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

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In the Matter of	)	IB Docket No. 95-91
	)	
XM Radio, Inc. Request for Special Temporary Authority	)	File No. SAT-STA-20010712-00063
	)	
Sirius Satellite Radio, Inc. Request for Special Temporary Authority	)	File No. SAT-STA-20010724-00064

REPLY COMMENTS OF VERIZON WIRELESS

SUMMARY

Verizon Wireless hereby replies to comments filed with the Commission in response to applications for Special Temporary Authority ("STA") filed by XM Radio Inc. ("XM") and Sirius Satellite Radio Inc. ("Sirius") (the "Applications").[1] The Applications seek authority to operate high-power (above 2kW EIRP) terrestrial repeaters in the Digital Audio Radio Service ("DARS"). Verizon Wireless is opposed to the grant of the Applications. First, they fail to satisfy the relevant legal standard for an STA. Second, the proposed operations would severely impair Verizon Wireless' planned use of the adjacent Wireless Communications Service ("WCS") band for emerging broadband wireless access ("BWA") services.[2] The Applications for STA should both be denied.

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[1] *XM Request for STA*, File No. SAT-STA-20010712-00063 (filed July 12, 2001) ("XM STA"); *Sirius Request for STA*, File No. SAT-STA-20010724-00064 (filed July 24, 2001) ("Sirius STA").

[2] Verizon Wireless (bidding as PCSCO Partnership) paid $1.6 million for the A block WCS licenses in the Boston (ME01), New York (ME02), Buffalo (ME03), Philadelphia (ME04), Washington (ME05), Richmond (ME06), Pittsburgh (ME12), and Cincinnati (ME13) Major Economic Areas.

A. The STA Applications Fail To Make The Required Legal Showing, And Should Be Denied.

Congress established the legal standard by which the Commission must evaluate STA applications. Section 309(f) of the Communication Act of 1934, as amended ("the Act"), mandates that the Commission "find that there are extraordinary circumstances requiring temporary operations in the public interest and that delay in the institution of such temporary operations would seriously prejudice the public interest."[3] Further, "grant [of] a temporary authorization, [must be] accompanied by a statement of its reasons therefor…."[4] Such a finding, to avoid being arbitrary and capricious, must be well reasoned and based on evidence in the record.

The Commission codified Section 309(f) in Section 25.120 of its rules.[5] The rule requires that applicants demonstrate that "circumstances requiring immediate or temporary use of facilities" exist.[6] Further, the application must contain "the full particulars of the proposed operation including all facts sufficient to justify the temporary authority sought and the public interest therein."[7] The rule clarifies that only "upon a finding that there are extraordinary circumstances requiring temporary operations in the public interest and that delay" "would seriously prejudice the public interest"[8] will the Commission grant an STA. The rule specifically states that its finding of extraordinary

[3] 47 U.S.C.A. § 309(f)(1991).

[4] *Id.*

[5] 47 C.F.R. § 25.120(a).

[6] *Id.*

[7] *Id.*

[8] *Id.* at § 25.120(b).

circumstances cannot be based on "convenience to the applicant, such as marketing considerations of meeting scheduled customer in-service dates."[9]

As the initial comments demonstrate, there is no plausible basis for granting STAs to XM or Sirius.[10] Neither comes close to meeting the legal standard. XM and Sirius do not describe the "full particulars" of their proposed terrestrial repeater operations. While both applicants indicate that they intend to deploy low-power terrestrial repeaters operating below 2kW, neither has provided any information regarding these repeaters.[11] As AT&T Wireless notes, the Commission's rules do not permit the blanket authorization of <u>any</u> terrestrial repeaters regardless of power levels.[12] Since any STA issued to XM or Sirius will obligate them to operate on a non-interference basis, WCS and other affected licensees must know the location and operational characteristics of <u>all</u> proposed repeater deployments so that they can adequately assess how these repeaters will impact their existing and planned operations.

XM and Sirius fail to show that there are "extraordinary circumstances" present that would require grant of the Applications. In fact, neither Application makes any mention of "extraordinary circumstances". Instead, the Applications make unsupported statements that grants would be in the "public interest." The current circumstances are anything but extraordinary. First, as XM and Sirius acknowledge in their Applications, there is a pending rulemaking in which the Commission is considering rules governing

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[9] *Id.*

[10] *See* Comments of Metricom, Inc., filed in response to XM and Sirius STAs ("Metricom Comments") (filed August 21, 2001) at 5; *see* Comments of AT&T Wireless Services, Inc., filed in response to XM and Sirius STAs ("AT&T Comments") (filed August 21, 2001) at 2; *see* Comments of BellSouth Corporation, filed in response to XM and Sirius STAs ("BellSouth Comments") (filed August 21, 2001) at iii.

[11] XM STA at p. 2, n. 4; Sirius STA at p. 3, n. 9.

the use of satellite DARS terrestrial repeaters.[13] XM and Sirius fail to show why that rulemaking is not the proper proceeding to address their use of terrestrial repeaters and the technical requirements for such use. Their STA requests are an obvious attempt to circumvent the rulemaking.

Second, the circumstances XM and Sirius find themselves subject to are of their own making. Specifically, XM states that it "has been operating repeaters in these markets for several months pursuant to its nationwide experimental license and now seeks to use its repeaters to provide service to consumers."[14] Sirius has been operating its terrestrial repeaters since October 14, 1999 pursuant to an experimental license.[15] Now, XM and Sirius want to parlay that experimental authority into commercial use. However, they fail to cite any Commission precedent that would support grants of these Applications in light of the fact that they have constructed facilities pursuant to experimental authorizations without regard for the ultimate resolution of the pending rulemaking. The FCC has previously warned against just such attempts "to establish commercial businesses under the guise of experimental licenses."[16] It should not allow XM and Sirius to do so here. As AT&T notes, grant of the STAs could have "a more widespread impact on the integrity and enforcement of the Commission's rules if it is

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[12] AT&T Comments at 4.

[13] *In the Matter of Establishment of Rules and Policies for the Digital Audio Satellite Service in the 2310-2360 MHz Frequency Band*, 12 FCC Rcd 5754, 5810-5812 (1997) (Report and Order Memorandum Opinion and Order and Further Notice of Proposed Rulemaking) ("DARS Proceeding").

[14] XM STA at 1.

[15] Sirius STA at 2.

