 07-293, Section 2.3.9 and Exhibit [C].

5 *See* Exhibit C and Figure 5.

parties in various AWS proceedings[6]. Most importantly, this analysis and data contradicts the assumptions and recommendations of the WCS Coalition, who's theoretical analysis exaggerate path loss by at least 10-12 dB over other industry sources and field data.

[6] *See e.g.*, Comments of Verizon Wireless, WT Docket No. 07-195. *See also*, Comments of CTIA-The Wireless Association™, WT 04-356, Dec 8, 2004, note 59.

Figure 3 Measured Peer to Peer Path Loss at 2.1 GHz[7]

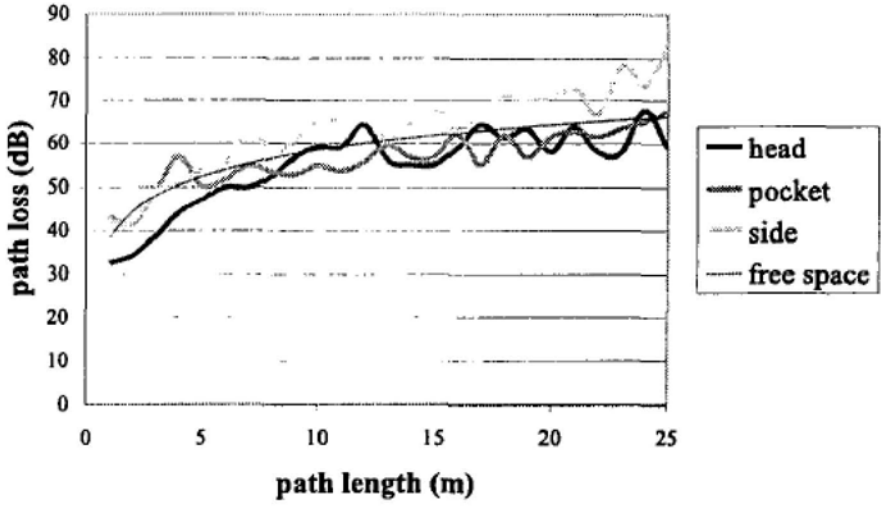


Fig. 4. Path loss for transmitter at head height, LOS path

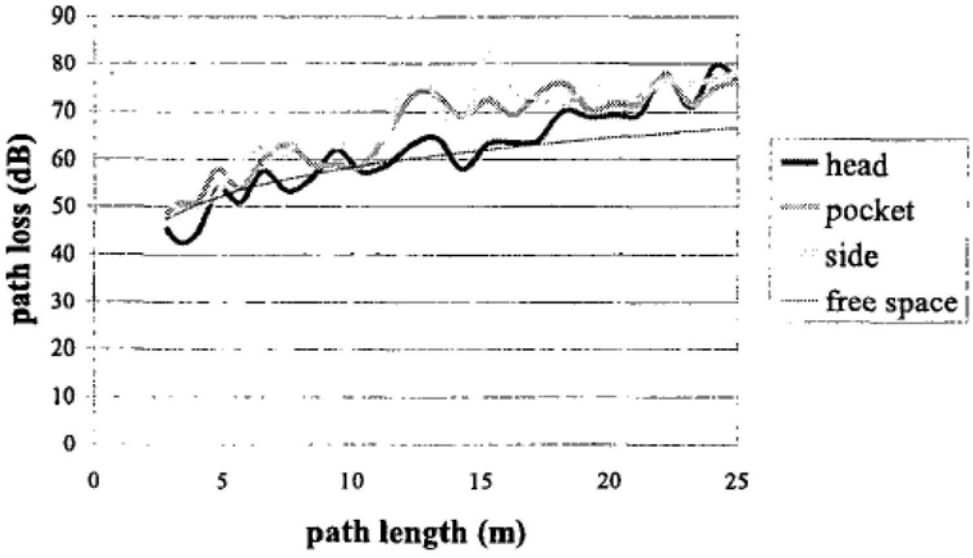


Fig. 7. Path loss for transmitter at head height, non-LOS path

[7] *See* n. 2. *supra.*

Figure 4 Predicted Path Loss (from NTIA Report[1])

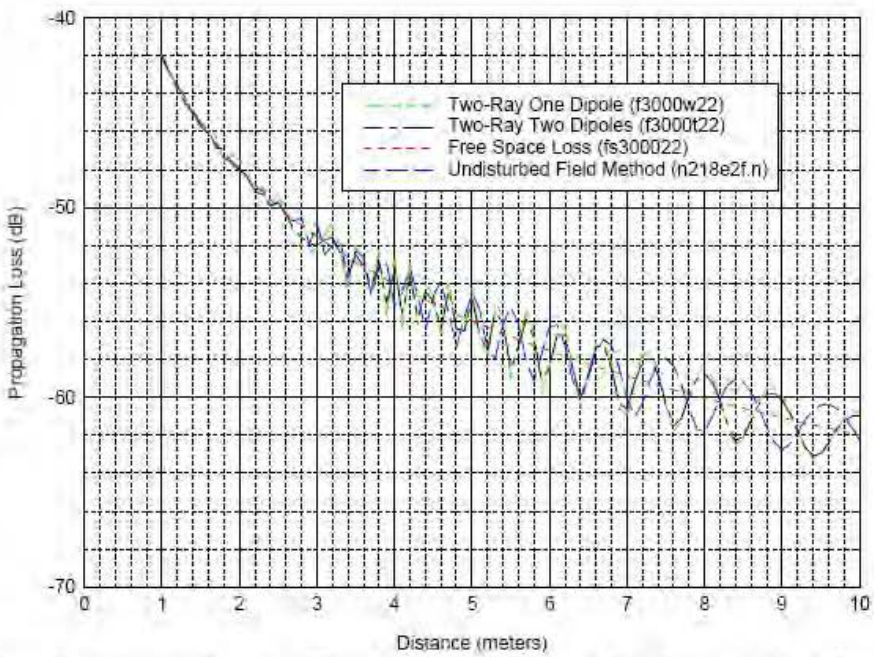
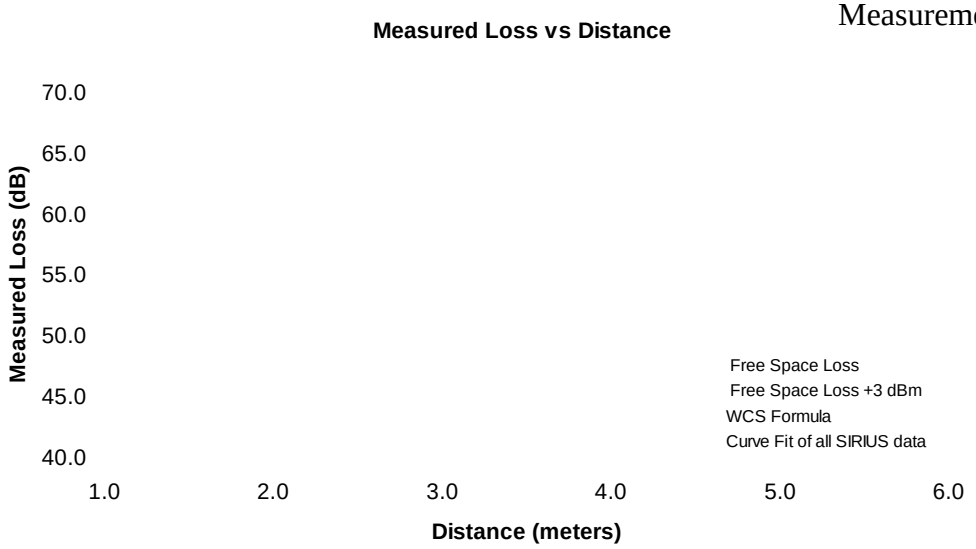


Figure F-34. Comparison of the undisturbed-field method with other methods at 3000 MHz for antenna heights h_1=2m and h_2=2m.

Figure 5 Sirius Re-Measured Path Loss[8]

WCS Measurements



8 The description of this figure is detailed in Exhibit C of this filing. It is reprised here for clarity.

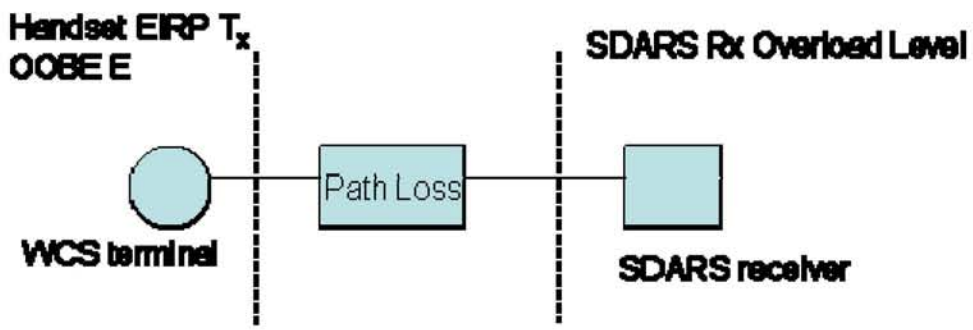
Relationship between WCS Terminal Transmit Power and Out of Band Emission Limits

Introduction

One of the central issues in this proceeding is the proposal of the WCS Coalition to relax the mobile terminal out of band emission (OOBE) limits (by a factor of over 100,000). To gain a full understanding of the issues associated with that recommendation it is necessary to analyze the relationship between OOBE and mobile transmit power in terms of the interference impact on satellite radio reception as they are linked together in terms of their overall effect on reception.

The model of Figure 6 illustrates the basic interference model of a WCS handset at a distance D from a satellite receiver. The WCS handset has an EIRP of T_x dBm and an out of band emissions limit of OOBE (in 1MHz BW) which can be expressed in the form xxx+10log (P) where P is the transmitter output power in watts). For simplicity, the WCS handset antenna gain is assumed to be 0 dBi and so transmitter output power equals EIRP.

