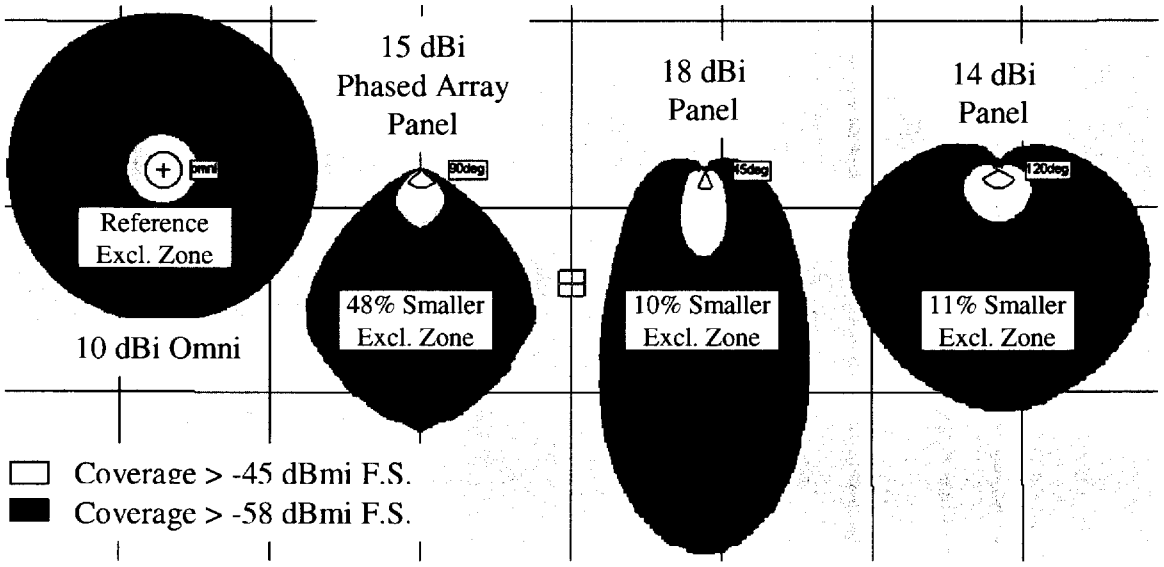


Figure 16. Line of Sight Exclusion Zones for Omni Vs. Panel Antennas

RF Power at Ant. Feed (Watts)	Antenna	Peak EIRP (Watts)	-45 dBmi Excl. Zone (Sq. Miles)	-58 dBmi Excl. Zone (Sq. Miles)	Excl. Zone Reduction (percent)
200	10 dBi Omni	2 000	8.0	158	0
200	15 dBi PA Panel	6 325	4.2	82	48
200	18 dBi Panel	12 619	7.2	142	10
200	14 dBi Panel	5 024	7.1	141	11

Table 3. Peak EIRP and Exclusion Zones for Omni and Panel Antennas

When other factors mitigating signal propagation are included, panels exhibiting a gain average below the 10 dBi omnidirectional antenna, where the gain average is determined by integration of the azimuth pattern, will further reduce the exclusion zones.

IV. The advantages of using fewer higher power repeaters instead of a greater number of low power repeaters

The following set of charts demonstrates the extent to which XM Radio has reduced the likelihood of interference to WCS receivers by designing networks for urban coverage that use fewer repeaters. Figure 17 depicts the exclusion zones (using a worst-case, line-of-sight interference model) where the signal level of a 2 kW EIRP transmitter will exceed the interference limits of -45 dBmi and -58 dBmi, the overload threshold that AT&T Wireless has identified for its WCS base stations and consumer units, respectively.