[16] *Amendment of Part 5 of the Commission's Rules to Revise the Experimental Radio Service Regulations*, 11 FCC Rcd. 20130, 20136 (1996).

viewed as a ratification of an abuse of the Commission's experimental authorization regime."[17]

Further, XM makes a conclusory statement that "[g]rant of this STA will serve the public interest by ensuring that the public enjoys the full benefit of DARS at the earliest possible date."[18] Similarly, Sirius states that a grant "would serve the public interest by allowing Sirius imminently to initiate uniformly high quality commercial satellite DARS programming nationwide."[19] As noted above, both the Act and the Commission's STA rule state that the Commission must find that "extraordinary circumstances" require temporary operations in the public interest and that delay of the temporary operations would seriously prejudice the public interest. XM and Sirius "rest their claims of 'extraordinary circumstances' on their desire to market and provide services to customers sooner rather than later."[20] However, the Commission's rules explicitly identify "marketing considerations" as a circumstance that is <u>insufficient</u> to justify an STA.[21] Apart from these "marketing considerations," neither Application provides any additional factual basis upon which the Commission could find that temporary operations pursuant to STAs are in the public interest and further that delay of the STAs would seriously prejudice the public interest.

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[17] AT&T Comments at 8.

[18] XM STA at 2.

[19] Sirius STA at 1.

[20] BellSouth Comments at 13.

[21] 47 C.F.R. § 25.120(b); *see also In the Matter of Applications of COMSAT Corporation*, Order, 13 FCC Rcd 319 (International Bureau denied an application for STA where applicant argued that robust consumer demand, coupled with adverse effect of applicant's inability to market services constituted emergency-like circumstances satisfied requirement of demonstrating "extraordinary circumstances.") ¶¶ 2,7.

XM and Sirius bear the burden of demonstrating why a grant of the Applications is warranted. However, they have failed to provide the "full particulars" of their proposed repeater networks, failed to demonstrate the "extraordinary circumstances" that would justify an STA, and failed to demonstrate how a delay in the institution of these operations would "seriously prejudice the public interest." Accordingly, the Commission must deny the Applications for STA.

B. The Use Of DARS Terrestrial Repeaters Will Cause Harmful Interference To WCS Operations.

There is clear evidence in the record that the proposed deployments of terrestrial repeaters operating in the 2320-2345 MHz DARS band will severely impair the use of the adjacent 2305-2320 MHz and 2345-2360 MHz WCS bands by creating large exclusion zones within which WCS operators will be effectively precluded from providing service.[22] These exclusion zones are the result of two primary sources of interference – blanketing interference and intermodulation distortion.

Blanketing Interference. This type of interference, sometimes referred to as "brute force overload", occurs when a very high power signal in one band overwhelms lower power signals in nearby bands, overloading the front end of the radio receivers in those bands. This phenomenon is well recognized, and the harmful effects of blanketing interference that would result from the use of high power DARS terrestrial repeaters has been clearly demonstrated in the DARS proceeding.[23]

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[22] AT&T Comments, Attachment B; BellSouth Comments, Attachment B.

[23] *See generally* Comments of BellSouth Corporation, (filed Feb. 22, 2000), in response to Supplemental Comments of XM Radio Inc. and Sirius Satellite Radio, DARS Proceeding, IB Docket No. 95-91; *see generally* Ex Parte Presentation of AT&T Wireless Services, Inc., DARS Proceeding (filed Feb. 20, 2001).

The objections raised in the comments to the Applications should, therefore, come as no surprise to the applicants or to the Commission. The analyses submitted by various commentators clearly show that the operation of high-power terrestrial repeaters as proposed by XM and Sirius will create large exclusion zones that will effectively preclude the provision of WCS.[24] In fact, the analysis submitted by BellSouth concludes that the effects of blanketing interference are significant even when DARS terrestrial repeaters are limited to 2 kW power levels.[25]

Intermodulation Distortion. XM and Sirius intend to use spectrum in the 2324.25-2328.25 MHz and 2336.75-2340.75 MHz bands to deploy terrestrial repeaters.[26] The frequency spacing between these two bands is such that the 3rd order intermodulation products of the two repeater signals will land directly in the WCS band.[27] This produces intermodulation distortion at the WCS receiver that would result in exclusion zones that are potentially much greater than those resulting from blanketing interference.[28] As a result, WCS operations will be restricted in any market where both XM and Sirius deploy terrestrial repeaters.[29] BellSouth notes that "the potential for intermodulation distortion from nearby DARS repeaters is tremendous" and that "this condition would apply to any DARS repeaters, whether they are high power or micro-repeaters [less than 2 kW]."[30]

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[24] AT&T Comments, Attachment B; BellSouth Comments, Attachment B.

[25] BellSouth Comments, Attachment A, at 4.

[26] *See Agreement Between the Government of the United States of America and the Government of the United Mexican States Concerning the Use of the 2310-2360 MHz Band*, (July 24, 2000), at Appendix I.

[27] *See* Comments of BeamReach Networks, Inc., filed in response to XM and Sirius STAs ("BeamReach Comments") (filed August 21, 2001), at 5; BellSouth Comments, Attachment C, at 10.

[28] BeamReach Comments at 9.

[29] *Id* at 5.

[30] BellSouth Comments, Attachment C, at 9.

Interference Analysis. Verizon Wireless has conducted its own assessment of the potential for blanketing interference and intermodulation distortion that would result from the operation of DARS terrestrial repeaters. This analysis, included in the attached Appendix, was performed in conjunction with BeamReach Networks, Inc. – a company that has developed spectrally efficient Adaptive Multibeam OFDM wireless technology for the provision of BWA services in the WCS band.[31]

The analysis clearly demonstrates that the deployment of high-power DARS terrestrial repeaters, as proposed by XM and Sirius, would result in significant harmful interference to WCS operations. Using the Atlanta market as an example, the analysis concludes that 29.6% of the market would be excluded due to blanketing interference and 51.7% of the market would be excluded due to intermodulation distortion. The size of these exclusion zones would effectively preclude the offering of WCS in Atlanta.

The analysis also demonstrates conclusively that the deployment of DARS terrestrial repeaters at power levels in excess of 2 kW is likely to create similarly large exclusion zones in other areas, and thus, preclude the offering of WCS in any market in which such repeaters are deployed. Moreover, the analysis demonstrates that the number of terrestrial repeaters deployed will impact the size of the exclusion zone even if the power levels of such repeaters are limited to 2 kW. For example, Case 2 in Table 1-1 illustrates how the exclusion zone resulting from intermodulation distortion would increase from 2.2% to 33.7% if the spacing between 2kW terrestrial repeaters were decreased from 8 km to 4 km. Based on this analysis, it can be concluded that the

[31] Verizon Wireless is considering the deployment of BeamReach equipment in its WCS markets, and has planned a technical trial for the first quarter of 2002.

potential for DARS terrestrial repeaters to cause harmful interference to WCS operations is affected by both the power levels of the repeaters and the number of repeaters deployed in each market.