Figure 6 Trade Space Model



The distance D has associated with it a certain path loss which attenuates both the transmitted WCS signal and the out of band emissions equally. It is instructive to calculate the pair of values (i.e. the values of WCS Terminal EIRP and WCS Terminal OOBE), associated with a given distance D that each cause the satellite radio to be impaired. In the case of the transmitted WCS signal Sirius has demonstrated in its white paper and its previously filed comments that satellite receiver will mute at a field strength of 100 dBµV/m (equivalent isotropic antenna received level of -44 dBm) in the WCS A, B blocks and 90 dBµV/m (equivalent isotropic antenna received level of -55 dBm) in the WCS C and D blocks. In the case of OOBE, the 1 dB noise floor rise criteria implies the impairment occurs when -125 dBm is received in a 1MHz bandwidth[9].

To establish the trade space it is necessary to choose a path loss model that is appropriate to the short distances used. For the calculation, the path loss associated with the separation distance is calculated using free space path loss +3dB.

[9] Comments of Sirius Satellite Radio, WT 07-293, Exhibit [C)].

The calculation proceeds as follows to determine the maximum allowable WCS terminal EIRP level:

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

- The maximum allowable WCS terminal EIRP is then calculated by adding the path loss to the appropriate receiver overload level, using the equivalent power that would be received by an isotropic antenna. (-44 dBm in the case of A, B blocks and -55 dBm in the case of C,D blocks).

The calculation proceeds to determine the maximum allowable WCS terminal OOBE level as follows:

- The maximum allowable OOBE in 1 MHz bandwidth is then calculated by adding the path loss to that noise power that (in 1MHz) causes a 1 dB increase in the Sirius noise receiver noise floor of -113 dBm.

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

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

At a separation of 3 meters between the WCS mobile terminal and the victim satellite receiver, this analysis establishes a maximum WCS mobile transmitter EIRP of less than 10 dBm and an OOBE requirement of approximately -107 dB + 10 log (P) for operations within A and B blocks to avoid causing harmful interference.

It should be noted that the WCS Coalition overload and OOBE with a 2 W mobile WCS terminal[10] which would then require 77 dB of path loss for the WCS A and B blocks and 87 dB of path loss for C and D blocks. Based on the established free space + 3 dB model, this corresponds to an exclusion distance of over 51 meters for A and B blocks and over 163 meters for C and D blocks. Clearly such exclusion zones would significantly impact SDARS reception over large areas as is illustrated in the next section.

[10] Comments of the WCS Coalition, WT 07-293.

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

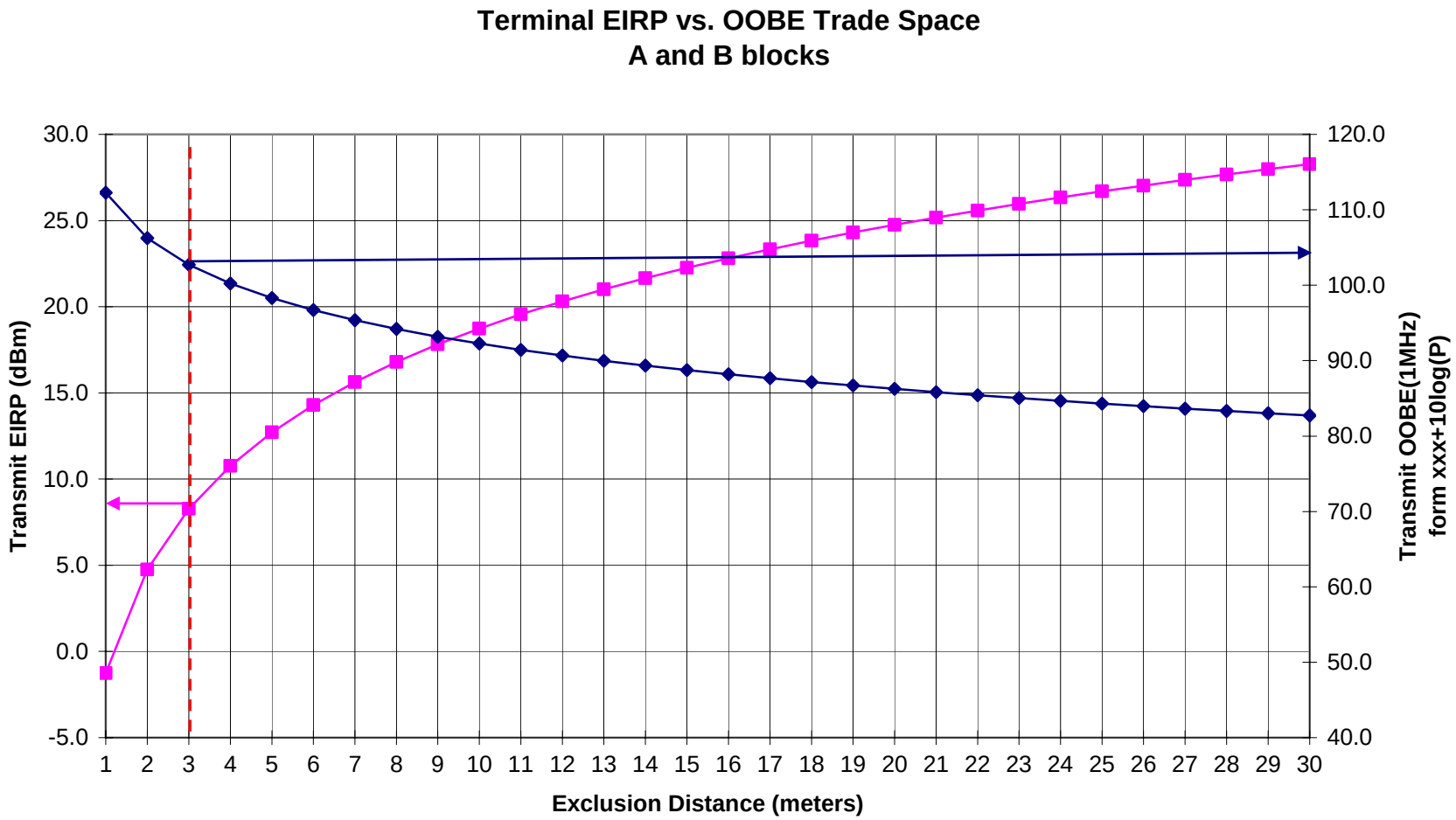
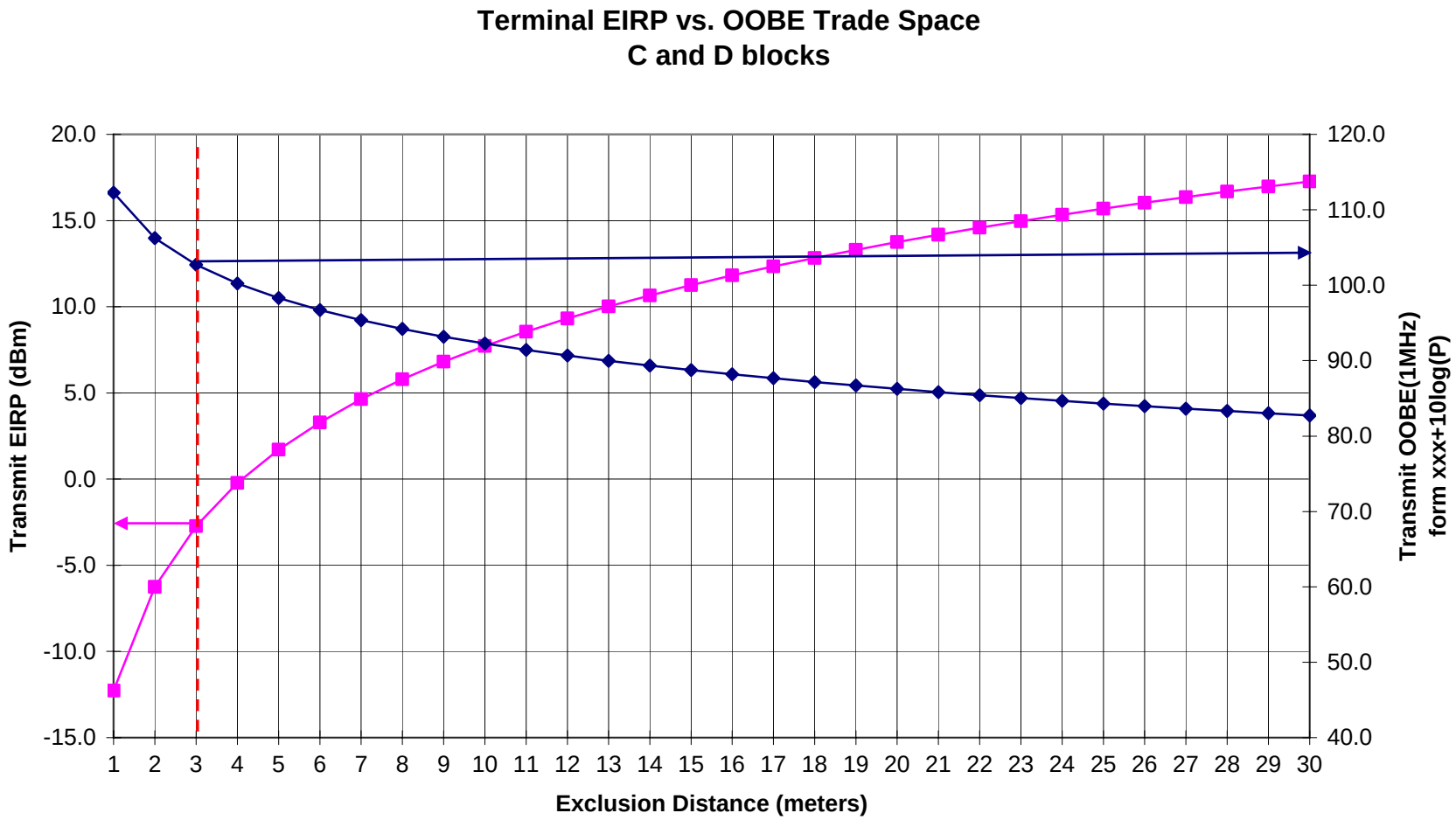


Figure 8 WCS Terminal EIRP/OOBE Trade Space (C,D Blocks)



Example Interference Models

As a simple example of the likely impact of these interference zones on Sirius service consider the roadway segments illustrated in Figure 9 and Figure 10. These are road junctions associated with the New Jersey Turnpike, a high volume toll road and Route 18, a high volume highway. These represent a "real world" concentration of SDARS customers in contrast to the arbitrary uniform distribution assumed by the WCS Coalition in their probability model. The circles represent the two interference distances associated with the WCS Coalition proposal (Figure 9 for the WCS C and D blocks and Figure 10 for the WCS A and B blocks). There is little to no residual repeater coverage in these areas (as it is not needed due to "open sky" satellite coverage).