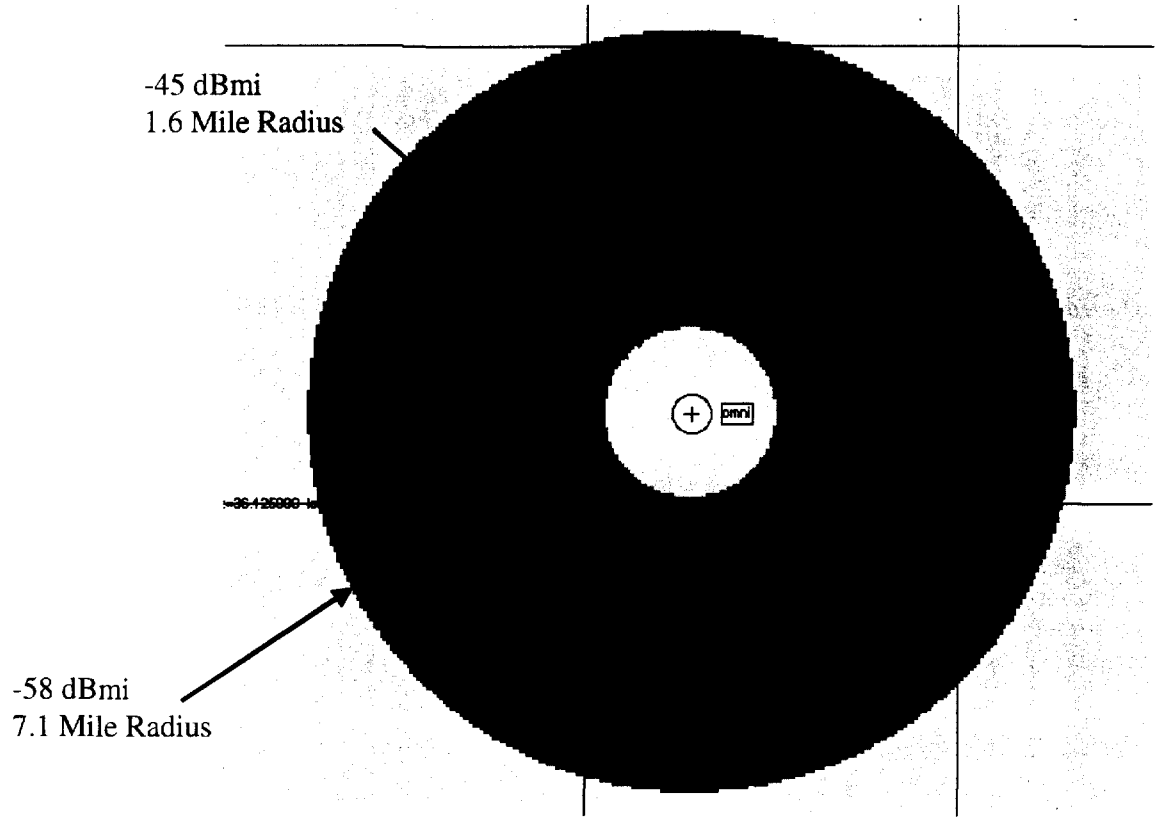


Figure 17. 2 kW EIRP Omni Line of Sight Exclusion Zones For WCS Receivers

The AT&T WCS base stations and consumer receivers will be susceptible to blanketing interference at distances of 1.6 miles and 7.1 miles, respectively, from any 2 kW EIRP transmitters in nearby bands, including those of other WCS licensees. These distances are based on a line of sight propagation model where the path loss in dB is equal to 32.44 + 20 log f(MHz) + 20 log R(Km). This is a worst-case analysis since multiple simultaneous factors must be present for there to be actual interference, such as an absence of shielding or blockage, the receiver operating at threshold, the transmitter being in the boresight of the receive antenna, and the antenna polarizations being aligned.

In an earlier filing, AT&T concedes that the replacement of higher-power repeaters with multiple lower-power repeaters will not reduce the aggregate size of the exclusion zones for consumer receivers.[1] AT&T's analysis of base station interference, however, concludes that the use of multiple lower-power repeaters would reduce their exclusion zones. Our analysis is to the contrary. The apparent error in the AT&T's analysis is its assumption that the lower-power repeaters would be clustered in a way that is actually unrealistic and impractical. The costs associated with site deployment and ongoing site maintenance are high, so RF broadcast networks, by design, avoid inefficient site configurations with large amounts of overlapping coverage. A more

[1] Letter from William M. Wiltshire, Counsel for AT&T Wireless, to Ms. Magalie Roman Salas, FCC, IB Docket No. 95-91 (April 30, 2001), at 8.

realistic comparison of exclusion zones for the line of sight environment is observable in the following examples from Los Angeles and Indianapolis, based on XM Radio's experience in deploying repeater networks in those markets.

In order to establish a correct site configuration to provide highly reliable radio service within a given market boundary, XM Radio follows a terrestrial RF network design process, which includes collection of field strength data from each planned site. This data is then post processed to determine the minimum site configuration necessary to meet the market coverage reliability requirements. Figure 18 depicts the worst-case line-of-sight exclusion zones for a section of the Los Angeles market that is covered by the minimum site configuration, based on the measured field strength data, which includes the 40 kW EIRP high power repeater at site 101. The yellow shaded region represents the area where the signal strength exceeds -45 dBmi and the red shaded region represents the area where the signal strength exceeds -58 dBmi, based on free space path loss plus RMD. Figure 19 depicts the same exclusion zones when XM Radio is limited to deploying repeaters with a maximum EIRP of 2 kW. This is our best effort to model a less-than-ideal case, trying to cover the same area as is covered by the preferred case.