BeamReach has examined the technical feasibility and incremental costs associated with the use of high-Q filters in the BWA receiver front-end to attenuate DARS emissions. Its analysis concludes that the cost of incorporating such filters into the CPE would be uneconomical. Moreover, it would be "insufficient to allow unlimited deployment of high-power repeaters and would therefore require considerable coordination efforts between WCS licensees and DARS operators."[32]

C. The Commission Must Impose Limits On The Deployment Of DARS Terrestrial Repeaters.

Verizon Wireless and other WCS licensees purchased their licenses with the intent of providing service to the public. Bringing a new wireless service to the public requires multiple stages of development including network design, testing, and construction. Each stage of development requires a substantial investment of time and financial resources. A key consideration in the decision to make any investments in WCS (or any other wireless service) is the certainty that the licensee will be protected from harmful interference. The Applications, if granted, will cause harmful interference to existing and future WCS operations and effectively preclude the offering of broadband wireless services in the WCS band.[33]

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[32] *DARS Terrestrial Repeater Analysis*, discussed *infra*, Appendix, at 5; *see also* Ex Parte Communications of BeamReach Networks, Inc., DARS Proceeding (filed May 30, 2001) at 3-6.

[33] *See* Opposition to STA Request of WorldCom, Inc., filed in response to XM and Sirius STAs ("WorldCom Opposition") (filed August 21, 2001) at 2; AT&T Comments at 7.

The Commission can avoid this undesirable outcome by establishing appropriate limits for the deployment of DARS terrestrial repeaters in the pending rulemaking proceeding. The Commission routinely has adopted rules to limit the potential for harmful interference from one service to another.[34] It should do so here.

We urge the Commission to adopt rules that would limit the power levels of all DARS terrestrial repeaters to 400 W/MHz (for a maximum of 2kW over a 5 MHz bandwidth). However, we do not agree with other WCS licensees that XM and Sirius should be permitted to deploy "as many terrestrial DARS repeaters operating at power levels up to 400 W/MHz as are necessary".[35] As our analysis indicates, the deployment of a large number of 2kW repeaters will also result in significant blanketing interference. Thus, we also recommend the adoption of field strength contours that would minimize the potential for large signal blockage caused by DARS repeaters. A practical limit would be -45dBm, in a resolution bandwidth of 1 MHz, for no more than 2% of the population at a reference height of 25 feet in each coverage area.

The Commission should also adopt rules that require XM and Sirius to coordinate their terrestrial repeater deployments with each other to ensure that the overlapping field strength contours do not result in excessive intermodulation distortion, and thus, create large exclusion zones for WCS. We recommend the coordination of field strength contours at -50 dBm/-80 dBm (or vice versa), -60 dBm/-60 dBm, and -40dBm/-100 dBm (or vice versa) at a reference height of 25 feet.

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[34] *See* 47 C.F.R. §§ 22.353, 73.88, 73,318, and 73.685(d). *See also Amendment of Part 73 of the Commmission's Rules to More Effectively Resolve Broadcast Blanketing Interference*, 11 FCC Rcd. 4750 (1996) (pending NPRM).

[35] BellSouth Comments at 32.

CONCLUSION

Verizon Wireless urges the Commission to promptly deny the Applications because they fail to satisfy the relevant legal standard for an STA and would effectively preclude the offering of broadband wireless services in the WCS band. We also urge the Commission to quickly conclude its DARS Proceeding by adopting the power limits and other requirements described herein.

Respectfully submitted,

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Appendix

DARS Terrestrial Repeater Analysis

This report documents two independent analyses of blocking and intermodulation distortion (IMD) overload due to the proposed operation of terrestrial repeaters in the 2.3 GHz Digital Audio Radio Service (DARS) band.[1] The first is a generic analysis of a typical urban/suburban coverage area. Within the coverage area, broadband wireless access (BWA) systems, deployed in the Wireless Communications Service (WCS) band, attempt to operate in the presence of high power (greater than 2 kW at 5 MHz) terrestrial DARS repeaters. A significant number of households were excluded from coverage due to blocking and IMD overload.

In the second analysis, the repeater networks proposed by XM and Sirius in the city of Atlanta were analyzed using a terrain-based propagation tool. Once again, a significant number of households were excluded from coverage due to blocking and IMD overload.

Generic Analysis of Blocking and IMD Overload of BWA Systems Due to DARS Terrestrial Repeater Operation

This section analyzes potential blocking and IMD overload to fixed, BWA systems operating in the same geographical region as terrestrial repeaters proposed by XM and Sirius. This analysis assumes generic parameters emulating those of the XM and Sirius repeaters. The parameters of the BeamReach BWA customer premise equipment (CPE) were used for the victim receiver parameters.

Two cellularized networks were analyzed, one with XM repeaters and the other with Sirius repeaters. Each has the following characteristics:

- Each system uses a cellularized layout of radius R using hexagonal cells.
- The area of each cell is $2.6R^2$ accounting for the hexagonal area of the cell.
- The radius is settable, with a nominal radius of 8 km emulating the Boston and Atlanta repeater layouts. 4 km cells were also analyzed.
- Each system uses an average transmitter height of 60 m emulating the Boston deployment, and 120 m emulating the Atlanta deployment.
- No additional transmitter height due to terrain was used, though this may be warranted.
- Repeater EIRP was settable, and was evaluated at 2kW, 10 kW, and 20 kW.

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[1] *XM Request for STA*, File No. SAT-STA-20010712-00063 (filed July 12, 2001) ("XM STA"); *Sirius Request for STA*, File No. SAT-STA-2001-0724-00064 (filed July 24, 2001) ("Sirius STA").

- The antenna patterns of the repeaters were omni-directional.
- The XM and Sirius repeaters were spacing R km apart. The cell centers of one network were coincident with the cell vertices (hexagonal grid) of the other network.
- CPE were uniformly distributed within each cell.
- On average, each CPE is in close proximity to two repeaters per repeater cell, the XM repeater and the Sirius repeater. Each contributes to blocking, and each jointly contributes to IMD (additional repeater power from more distance repeaters is also significant).