It can be seen that the zones encompass all the lanes and some of the access ramps of both these highway types.

Additionally Figure 11 illustrates the exclusion zone that would be associated with C or D block operation of a single 2 W WCS terminal in the center of downtown Princeton NJ. This town has sidewalks along the main street. While buildings and trees would provide additional protection, all the traffic on the main streets would be directly affected.

Figure 9 C and D Block Interference Zone, from a 2 W WCS Terminal

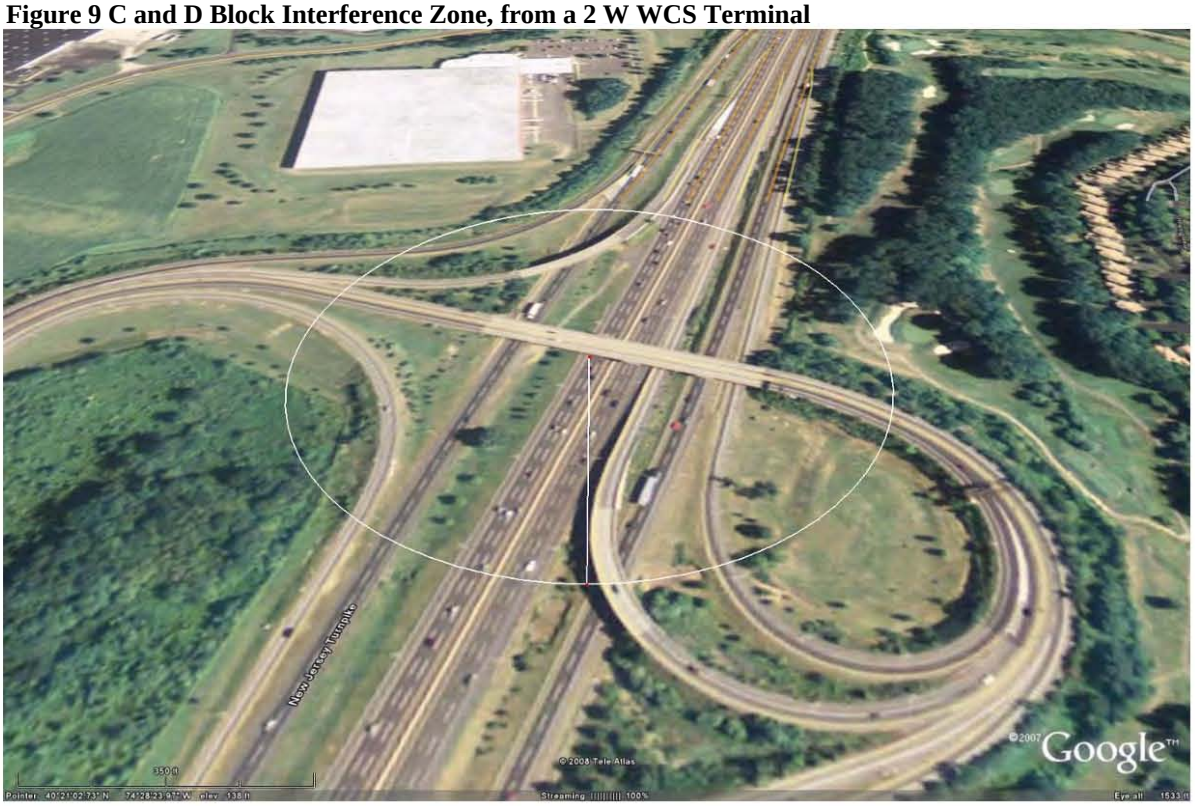


Figure 10 A and B Block Interference Zone, 2 W WCS Terminal

Figure 11 C, D Block Exclusion Zone Princeton, NJ from a 2 W WCS Terminal

To get a numerical sense of the problem without resorting to elaborate computer models, we can examine the New Jersey Turnpike example with a simple interference model as follows:

Figure 12 shows the road segment between two junctions. The segment length is approximately 16 miles. The average daily traffic volume between these two junctions (either direction) is approximately 80,000 vehicles per day (2006[11]). It can be assumed that the majority of this traffic volume is concentrated within a total period of 8 hours out of the 24 (4 hours in the morning and 4 hours in the evening), giving an average volume per hour of 10,000 vehicles.

We can also estimate the average penetration rate of SDARS receivers into these vehicles as follows:

Number of vehicles in the USA:[12]	143,000,000 (2005)
SDARS subscribers:	17,000,000 (2007)
% of Subscribers using their radio in a vehicle:	95%
Average vehicle penetration rate:	11.2% (16M/143M)

We can then estimate the average number of SDARS equipped cars traveling this segment at any instant during the "busy hours" as follows:

Volume on the NJ turnpike segment per hour:	10,000 (both directions)
Distance traveled:	16 miles
Average speed:	60 MPH
Average time to travel between junctions:	0.267 hour (16/60)
Average number of vehicles on segment in one direction at any instant during busy hours:	2670 (0.267*10000)
Number of SDARS equipped vehicles on segment in one direction at any instant during busy hours:	298 (0.112*2670)

Now consider what happens when a single WCS WiMAX™ equipped vehicle gets onto the turnpike at the first exit and gets off at the other. During this trip the vehicle will pass, on average, 298 SDARS equipped vehicles going in the opposite direction. Each interaction can be modeled in terms of the time variance of the separation distance between the passing vehicles.

Using **Figure 13** we have:

Separation = S
Highway Spacing = H
Average speed vehicle 1 =V_1
Average speed vehicle 2 =V_2

---

[11] http://www.state.nj.us/transportation/refdata/roadway/TextFiles/2007/NJTPK_2006.pdf.

[12] http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html.

Assume vehicles start approaching each other at arbitrary time t=0 with an initial horizontal separation distance D

Then :

The separation at time t, $S(t) = SQRT([D- (V_1+ V_2)t)]^{\wedge 2}$

For this segment:

H= (11 meters to 29 meters) = 20 meters (average)
V_1, V_2= 60 mph (free flowing traffic)
D= 300 meters

The results are illustrated in Figure 14. The conclusion for this simple use case example is that a *single* WCS equipped vehicle traveling between these two exits has the potential to cause over 298 individual customer muting events in about 20 minutes of travel, each one lasting up to 6+ seconds for a C or D block transmission and up to 2+ seconds for an A or B block transmission.

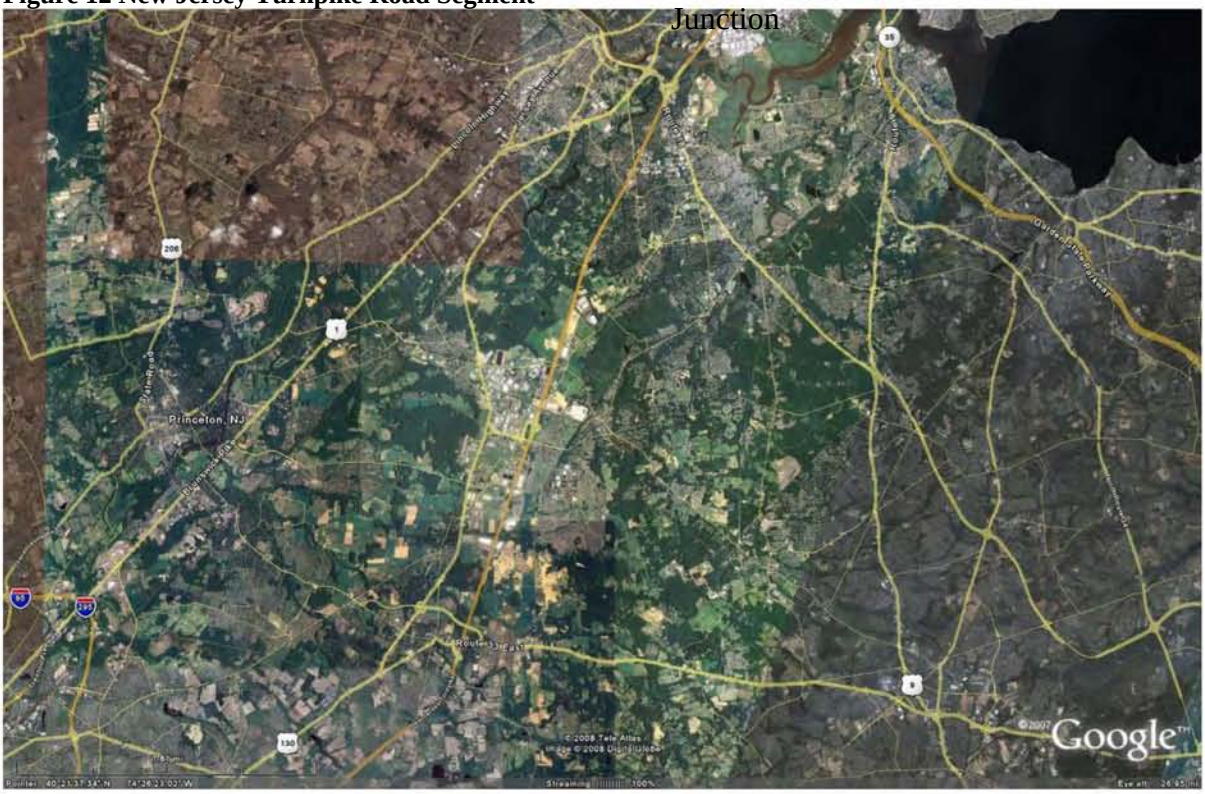
Under normal interference free conditions an SDARS customer would be expected to have NO muting events during this 20 minute commute as there is continuous access to one or both satellite signals with few overhead obstructions.