Figure 18. Los Angeles Market Exclusion Zones with High Power Repeater

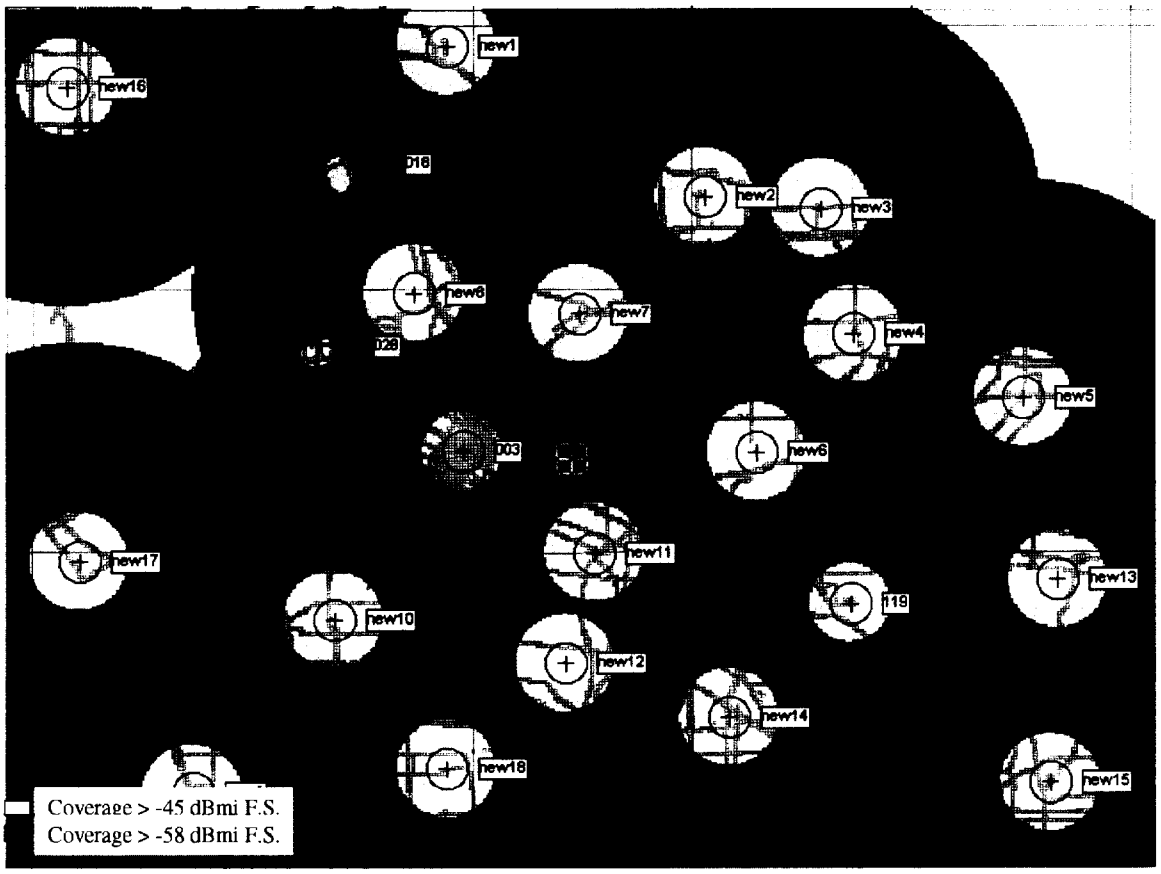
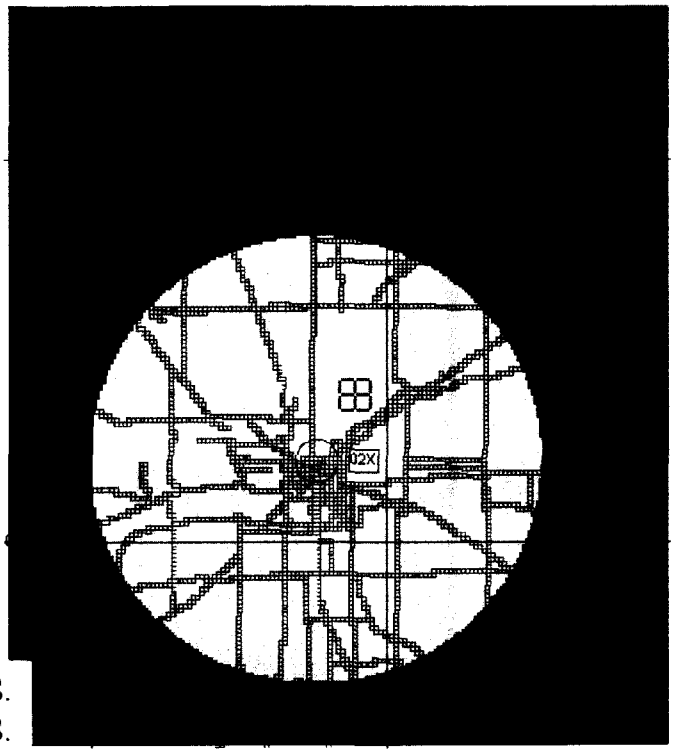