The following propagation model was used:

- Propagation Model, Hata with COST 231 extension, suburban model
- CPE antenna height 6 m, the reference height
- BTS antenna height 30 m
- Repeater antenna height 60 m emulating the Boston deployment, and 120 m emulating the Atlanta deployment
- Log normal shadowing parameter, 8 dB standard deviation. Note that Ricean or Rayleigh fading was ignored. The impact of this type of fading is to increase slightly the exclusion zone margin, due to the composite Rayleigh/lognormal distribution for the mean receiver power levels.
- 90% confidence exclusion zone[2]

The following receiver characteristics were used for the CPE:

- Pre-selection filtering, 55 MHz passband, passes the A, B and C/D bands simultaneously.
- TDD operation
- 1.25 MHz processing and IF bandwidth
- 5 dB noise figure

The following 3rd order non-linearity model was used for the CPE:

- $2P_0 + P_1 - 2IP3$ = Acceptable IMD Noise Floor (IMD_{NF})
- P_0, P_1 are the power levels due to repeaters 0 and 1 respectively.
- IMD_{NF} level set for an increase in the operational noise floor by 1 dB.

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[2] A 90% confidence level is typically used in mobile communications. In broadband fixed wireless, confidence exclusion zones may exceed 95%, which would increase the size of the exclusion zones.

- IIP3 = -7 dBm
- IMD_{NF} = -113.9 dBm

The following large signal-blocking model was used for the CPE:

- Blocking signal level = -31 dBm conducted for COFDM signals with 10 dB peak to average ratio (filtered COFDM running at –3 dB backoff)
- $NFloor_{Blocking}$ level set for an increase in the operational noise floor by 1 dB
- $NFloor_{Blocking}$ = -113.9 dBm

The following antenna characteristics were used for the CPE:

- 18 dBi gain
- Vertical polarization
- 36 degree beamwidth, sidelobe to sidelobe level
- -13 dB sidelobe level, -10 dB sidelobe level after installation w/ coupling and local multipath.
- Antennas arbitrarily pointed with respect to the repeaters, uniformly distributed in azimuth.
- Pointed with 0 degrees up tilt at the serving base station.

Exclusion zones were computed for each repeater for the following repeater induced impairments:

- Large signal blocking
- Spurious Emission meeting 75 dB + 10log(P) emission mask
- IMD blocking

Results for Blocking and IMD Limiting

Five analytic cases were computed, each determining an exclusion zone centered on each repeater due to blocking or IMD limiting[3]. The percentage of CPE excluded could then be computed. Table 1-1 summarizes the results. Four columns are shown in Table 1-1. The antenna coupling mechanism is listed in the second column. The third and fourth columns tabulate the percentage of CPE excluded by either blocking or IMD limiting. In these columns, separate numbers are given for either sidelobe coupling or mainbeam

[3] A more rigorous analysis for IMD limiting would require use of the probability density function of the 3rd order non-linearity output term, $2P_0 + P_1 - 2IP3$. This would lead to larger exclusion zones than the ones presented with the simplified approach used in this paper.

coupling. For the IMD limiting case, mainbeam coupling means that the stronger signal couples via the mainbeam and the weaker signal couples through the sidelobes. The 90%/10% blended results are shown in the rows designated "Mainbeam/SL + Sidelobes" and is indicative of the expected level of exclusion for a broadly deployed BWA system.

Table 1-1 Subscribers Excluded Due to Terrestrial Repeater Operation

Case	Antenna Coupling Mechanism	Blocking Limited	IMD Limited
2 kW, R=8 km, Htr=60m	Mainbeam/SL + Sidelobes	3.8%	2.2%
Hcpe = 6 m	Sidelobes Only	2.9%	1.7%
	Mainbeam/SL Only	11.7%	7.2%
2 kW, R=4 km, Htr=60m	Mainbeam/SL + Sidelobes	15.2%	33.7%
Hcpe = 6 m	Sidelobes Only	11.7%	15.2%
	Mainbeam/SL Only	46.8%	100%
20 kW, R=8 km, Htr=60m	Mainbeam/SL + Sidelobes	15.2%	33.6%
Hcpe = 6 m	Sidelobes Only	11.7%	15.2%
	Mainbeam/SL Only	46.7%	100%
10 kW, R=8 km, Htr=120m	Mainbeam/SL + Sidelobes	19.9%	43.5%
Hcpe = 6 m	Sidelobes Only	14.9%	26.0%
	Mainbeam/SL Only	64.9%	100%
2 kW, R=4 km, Htr=60m	Mainbeam/SL + Sidelobes	4.4%	2.8%
2x more BWA base stations	Sidelobes Only	3.4%	2.1%
Hbts=45 m, Hcpe = 3 m	Mainbeam/SL Only	13.5%	8.9%

Case 1 is characterized by a maximum effective isotropic radiated power (EIRP) of 2kW with a moderately high antenna height of 60 meters. In this case, an acceptable level of blocking and IMD limiting is achieved. In Case 2, the cell radius is reduced to 4km and the blocking percentage increases to over 15% and IMD limiting jumps to almost 34% of the subscriber base.

In Case 3, the transmitter power is increased to 20 kW with the cell radius returned to 8km. This case results in approximately the same performance. The blocking level increases to over 15% and the IMD limiting exceeds 33%.

Case 4 reduces the EIRP to 10 kW and increases the transmitter height to 120 meters. This case approximates the proposed Atlanta deployment. The outage percentages increase further as shown. Cases 2,3, and 4 present unacceptable business cases for the operator.

Case 5 attempts to reduce the influence of terrestrial repeater overload by reducing the CPE antenna height from 6 m to 3 m. This reduces the exclusion zones around the repeaters at the expense of doubling the number of BWA base stations and requiring that the BTS antenna heights be increased from 30 m to 45 m.

Results for the Base Station

The BeamReach base station incorporates very high Q cavity filters. These filters effectively attenuate terrestrial repeater energy such that the exclusion zones are modest and limited by the emission levels of repeaters and not by blocking or IMD mechanisms. Base stations co-located with repeaters still need a minimum separation distance defined below. Note that the cost of cavity filters precludes their use in the CPE.

Results for Emissions

The emission levels proposed by XM and Sirius of 75 dB + 10log(P) generate an exclusion zone of 230 meters provided that the emissions can be treated as a uniform broadband energy in the WCS band. If the WCS 80 dB + 10log(P) rule were employed, the exclusion zone would be reduced to 130 meters.