As can be seen, with the introduction of a single WCS equipped mobile using the Coalition's proposal, up to 298 customers will experience muting where they have none today on this one segment of highway.

Clearly, assuming more WCS equipped mobiles, slower speeds, closer highway spacing or adding in vehicles on the same side of the highway only intensifies the problem.

Figure 12 New Jersey Turnpike Road Segment

Ending Junction



Starting Junction

Figure 13 Turnpike Model

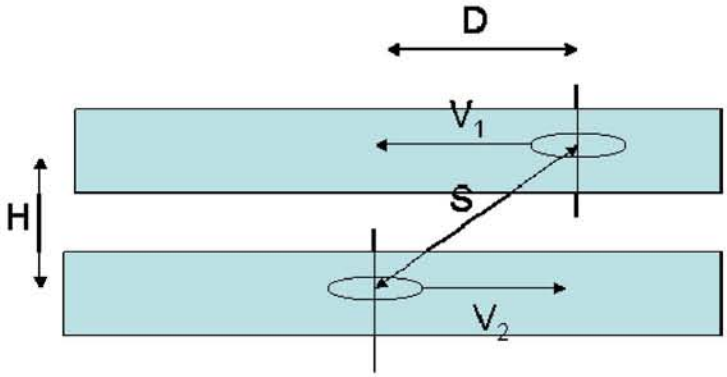
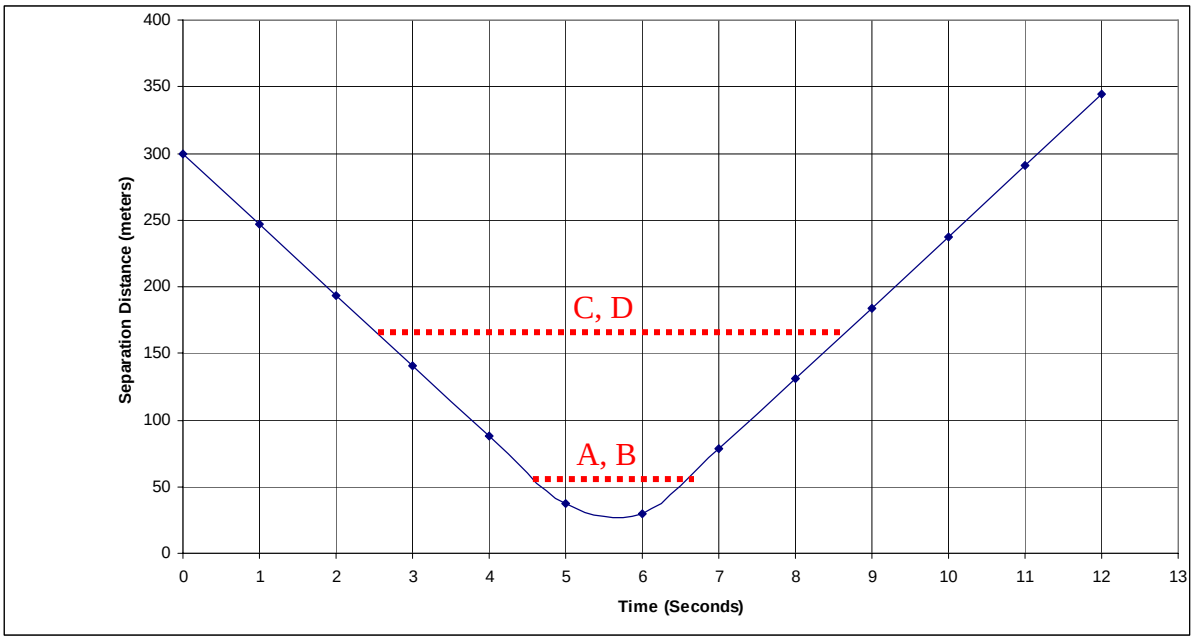


Figure 14 Vehicle Separation as a Function of Time



SDARS and DVB-H Receiver Performance Comparison

SDARS receivers are designed to allow mobile reception of the relatively weak satellite signals from 48,000 kilometers in space as well as taking advantage of any available repeater signals. In order to receive the satellite signals whose levels can be as low as -102 dBm, the operating noise floor of the receivers has to be lower than for a corresponding cellular device. The receivers come in a variety of formats including factory installed in cars, portable, aftermarket installed in cars. At this point in time, Sirius has produced three generations of SDARS receivers, which are now used in a variety of applications ranging from cars to handheld or belt mount portable units.

One way of benchmarking these receivers in terms of dynamic range (one of the key criteria in understanding adjacent band impact) and noise floor is to compare the performance against the more recent DVB-H standard specifications for portable receivers. The DVB-H receiver design target is to pass the MBRAI (2.0 specification) Mobile and Portable DVB-T Radio Access Interface Specification.[13]

For example it can be seen from Section 10.8.1 of the specification that the noise floor specification for a DVB-H handset is approximately -104 dBm after correcting for the slight bandwidth differences involved. This, compared to the -113 dBm SDARS noise floor illustrates the contrast between the satellite delivered service and the terrestrially delivered DVB-H and WiMAX services in terms of required noise floor protection.

Section 10.9 "Immunity to analogue and/or digital signals in other channels" looks at the interference from selectivity and linearity effects on the receiver.

On page 44, there is a table that lists power levels for adjacent channel signals, analog and UHF.

These values indicate 45 dB and 47 dB desired (SDARS signal) to undesired (interfering WCS signal) ratio, for linearity. For an SDARS receiver operating at -100 dBm receiving level, this would correspond to an overload performance requirement of between -55 and 53 dBm using the DVB-H receiver standards as a baseline. As a comparison, the SDARS receivers meet a -44 dBm specification for non adjacent channel (WCS A and B blocks) overload.

For the “C” block the more appropriate specification. would be that given by Table 28, page 40 of the specification, approximately 31 dB. This would correspond to an immediately adjacent channel overload performance level of -69 dBm for satellite signal reception at -100 dBm. As a comparison, the SDARS receivers meet a -55 dBm specification for adjacent channel (WCS C and D blocks) overload.

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[13] EICTA , MBRAI 2.0 specification MOBILE AND PORTABLE DVB-T/H RADIO ACCESS –Part 1: Interface specification

Exhibit C

Experimental Test Data

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Introduction

In developing these reply comments, Sirius undertook additional tests and measurements to augment the previously submitted path loss results between an interfering WCS emitter and the victim Sirius satellite radio receiver[1], and to include additional results for WCS interference tolerance within coverage of a terrestrial gap filler DARS repeater. The results of this effort are detailed in this exhibit.

Additional Path Loss Measurements

Sirius conducted additional tests to augment the initial path loss measurements in Sirius' opening comments to the subject NPRM. These tests were similar in design to the original tests previously submitted to the FCC but added path loss measurements along azimuth radials around the "victim" DARS receiver installed on a vehicle. Specifically, a cart with the interfering WCS transmitting equipment was moved along a straight line away from a vehicle equipped with a victim Sirius receiver antenna and spectrum analyzer. At predetermined intervals, measurements of the received signal power were taken and the resulting path loss was then calculated.

Figure 1 shows curves of a) theoretical free space loss (FSL), b) theoretical free space plus 3 dB, c) a curve-fit of the composite path loss measurement data compiled by Sirius and d) the theoretical curve fit offered in the WCS Coalition's comments[2]. As seen in the figure, the composite of measured results is consistent with Sirius' original assumption of FSL + 3dB, and well below the WCS' loss curve.

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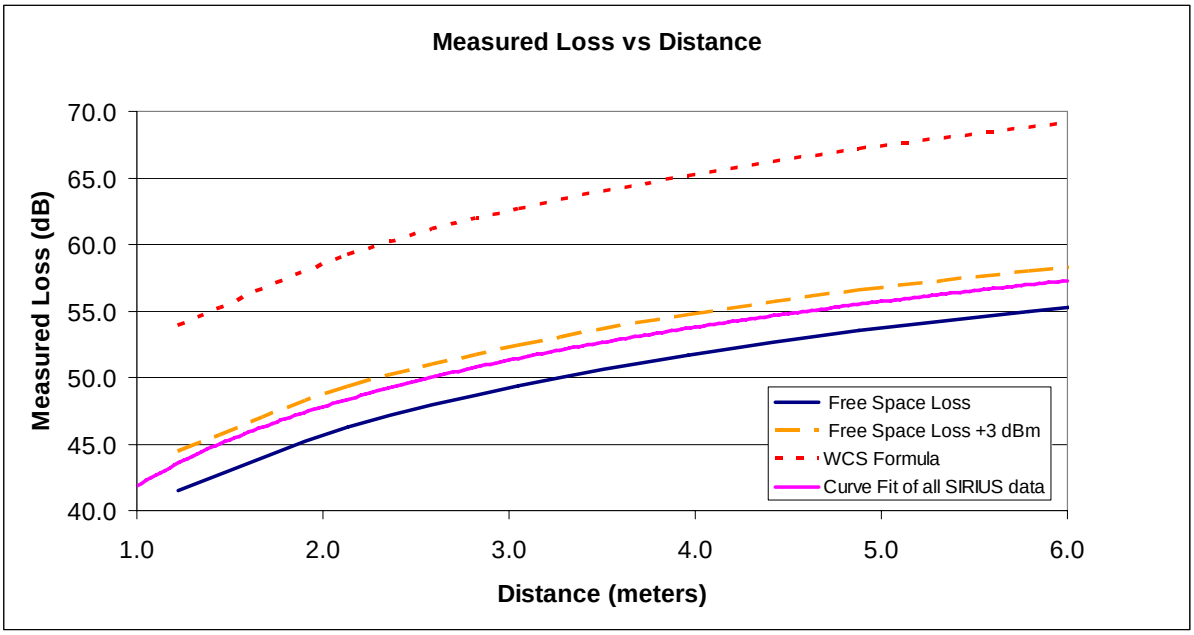
[1] Comments of Sirius Satellite Radio Inc., WT 07-239, Exhibit [C].

[2] Comments of the WCS Coalition, WT 07-239, Attachment B, Section 5, Figure 4.

Figure 1 Path Loss Measurement Comparison



As can be clearly seen in this figure, the WCS Coalition's path loss assumptions exaggerate the amount of attenuation by approximately 10-12 dB separation as compared to Sirius' measured data and the FSL +3 dB approach recommended by other commercial mobile wireless interests in the FCC's AWS-3 proceeding[3].

Effect of Path Loss Assumptions

The path loss assumptions directly affect the analysis of interference effects. For the proposed required interference mitigation distance of 3 meters and the associated path loss value, it is possible to derive appropriate transmit power and OOBE limits for the interfering transmitter. Excessive assumptions for path loss will result in overly optimistic interference predictions.

As an example, one can consider the WCS Coalition's estimate for overload and OOBE interference based on a required 87 dB line of sight path loss value and 2 Watt transmitter power[4]. Using Sirius' estimates, 87 dB of path loss occurs at a distance of approximately 160 meters. Using the WCS Coalition's own predictions, the corresponding distance would be approximately 38 meters, or 125 feet. Even with the wide variance in measured path loss, both assumptions result in interference mitigation distances far greater than the 3 meters Sirius proposal based on the DARS service requirements.

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[3] *See*, e.g., Comments of Motorola, Inc., WT Docket No. 07-195, submitted December 14, 2007. *See also*, Comments of Verizon Wireless, Inc., WT Docket No. 07-195, submitted December 14, 2007.

[4] omments of the WCS Coalition, WT 07-239, 14 February 2008, at 13.

Interference Performance with Terrestrial Coverage

In response to the claims of the WCS Coalition that the risk of interference from WCS transmitters to satellite radio receivers is highly mitigated by the presence of strong desired signals from a satellite radio terrestrial repeater, Sirius conducted measurements to determine how its receivers perform under WCS interference conditions in areas with terrestrial repeater coverage and also to determine the terrestrial repeater signal level at which a Sirius receiver would continue operate even while in the presence of a WCS transmitter operating at 250 mW transmit power at 3 meter separation.

Distance to Mute with a 250 mW WCS Interferer

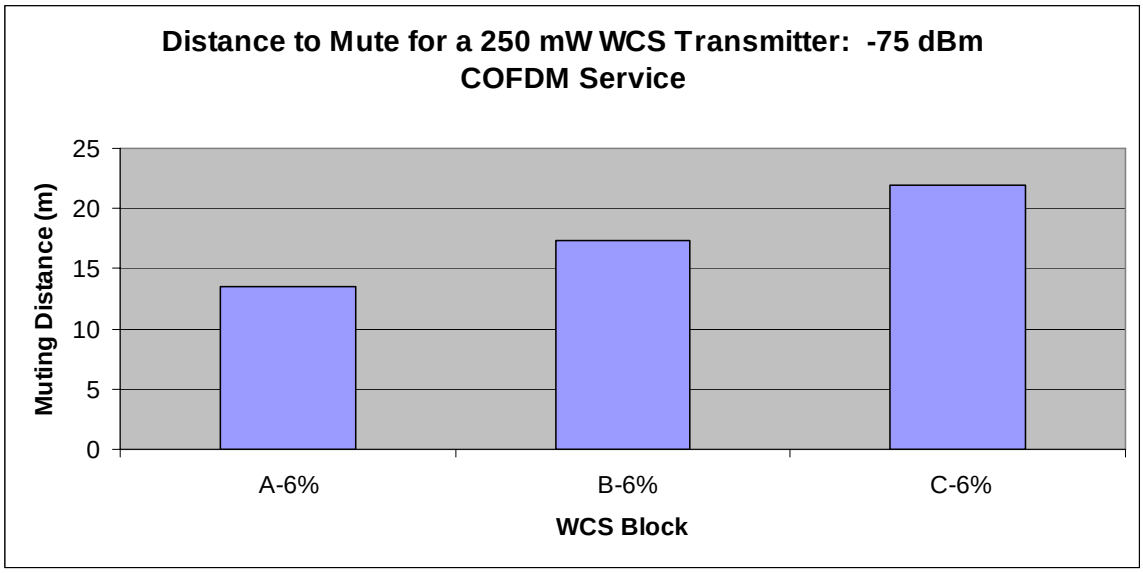
Similar to the satellite only cases previously submitted[5], Sirius conducted tests to determine the distance at which a 250 mW WCS transmitter causes interference into a victim receiver when that victim receiver is operating within a terrestrial repeater coverage area. The procedure is summarized as follows:

- With the WCS transmitter fixed at 250 mW, position the test cart at a distance that causes the Sirius receiver to lose signal lock
- Move the test cart with the interfering WCS transmitter away from the victim vehicle until the Sirius receiver reacquires the signal and decodes error-free audio
- Log the distance and received interference power.

The tests were run in an area with a moderately strong terrestrial repeater serving level of –75 dBm, and the results are shown in Figure 2 below. The 6% represents the shortest duty cycle uplink signal tested. It can be seen that interference occurred at distances between 14 and 22 meters, with the worst interference occurring from WCS transmitters operating in the WCS C-block. As shown in Exhibit A, -75 dBm is a moderately strong terrestrial repeater signal "on the ground" in the New York City and Washington DC markets that were analyzed in that exhibit.

Figure 2 Distance to Mute in Terrestrial Coverage for a 250 mW WCS Interferer

[5] Comments of Sirius Satellite Radio Inc., WT 07-239, Exhibit [C].



Allowable WCS Transmit Power Within Terrestrial Repeater Coverage

In addition to determining the required terrestrial coverage, Sirius also tested the receiver's C-Block performance when served by a -75 dBm terrestrial serving signal. As can be seen in Figure 3, WCS transmit powers ranging from approximately 30 mW to 40 mW interfered with the Sirius radio's reception.

Figure 3 Maximum Tolerable WCS Transmitter Power at 3 meters with -75 dBm Terrestrial Signal

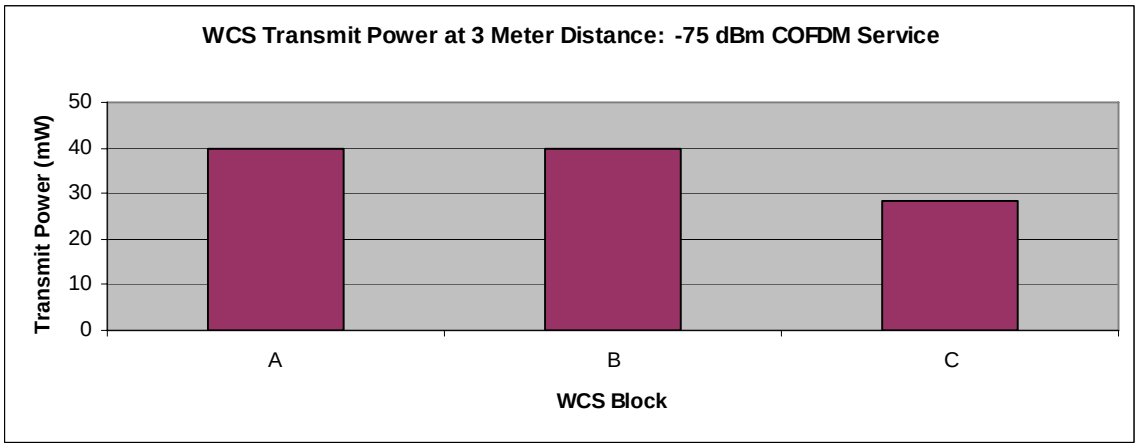
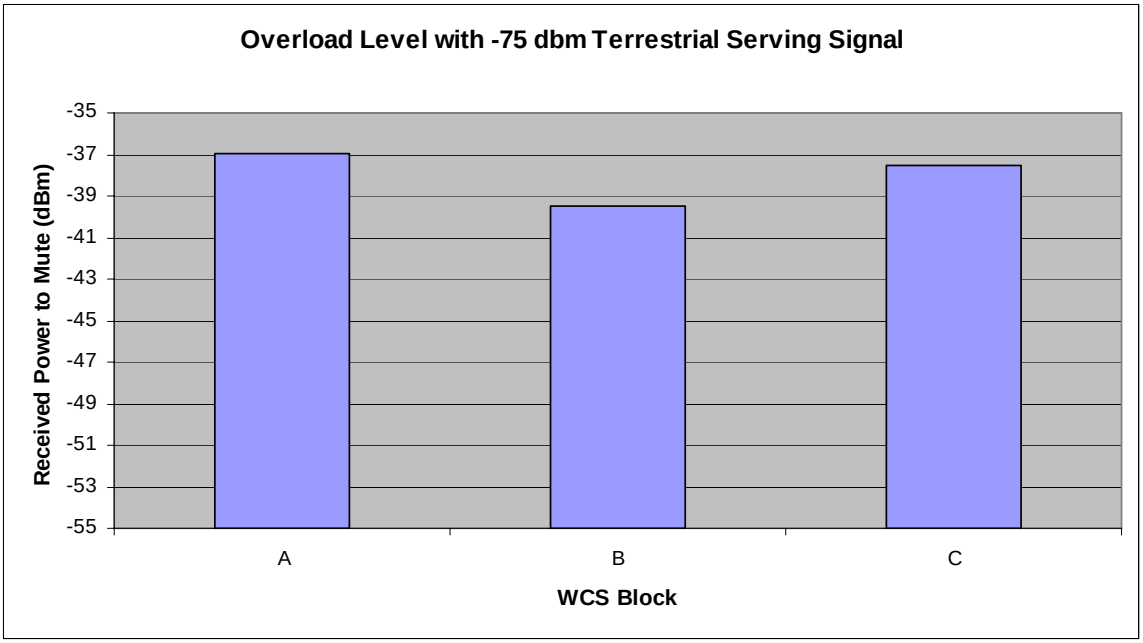


Figure 4 below shows the corresponding averaged signal levels at which muting occurred due to overload when the SDARS receiver is served by a moderately strong -75 dBm terrestrial repeater signal.