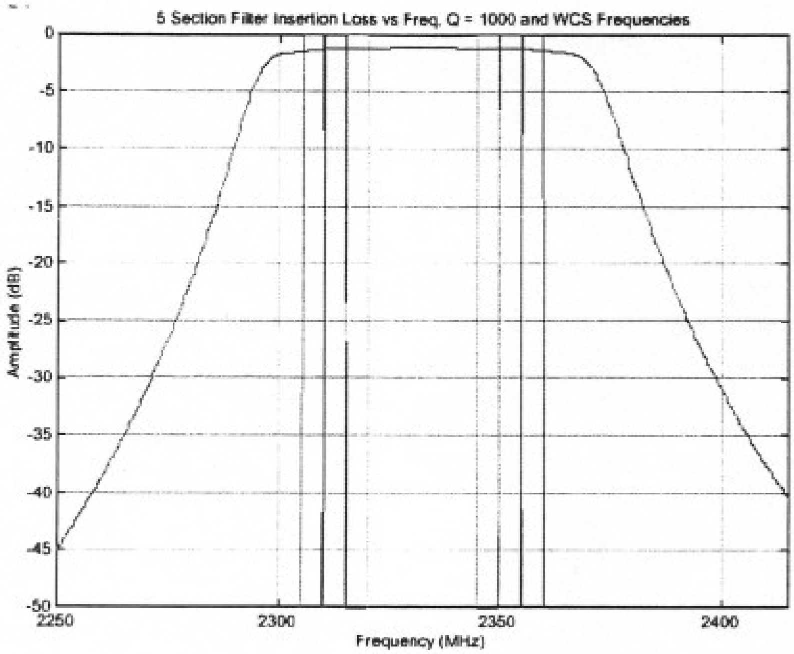
Additional CPE Filtering Costs to Attenuate DARS Emission

We have examined the technical feasibility and incremental costs associated with high-Q filters in an attempt to attenuate DARS emissions.

High performance BWA CPE, such as that from BeamReach, typically use a bandpass filter ahead of the Low Noise Amplifier (LNA) in the receive path. A subsequent SAW filter (after the LNA) is used to reduce unwanted in-band signals, such as adjacent WCS or DARS satellite or terrestrial repeater signals. Signal energy within the DARS band is not attenuated by the bandpass filter but is attenuated by the SAW filters.

The characteristics of such a low cost bandpass filter are shown below in Figure 1-1. This device represents a cost to the service provider of approximately $30 in high volumes.

This receiver filtering design is based on the assumption that DARS Licensees may deploy terrestrial repeaters operating at a peak EIRP of up to 400 W/MHz, evenly distributed across the band (for a total of 2 kW per 5 MHz). This is the same emission limit to which the WCS licensees themselves are subject. The design also assumes that the out of band emissions generated by DARS terrestrial repeaters shall be limited to at least 75 + 10 log (p) dB (where p is the EIRP in watts) less than the transmitter EIRP.



Parameter	Specification
1.5 dB Insertion Loss Passband	2305 to 2360 MHz
Rejection Characteristics	
DC to 2200 MHz	50 dB min
2200 to 2275 MHz	26 dB min
2390 to 2450 MHz	26 dB min
2450 to 4000 MHz	50 dB min

Figure 1-1: BeamReach CPE - Current Bandpass Filter

(Vertical Markers indicate WCS sub-bands A, B, C and D)

As a result of XM and Sirius proposals to use high power terrestrial repeaters, BeamReach has investigated the feasibility and costs of additional front-end filtering for the CPE. Figure 1-2 below shows the frequency response of a 6-section pseudo-elliptic notch filter that could be added to the receiver front-end circuitry. Using pricing from our filters vendors, this filter would increase the price of the CPE unit by $50 in high volumes (in excess of 25% of the long term price objective). If this filter were added, an increase in power amplifier cost would be necessary to overcome the additional filter loss and still maintain the necessary system performance. This would add an additional $20 to the price of the CPE in high volume.

This additional filter would partially attenuate the DARS interference, protecting the LNA/front-end from some of the harmful compression that would otherwise be caused. However, this design would still be insufficient to allow unlimited deployment of high power terrestrial repeaters and would therefore require considerable coordination efforts between WCS licensees and DARS operators. Moreover, the filter shown in Figure 1-2 severely attenuates the C/D block. A higher order, higher cost filter would be necessary for these blocks.

In summary, the incremental CPE cost of $70 for A and B block operators, which is 35% of the long term CPE price objective, is economically not feasible in this very price sensitive consumer application. Incremental costs are even higher for C/D block operators.

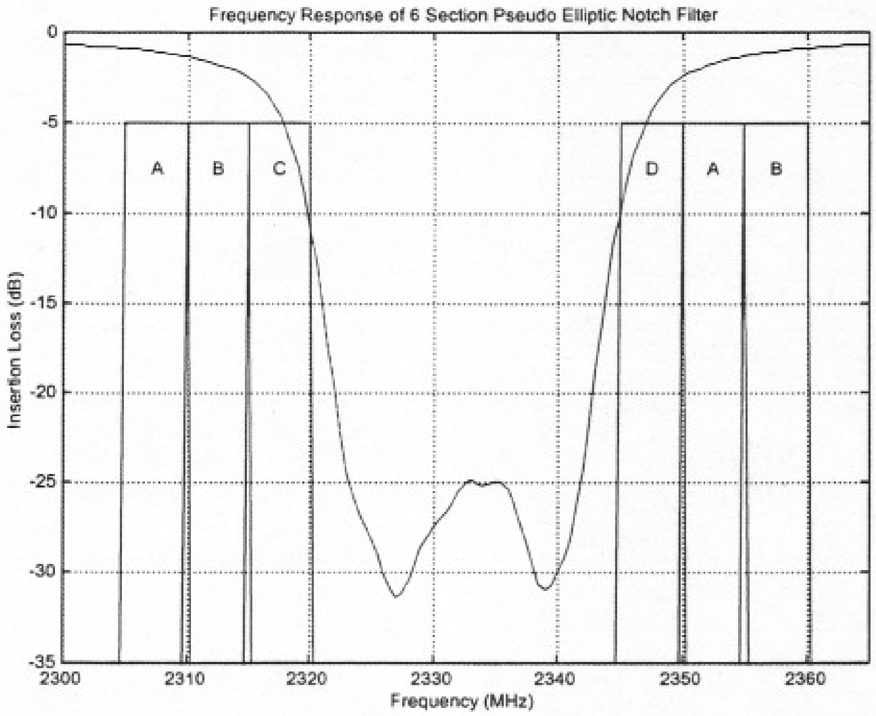


Figure 1-2: Simulated 6-section Band-reject Filter

(Vertical Markers indicate WCS sub-bands A, B, C and D)

Blocking and IMD Overload Analysis in the Greater Atlanta Region

This section analyzes potential blocking and IMD overload to fixed, BWA systems operating in the same geographical region as terrestrial repeaters proposed by XM and Sirius. XM and Sirius data was available for the Greater Atlanta region for this analysis. The parameters of the BeamReach BWA system were used for victim receivers.

Two overlapping terrestrial repeater networks were analyzed in the greater Atlanta region, one with XM repeaters and the other with Sirius repeaters. The coverage area of each network was determined using CommStudy, a terrain based propagation modeling tool. For each network, the proper location, EIRP, antenna pattern, antenna pointing angle and antenna height were input according to Tables 2-1 and 2-2. This data was derived from the XM and Sirius STAs. The following methodology was used:

- CommStudy was used to evaluate field strength over the coverage area for the two networks.
- Field strength maps were computed in dBu for each network independently.
- Population overlay maps were used to assign the population into 12 field strength bins from 50 dBu to 105 dBu in 5 dB increments.
- The number of users affected by large signal blocking was then determined for CPE that couple to the repeater through the sidelobe region of the antenna. In addition, the number of users blocked in the mainbeam region was also determined. The total number of affected users was determined by blending sidelobe and mainbeam blocked users in the ratio of 90% to 10%. This corresponds to the ratio of the CPE antenna sidelobe region to mainbeam region.
- The Longley Rice propagation model was used, using 50% confidence levels for all parameters.
- The reference height of CPE was used to determine field strength level.
- 5 dB was added to the Longley Rice field strength bins to produce the data for 90% confidence exclusion zones.
- In addition, the number of users affected by IMD signal limiting was then determined for CPE that couple to the repeater through the sidelobe region of the antenna. In addition, the number of users blocked in the mainbeam region was also determined. The total number of affected users was determined by blending sidelobe and mainbeam blocked users in the ratio of 90% to 10%.

Table 2-1 XM Repeater Data, Greater Atlanta Area

XM Site	Antenna Beam /Pointing Angle	EIRP (Watts)	Antenna Height (ft)
10B	90 deg. 160 deg.	3444	664
27A	120 deg. 180 deg.	2486	170
41B	90 deg. 180 deg.	12926	230
43B	120 deg. 270 deg.	2396	190
46A	360 deg. 0 deg.	7294	600
48B	120 deg. 135 deg.	3606	148
63A	120 deg. 60 deg.	2014	256
67A	120 deg. 45 deg.	2634	157
69A	120 deg. 300 deg.	3444	208
508B	120 deg. 10 deg.	2416	133
510B	360 deg. 270 deg.	3444	664

Table 2-2 Sirius Repeater Data, Greater Atlanta Area

XM Site	Antenna Beam /Pointing Angle	EIRP (Watts)	Antenna Height (ft)
Atl. 1a	180 deg. 0 deg.	6309	1016
Atl. 1b	180 deg. 180 deg.	7943	1016
Atl. 2	120 deg. 270 deg.	19962	443
Atl. 3a	090 deg. 30 deg.	8317	228
Atl. 3b	090 deg. 150 deg.	7586	228
Atl. 4a	090 deg. 45 deg.	10715	231
Atl. 4b	090 deg. 180 deg.	10964	231
Atl. 5a	180 deg. 0 deg.	7589	164
Atl. 5b	180 deg. 180 deg.	7413	164

Results

Field strength maps for the XM and Sirius repeater networks are shown in Figure 2-1 and Figure 2-2 respectively. We note that the coverage area is over 4572 square miles with a population of 1.17 million people, each having a signal strength of over 85 dBu. 31% of these have signal strengths of over 95 dBu. The CommStudy propagation tool automatically computes the number of users within field strength bins shown in Figures 2-1 and 2-2. The population density map is shown in Figure 2-3 for reference.