Figure 4 Overload Level with -75 dBm Terrestrial Coverage

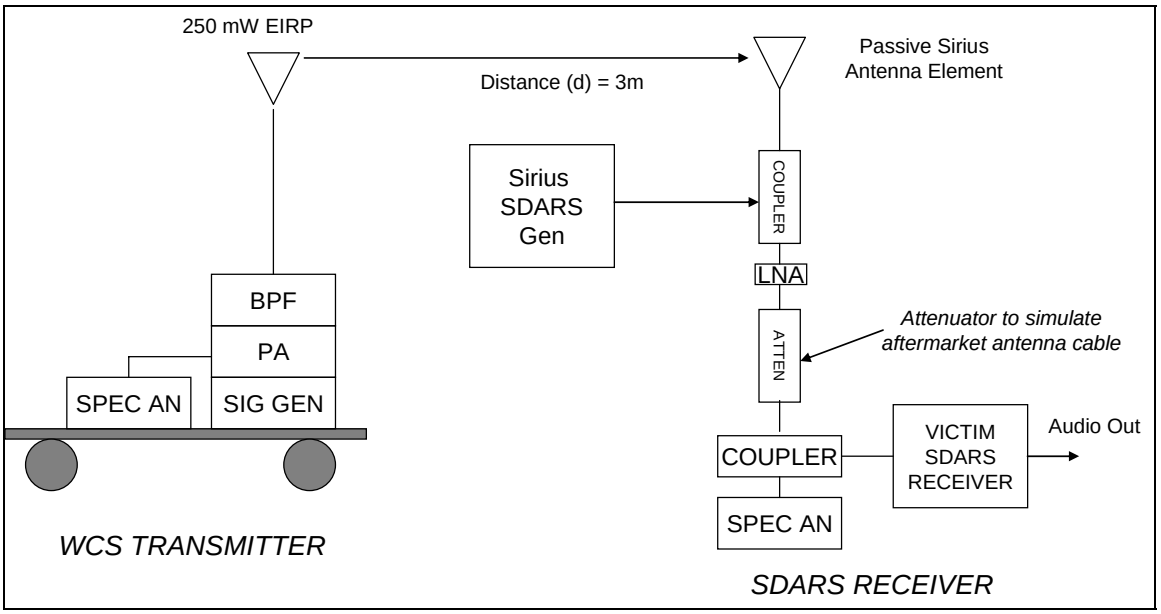


In addition Sirius also tested the receiver's C-Block performance when served by a -88 dBm terrestrial repeater serving signal. This test showed that an interfering WCS transmitter at 0 dBm caused audio muting in the Sirius receiver with a corresponding received signal level of -53 dBm.

Required Coverage to Overcome WCS Interference

To control the terrestrial coverage level, Sirius constructed a test where the terrestrial serving signal was injected into the receive chain and combined with an over-the-air WCS signal. As described in Figure 5 below, the interfering WCS transmitter was positioned 3 meters from the victim vehicle and set to a 250 mW transmit power. Sirius generated a terrestrial signal DARS generator and combined the signal with the WCS signal received via the passive antenna element prior to the low noise amplifier (LNA).

Figure 5 Terrestrial Serving Level Test Configuration



Starting from a low level, the terrestrial signal level was increased until the receiver acquired the signal and played error free audio even while within 3 meters of a WCS transmitter.

Figure 6 shows the resulting terrestrial coverage signal level requirements for this scenario. It can be seen that, allowing a small additional margin of 2-3 dB for limited fading, a serving repeater signal level of -60 dBm would allow the DARS receiver to acquire and play error-free audio with interference from a 250mW WCS transmitter located at 3 meter distance. The amount of terrestrial repeater infrastructure needed to blanket urban areas with -60 dBm service several orders of magnitude greater than the existing Sirius and XM networks.

Figure 6 Minimum Required Terrestrial Serving Level

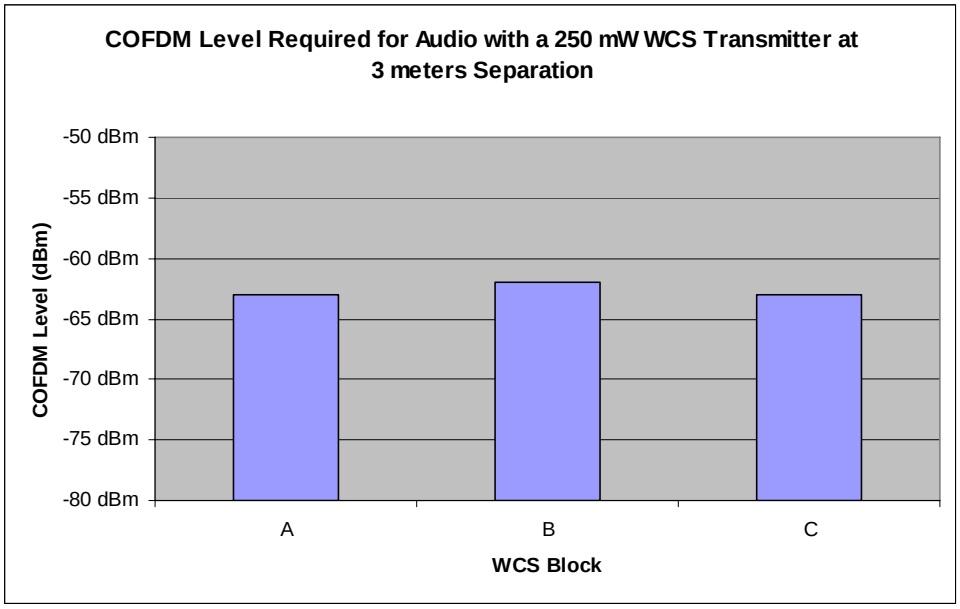


Exhibit D

Power Measurements

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Executive Summary

This Exhibit addresses the issue of how to develop appropriate power measurement requirements for two disparate systems such as WCS/WiMAX™ and SDARS.

Sirius reiterates its opposition to regulating inter-service interference on the sole basis of transmitter output power and out-of-band emissions restrictions. As noted in its comments and the attached reply comments, Sirius supports adoption of a ground level power measurement that would regulate energy where it is potentially capable of causing interference. However, should the Commission disagree and instead choose to adopt transmitter output power restrictions for either the WCS or the satellite radio service, it is imperative that it address these power measurement issues addressed in this exhibit.

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

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

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

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

Average Power Measurement

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

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

The measurement procedure proposed is:

> "*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."* (footnote omitted)[3]

Sirius disagrees with both the 2 kW value proposed and the measurement method. The method of measurement is addressed in this exhibit.

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

Sirius has established that the interference potential of the WiMax waveform is a strong function of the individual frame "burst" power, not the "average" power as would be estimated using the WCS Coalitions method[4]. Sirius believes therefore that the individual frame "burst" power needs to have an unambiguous limit, regardless of the operating duty cycle (which in any case may be adaptive, further complicating a simple compliance procedure).

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[2] Comments of the WCS Coalition, WT 07-293, Feb 14, 2008, II(B)(1)(emphasis added).

[3] *Id.*(emphasis added).

[4] Comments of Sirius Satellite Radio Inc., WT 07-239, Exhibit [C], Table 1 where it is seen that the measured overload level with a 6% duty cycle is less that that at a 44% duty cycle. This is due to the complex interaction of the time division waveform with the various gain control functions of the SDARS radio. This type of effect would be expected in any receiving system where the adjacent band services can be of almost any type and the systems are not synchronized.

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

Peak Power Measurement

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

> "*The WCS Coalition has advised the Commission that it would be amenable to the imposition of a maximum peak-to-average power ratio ("PAR") for both WCS and SDARS services of 13 dB"* (footnote omitted)[6]

The WCS Coalition has proposed the following measurement method:

> "*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"*[7]

Sirius believes that the WCS Coalition measurement proposal should be slightly modified, to reduce further any ambiguity in ensuring compliance. In addition to specifying the Peak to Average Ratio, the cumulative amplitude probability (commonly referred to as CCDF) should also be specified associated with that PAR. This leads to a more precise and repeatable definition of the PAR. Sirius recommends an associated cumulative amplitude probability of 0.01%. As with the average power, in the situation where the transmission format involves a duty cycle, this measurement should be made using time gating to gather the statistics of the relevant transmission frames. As previously stated, this is consistent with existing test equipment and most modern spectrum analyzers.

An illustrative example of how the WiMAX™ industry measures transmit power, Figure 1 illustrates the burst waveform structure in question and Figure 2 illustrates the various time gated power measurement results[8].

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

6 Comments of the WCS Coalition, WT 07-239, II(B)(1) (emphasis added).

7 *Id.* (emphasis added).

8 From "Power Measurement and Power Calculation of IEEE 802.16 WiMAX OFDMA signals" Application Note 1EF60, Rohde and Schwarz,

An illustrative example of how a Sirius repeater would have its peak power verified under this proposal is given in Figure 3.

Figure 1 Illustration of WiMAX™ Burst Structure

A **typical TDD WiMAX signal** is not continuous, but has a burst structure. The following figure shows the power versus time graph of a WiMAX signal.

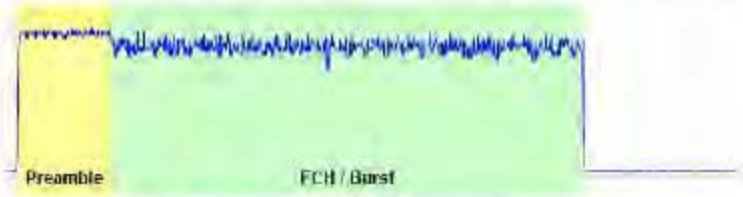


Figure 1: Power vs. time graph of a WiMAX signal [1]

The start of every downlink frame is the preamble followed by the frame control header (FCH) / burst. The preamble, used for synchronisation, contains BPSK-modulated carriers and is one OFDMA symbol long. It is **power boosted** and the level is a few dB higher than the level of the following data burst [2].

Figure 2 Illustration of WiMAX™ Time Gated Power Measurement

Measurement using a Spectrum Analyzer

The figure below shows the measurement of the TD Power DL Preamble. The measured value correlates with the one in 'List 1' (figure 2).