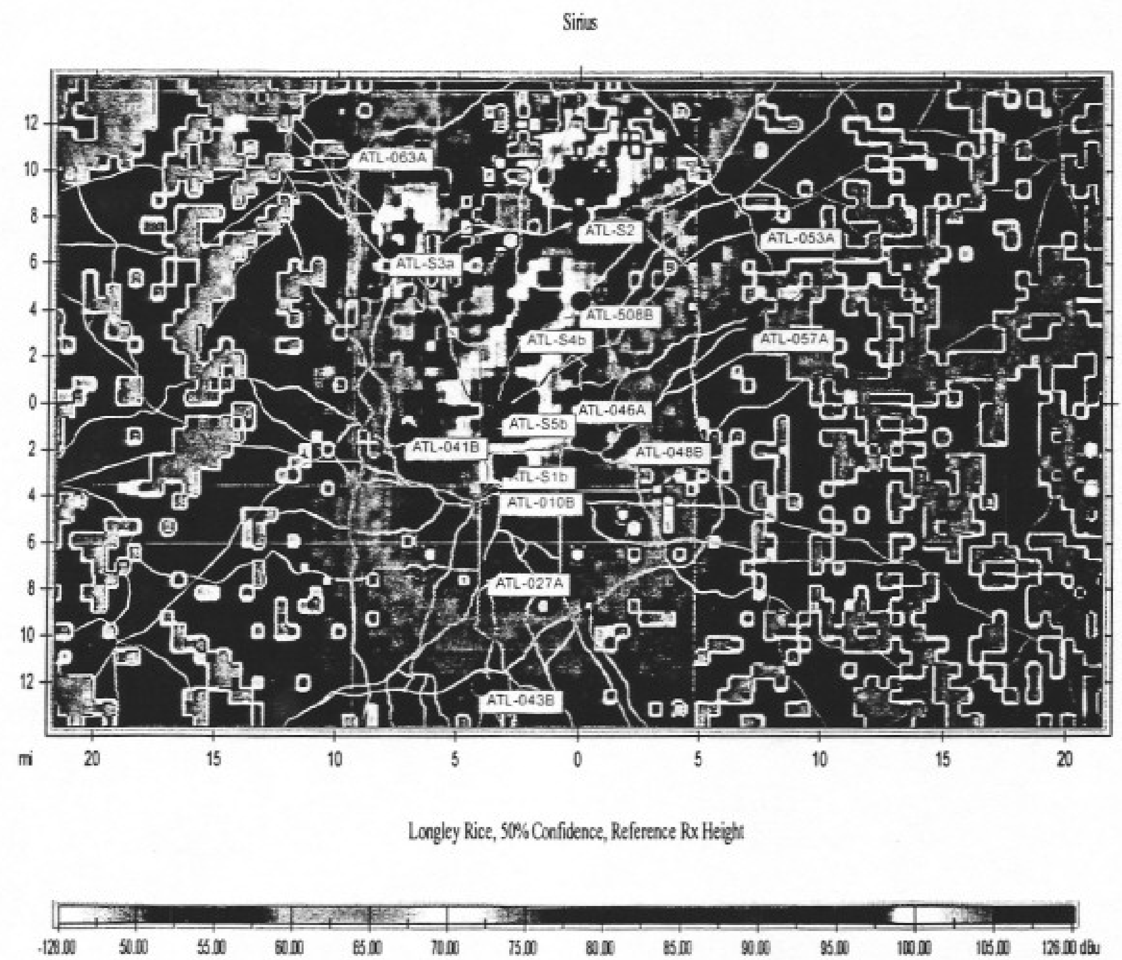


Figure 2-1 Field Strength Map of Sirius Repeaters in the Greater Atlanta Region

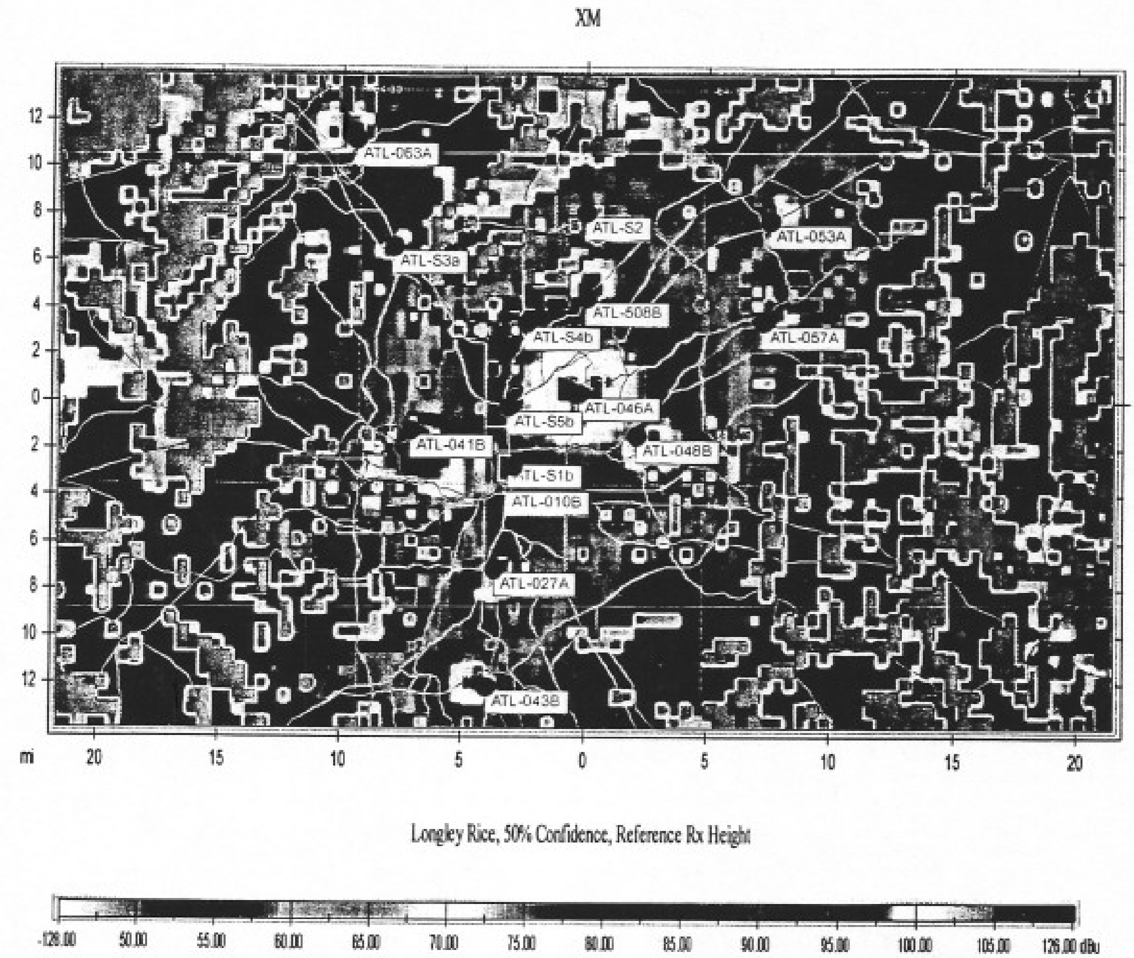


Figure 2-2 Field Strength of XM Repeaters in the Greater Atlanta Region

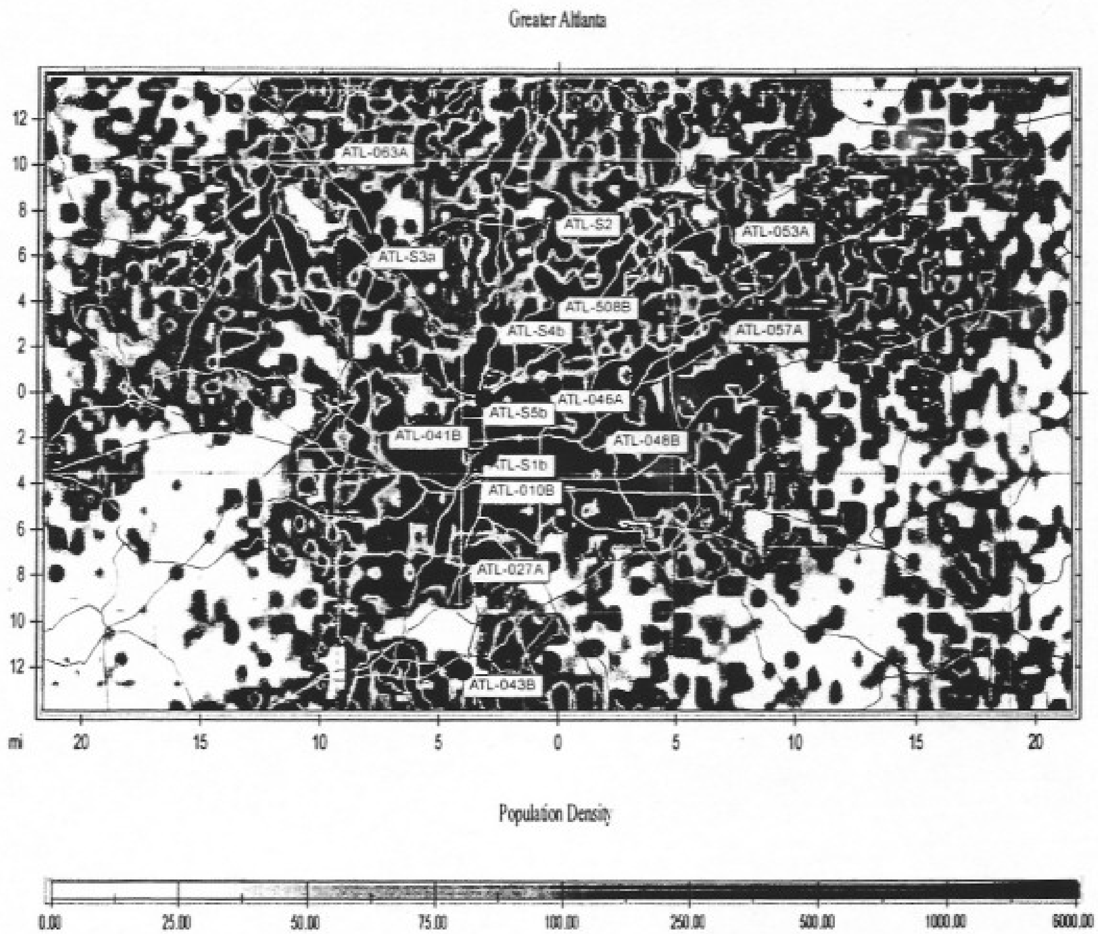


Figure 2-3 Population Density of the Greater Atlanta Region

Using the receiver parameters given in Section 1, the number of subscribers excluded from BWA is given in Table 2-3. While 29.6% of potential BWA subscribers are limited by strong signal blocking, IMD effects limit 51.7% of these subscribers.

Four columns are shown in Table 2-3. The antenna coupling mechanism is listed in the second column. The third and fourth columns tabulate the population limited by either blocking mechanisms or IMD limiting. In these columns, separate numbers are given for either sidelobe coupling or mainbeam coupling. For the IMD limiting case, mainbeam coupling means that the stronger signal couples via the mainbeam and the weaker signal couples through the sidelobes. The 90%/10% blended results are shown in the rows designated "Mainbeam/SL + Sidelobes" and is indicative of the expected level of exclusion for a broadly deployed BWA system.

Table 2-3 XM Repeater Data, Greater Atlanta Area

Atlanta Case Study	Antenna Coupling Mechanism	Blocking Limited (pops)	IMD Limited (pops)
XM Repeaters	Mainbeam/SL + Sidelobes	152,157	285,036
	Sidelobes Only	90,068	216,427
	Mainbeam/SL Only	710,953	902,521
Sirius Repeaters	Mainbeam/SL + Sidelobes	194,449	319,628
	Sidelobes Only	133,208	248,747
	Mainbeam/SL Only	745,619	957,559
Total Population Effected	Mainbeam/SL + Sidelobes	346,605	604,665
Total Population > 85 dBu		1,169,449	1,169,449
% Population Excluded		29.6%	51.7%

Conclusion

In summary, BeamReach Networks has undertaken an analysis of the DARS terrestrial repeater deployment proposed by XM Radio for the Atlanta market as part of its STA application. This analysis concurs with comments previously submitted that DARS repeaters will cause blocking interference in the WCS band and that DARS transmissions mixing within WCS equipment will create 3rd order intermodulation products within the WCS band.[4] The analysis also shows that when both DARS licensees utilize terrestrial repeaters in the same market, the 3rd order intermodulation products resulting from

[4] *See* Written Ex Parte Communications of the Wireless Communications Association International, Inc., (filed Dec. 15, 2000), *In the Matter of Estalishment of Rules and Policies for the Digital Audio Radio Service in the 2310-2360 MHz Frequency Band*, IB Docket No. 95-91, Notice of Proposed Rulemaking ("DARS Proceeding").

mixing of both DARS frequencies at the WCS receiver have an even greater impact than large signal blocking. This phenomenon will occur within a WCS receiver (such as BeamReach's) when the interfering DARS signals exceed – 60 dBm, resulting in exclusion zones much larger than previously noted within this Docket. The close proximity of these bands does not allow for economical filtering at the CPE. As such, granting the DARS licensees' proposals to use high power terrestrial repeaters would render WCS spectrum useless and eliminate the option of using the WCS band for competitive broadband services.