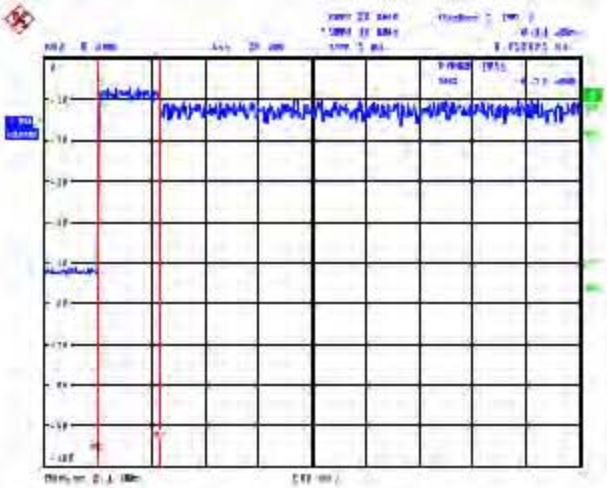
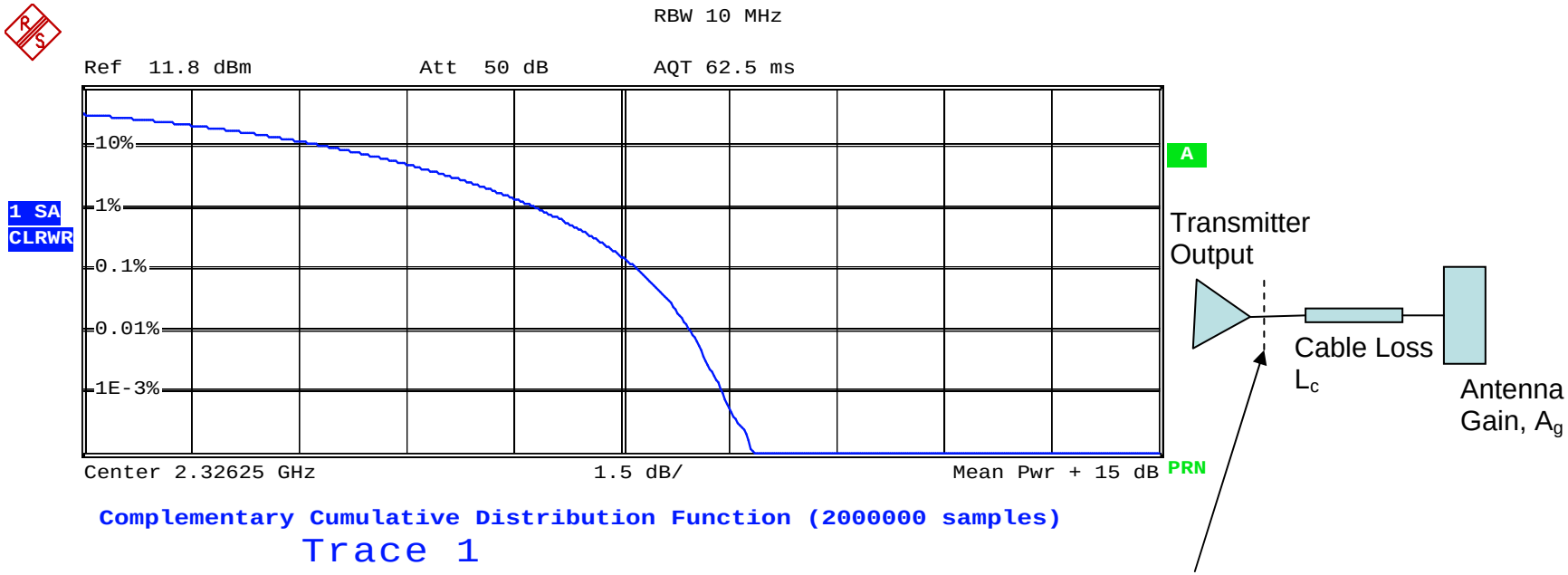


Figure 4: Time Domain measurement – TD Power DL Preamble

Between the other two TD Power parameters, measured in figure 5, and the values of 'List 1' there is also a good correlation:

	'List 1' (figure 2)	TD power measurement
TD Power DL Preamble	- 8.74 dBm	- 8.70 dBm (figure 4)
TD Power Subframe	-12.38 dBm	-12.38 dBm (figure 5, left)
TD Power Zone	-12.56 dBm	-12.54 dBm (figure 5, right)

Figure 3 Example of Peak Power Verification for an SDARS Repeater



Complementary Cumulative Distribution Function (2000000 samples)

	Trace 1
Mean	-2.04 dBm
Peak	7.39 dBm
Crest	9.43 dB
10% @	3.63 dB
1% @	6.42 dB
.1% @	7.77 dB
.01% @	8.20 dB

•Transmitter is set to the appropriate average power.

•Verification of compliance with the PAR limit would use the CCDF measured at the input to the antenna feed system to establish that, at a cumulative probability of 0.01%, the PAR was less than 13 dB.

•In this example the PAR is ~8.2 dB

Exhibit E

Comparison of the AWS-3 Proceedings (07-195) To The WCS/SDARS NPRM (07-293)

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Executive Summary

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

The approach taken is to compare the results of technical analysis submitted by Motorola, Verizon Wireless, AT&T, the CTIA and Nextwave Wireless on the feasibility of adjacent band operations between PCS/WiMax-like mobile terminals in the AWS3/2/1 bands with the almost identical situations addressed by some of the same parties (through the WCS coalition) in the WCS/SDARS NPRM.

It is demonstrated that the high level conclusion reached by these parties regarding AWS3 block usage, namely, the lack of feasibility of unfettered mobile broadband deployment, is virtually identical to the conclusion reached by Sirius and XM regarding WCS block usage.

By comparing the real-world mobile data developed by the parties in the AWS proceedings with almost equivalent SDARS measurements and parameters further confirmation is obtained that the WCS Coalitions proposals for mobile transmitter power and OOBE relief are more than an order of magnitude in error and, if implemented would lead to significant interference to SDARS service.

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

Comparison Methodology

Map Bandplans

In order to most easily illustrate the structural similarities, the block boundaries of the WCS/SDARS allocation have been translated and aligned to the AWS bandplan. This allows the nature of the WCS/SDARS and AWS3/AWS1 adjacent channel operations to be more easily compared. This is shown in Figure 1 located at the end of this exhibit.

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

[1] Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band, WT 07-195.

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

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

System Categorization

In both the AWS1/AWS3 case and the SDARS/WCS case the systems can be considered **not synchronized**. This was best described by the WCAI in a recent filing:

> *Two systems are considered synchronized if they always transmit in the same direction (i.e., uplink or downlink) at the same time. They are not synchronized, however, if one system can transmit in the uplink direction when the other is transmitting in the downlink direction. For example, since the AWS-1 licensee immediately below the 2155-2175 MHz band is required to utilize its spectrum solely for downstream transmission (see 47 C.F.R. § 27.50(d)), that system will only be synchronized with an AWS-3 system that utilizes its spectrum solely for downlink transmission. It will not be synchronized with an AWS-3 system that is utilizing adjacent spectrum for upstream transmissions, either full-time as part of an FDD system paired with spectrum in some other band or part-time because that system is using a TDD technology. Similarly, two TDD systems will also be non-synchronized unless the system operators take steps to assure that their systems are always transmitting in the same direction at the same moment in time.*[2]

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

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[2] Comments of the Wireless Communications Association International, Inc., WT 07-195, December 2007, n. 6 (emphasis added).

"Victim" Receiver Characteristics

In this case, the two victim receivers that need to be compared are an AWS1 receiver (in the F block) and an SDARS receiver operating in the upper XM satellite channel(s). In the AWS analyses used here the bulk of the data was collected using the model of two CDMA handsets interfering with each other, one receiving in AWS1(F block) and one transmitting in AWS3. In all the tests described, some form of guard band existed and so the data represents a "best case" in terms of comparison to a D (or C) block interferer into a satellite channel. While there are various technical differences between the CDMA airlink and the SDARS system, they essentially lie in the direction of the CDMA terminals being less susceptible to interference than an SDARS receiver[3] and so the AWS3 conclusions can be regarded as "best case". This difference in performance is based primarily on the higher sensitivity required of satellite receivers necessitated by receiving space based transmissions."

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

Nominal Receiver Sensitivity

The reference AWS1 receiver used by Motorola had a bandwidth of 1.23 MHz (CDMA). The reference sensitivity level used in the tests was -105 dBm. This can be approximately compared with the satellite levels used in the SDARS case of -102 dBm/ 4MHz or -108 dBm/MHz (SDARS) vs. -105.9 dBm/MHz for the victim AWS1 receiver. One difference is that the AWS receiver, at -105 dBm, is operating nominally with a higher noise floor (i.e. has a lower threshold) than the SDARS receiver which relies on a lower noise temperature for satellite reception under land mobile conditions.

Approach and Results for Maximum Mobile EIRP, OOBE

<u>Mobile EIRP</u>

Using an almost identical methodology to Sirius in its NPRM filing[5], Motorola used a combination of measurements and analysis to estimate the maximum EIRP that a mobile AWS3 terminal could have before it would cause the AWS1 receiver to drop its call. Motorola used an exclusion zone distance of 1 meter. Their stated reason was:

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

This should be contrasted with Sirius using a 3 meter distance in its study which is much more optimistic in our vehicle based customer interference scenarios.

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

[4] *See* Comments of Motorola, Inc. WT 07-195, Dec. 17 2007.

[5] Comments of Sirius Satellite Radio, WT 07-293, February 14, 2008, Section 2.3.9.

[6] omments of Motorola, WT 07-195, December 17 2007 (emphasis added).

An additional note is that there was a guard band of one channel (1.25 MHz) between the AWS3 transmitter and the AWS1 victim receiver.

The Motorola results indicated that a received level of -34 dBm[7] from the AWS3 transmitter caused the AWS1 handset call to drop. Using Motorola's approach adjusted for 3 meter, this would be equivalent to an AWS3 transmit level of +21 dBm. Applying the Sirius analysis, (which uses 52 dB as the free space + 3 dB path loss value at 3 meters) this would be equivalent to an AWS3 transmit level of -34+52=18 dBm at 3 meter.

Allowing an additional 2 dB for the difference in base sensitivity yields +16 dBm.
Differences in demodulation thresholds and the presence of an effective guard band of one channel (1.25 MHz) between the transmitter and receiver in the measurements would also apply here with the CDMA receiver operating at lower thresholds than the SDARS satellite link. It should be noted that 16 dBm proposed by Motorola is **17 dB less** than the 2 W (33 dBm) mobile EIRP proposed by the WCS Coalition.

The results can then be compared with the A, B block Sirius proposal derived from actual measurements (i.e. at least one channel of guard band) of 10 dBm, illustrating that the AWS3 results are "best case" from an SDARS perspective as previously discussed. Given a -44 dBm WCS interference limit to prevent overload for SDARS terminals and comparing this to Motorola's -34 dBm requirement it can be seen that a similar analysis to that Motorola applied would result in a maximum allowed WCS mobile terminal EIRP of 6 dBm, which is even lower than the Sirius proposed restrictions on WCS mobile handsets.

OOBE
Motorola measured -102.6 dBm in 1.23 MHz as the threshold of performance for the AWS3 handset receiving OOBE from the AWS1 handset. This translates to a 3 m, 1MHz referenced value of -103.5+52 dBm = -51.5 dBm or equivalently, **81.5+10 log (P)** where P is the transmitter power in watts. This is **26.5 dB more stringent** than the WCS Coalition's proposal of 55+10 log (P).

This result can then be compared with the Sirius OOBE mask proposal derived from actual field tests (based on the actual SDARS receiver noise floor of -113 dBm and 1 dB allowable maximum noise floor raise due to interference), again illustrating that the AWS3 results are "best case" from an SDARS perspective as previously discussed. Given the -113 dBm SDARS noise floor and 1 dB allowable raise, WCS OOBE interference level at -119 dBm would have caused this to occur. -119 dBm would translate to -125 dBm per MHz given 4 MHz bandwidth of a Sirius satellite channel. A WCS transmitter's (located 3 meters away) out of band emissions should be less than -73 dBm/MHz in order to not cause interference. -73 dBm/MHz or -103 dBW/MHz would

[7] *Id.*

result in an OOBE emission mask requirement of 103+10 log (P) to prevent OOBE interference cases for the SDARS terminals.

Conclusions

Subsequent to the Motorola Filing used in the analysis above, AT&T filed reply comments and Verizon Wireless filed an exparte. Both companies extended the Motorola submission and presented additional technical and summary conclusions. These are summarized below in Table 1 and illustrate unambiguously the fact that the WCS Coalitions EIRP and OOBE mobile terminal proposals are orders of magnitude in error.

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Table 1 Summary Comparison

Company	OOBE Recommendation (corrected to 3 m and 1MHz)	Maximum Mobile EIRP Recommendation (corrected to 3m)	Conclusion
AT&T[8] (WCS Coalition Member)	-56 dBm/MHz 86+10log(P) For H block -66 dBm/MHz 96+10log(P)	9.5 dBm	"Based on the record and its own analysis, AT&T has concluded that the downlink only model represents the highest and best use of the AWS-3 spectrum. Provision of uplink transmissions in the band would require stringent restrictions on operating power and out-of-band emissions ("OOBE") and render deployment of a commercial mobile network impractical."
Motorola[9]	n/r	n/r	"Based on recent test performed by Motorola, allowing mobile use in the 2110-2155 MHz band may require power and out of band emissions restrictions on AWS-3 operations that are more restrictive than those applied in other mobile bands"
Verizon Wireless[10]	-66 dBm/MHz 96+10log(P)	9.5 dBm	"To prevent interference and efficiently utilize the spectrum, AWS-3 should be designated for downlink only transmissions or fixed services"
Nextwave Wireless		10 dBm[11]	
Tmobile	-56 dBm/MHz 86+10log(P)		
Sirius/XM (for WCS band)	-73 dBm/MHz 103+10log(P)	10 dBm (A,B) 0 dBm (C,D)	
WCS Coalition (for WCS band) (e.g. AT&T, Nextwave Wireless, Horizon,)	-25 dBm/MHz 55+10log(P)	33 dBm (all blocks)	

[8] Reply Comments of AT&T Inc. WT 07-195, Jan 14 2008.

[9] Comments of Motorola, Inc. WT 07-195, December 17 2007.

[10] Verizon Wireless ex parte presentation, WT 07-195, February 19 2008.

[11] Reply Comments of Nextwave Wireless Inc., WT 07-195, and January 14 2008. It is not clear in exactly what context this value was recommended and what the definition of the handset operating point was.

Figure 1 AWS and SDARS Bandplan Comparison

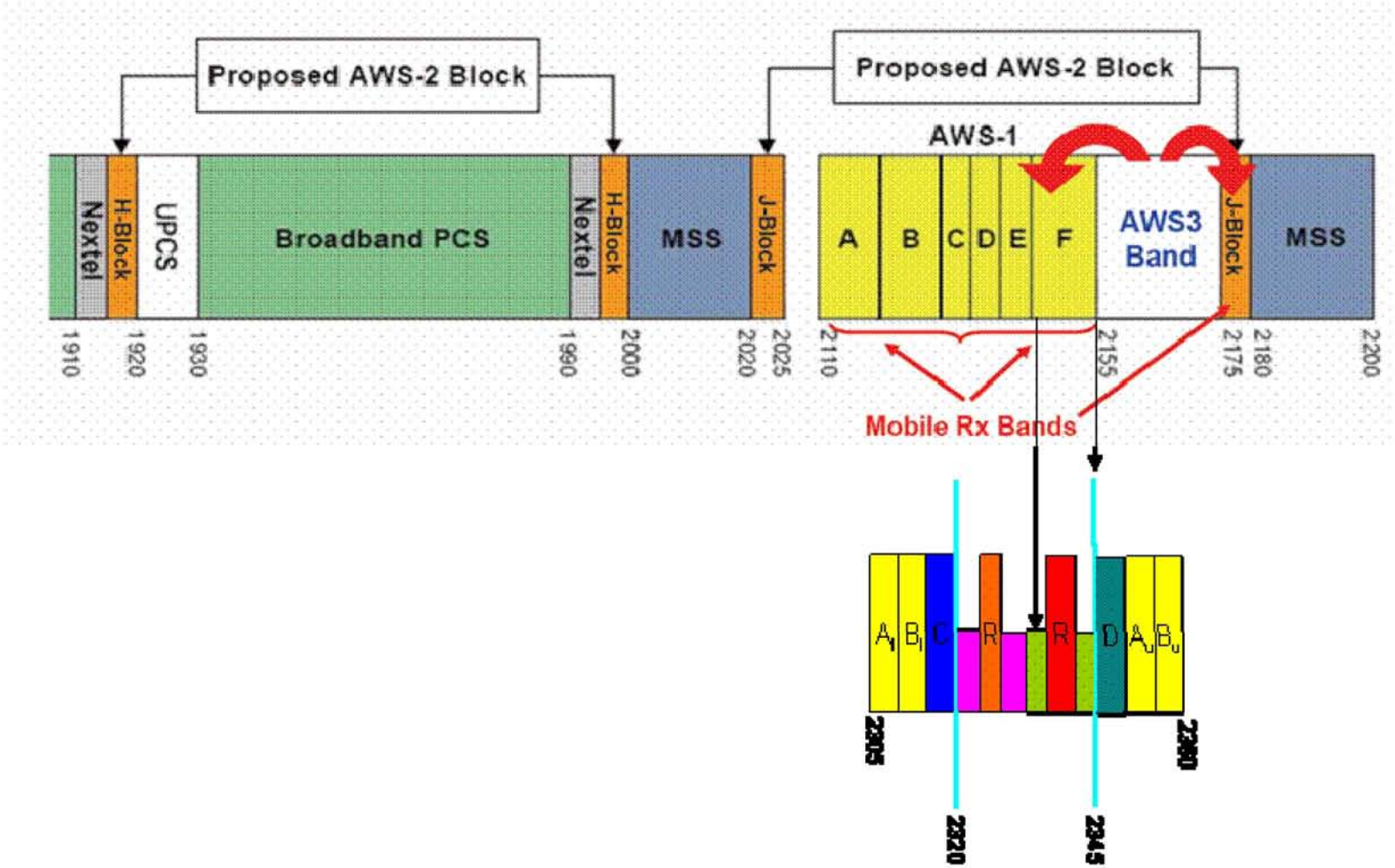

Exhibit F

Engineering Declarations

CERTIFICATION OF PERSON RESPONSIBLE
FOR PREPARING ENGINEERING INFORMATION

I, Terrence R. Smith, am the Senior Vice President, Technology at Sirius Satellite Radio Inc. I joined Sirius in 2002 and have been involved in digital technology for approximately 28 years. Prior to joining Sirius, I was employed at RCA Labs and Sarnoff Corporation. I hold a Bachelor of Science in Electrical Engineering from the University of Notre Dame and a Master of Science in Electrical Engineering from Drexel University.

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

Terrence R. Smith
Senior Vice President, Technology
Sirius Satellite Radio Inc.

Dated: MARCH 17, 2008

THIRD PARTY TECHNICAL CERTIFICATION

I, Michael D. Rhodes, am a Senior Engineer with the firm of Cavell, Mertz & Associates, Inc. in Manassas, Virginia, a position I have held for approximately 10 years. I am a registered Professional Engineer in the Commonwealth of Virginia and I hold a Bachelor of Science degree in Electrical Engineering from Virginia Polytechnic Institute and State University. I have submitted numerous engineering exhibits to the Federal Communications Commission and my qualifications are a matter of record with that agency.

I hereby declare under penalty of perjury that I participated in laboratory and field testing with Sirius Satellite Radio Inc. in connection with the technical information submitted in the foregoing Comments of Sirius Satellite Radio Inc. and associated attachments. I have reviewed those test results and the engineering information submitted in the Reply Comments of Sirius Satellite Radio Inc. and associated attachments, and that it is complete and accurate to the best of my knowledge and belief.

Michael D. Rhodes, P.E.
Cavell, Mertz & Associates, Inc.
7839 Ashton Avenue
Manassas, Virginia
20109-2883

Dated: March 17, 2008