This analysis of the proposed deployment of terrestrial repeaters in the DARS band concludes that the proposed deployment will severely cripple the use of the WCS band for emerging 2-way, fixed broadband services. The proposed terrestrial repeater deployments will have these negative effects on the BWA operators and their equipment suppliers:

- A significant number of otherwise eligible customers will be unable to receive broadband services because BWA receivers will suffer either blocking and/or intermodulation distortion caused by high power, in-band signals.

- Thus, the cost of BWA base stations and backhaul equipment will be shared over a smaller number of subscribers increasing the pro-rata cost per subscriber. More extensive filtering will be needed increasing base station cost and the BWA cell radius will be reduced due to added noise.

- Using the Atlanta metropolitan region as an example, over **50%** of the coverage area of 1.17 million people would lose BWA services if both XM and Sirius deployed the proposed repeaters. Extending this to other major markets, the entire WCS BWA business is in jeopardy.

- While it is technically feasible to add filtering to remove undesirable repeater energy, it is cost prohibitive in the CPE. High cost, high Q filter designs are needed to suppress DARS repeater energy only 13 MHz away.

- The unfortunate frequency spacing between XM and Sirius repeaters ensures that 3rd order intermodulation products between these two signals, will land directly in the WCS A, B and C/D blocks.

- CPE installation will become more time-consuming and costly due to complex antenna alignment procedures that jointly optimize the signal strength of the desired signals while trying to achieve acceptable interference/ IMD levels from the proposed repeaters.

Recommendations

Specifically, with respect to the terrestrial repeater rules, the Commission should limit emissions to no more than 400 watts/MHz with a maximum of 2,000 watts.

We note that even with 2,000-watt transmission, deployment on high towers and/or deployments with a cell radius less than 8 km will likely result in significant IMD overload. Accordingly, field strength contours must be coordinated between XM and Sirius. These contours should be –50 dBm/-80 dBm, -60 dBm/-60 dBm, and –40 dBm/-100 dBm at reference height of the 25 feet to limit the outage experienced by WCS operators. DARS operators may want to consider horizontal polarization for DARS terrestrial repeaters. In this case, the above contours could be relaxed by 10 dB accounting for the cross-polarization rejection of vertical CPE antennas.

The Commission should limit out-of-band emissions to 80 dB + 10log(P) in concert with the rules that WCS operators must follow with respect to the DARS band.

Finally, the Commission should adopt field strength contours which limit large signal blocking caused by terrestrial repeaters. A practical limit would be –45 dBm for no more that 2% of the population at reference height of the 25 feet in each coverage area.

Certificate of Service

I hereby certify that on this 30th day of August copies of the foregoing "Reply Comments of Verizon Wireless" in Applications of XM Radio, Inc. (SAT-STA-20010712-00063) and Sirius Satellite Radio, Inc. (SAT-STA-20010724-00064) for Special Temporary Authority were sent by first class mail or hand delivery (*) to the following parties:

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