Figure 19. Los Angeles Market Exclusion Zones without High Power Repeater

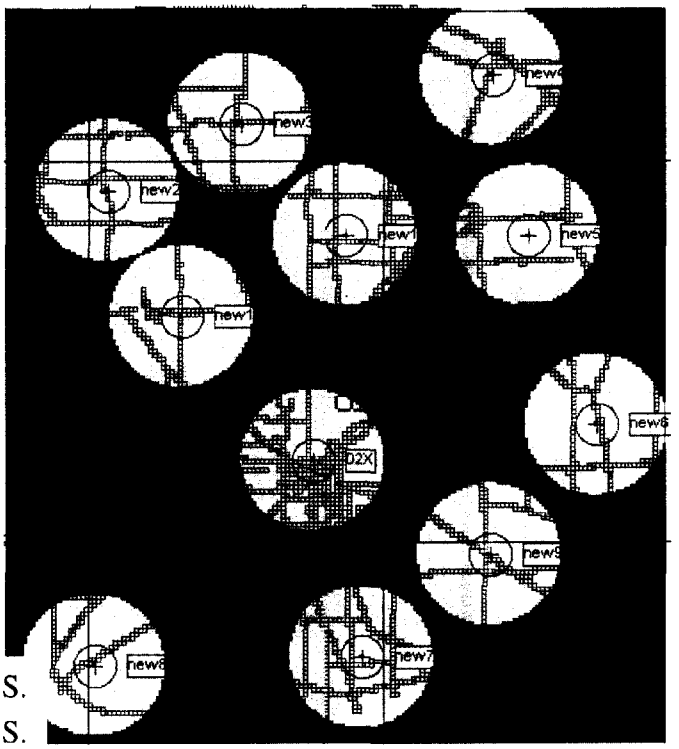
Figures 18 and 19 provide graphical evidence that deploying a greater number of low power repeaters in the XM network design will not reduce line of sight exclusion zones.

Moving to a second example, Figure 20 depicts the worst-case line-of-sight exclusion zones for the Indianapolis market for which a single 20 kW EIRP repeater is deployed at site 02x in the downtown area. The yellow shaded region represents the area where the signal strength exceeds -45 dBmi and the red shaded region represents the area where the signal strength exceeds -58 dBmi, based on free space path loss plus RMD. Figure 21 depicts the same exclusion zones when XM Radio is limited to deploying repeaters with a maximum EIRP of 2 kW and includes the additional sites required to provide equivalent market coverage.



Coverage > -45 dBmi F.S.
Coverage > -58 dBmi F.S.

Figure 20. Indianapolis Market Exclusion Zones with High Power Repeater



Coverage > -45 dBmi F.S.
Coverage > -58 dBmi F.S.

Figure 21. Indianapolis Market Exclusion Zones without High Power Repeater

Table 4 summarizes the exclusion zone area comparison for the Los Angeles and Indianapolis network designs presented in Figures 18-21. The analysis indicates the total –45 dBmi exclusion zone area is increased by replacing high power sites with additional low power sites to provide equivalent market coverage.

Los Angeles RF Network Configuration	-45dBmi Exclusion Zone Area Based on Freespace + RMD
Current Design configuration: 1 25 kW EIRP site with panel antenna 2 1.2 kW EIRP sites with omni antennas 1 4.5 kW EIRP site with panel antenna 1 3.4 kW EIRP site with panel antenna	20 square miles
Low Power Design configuration: 18 2 kW EIRP sites with omni antennas 2 1.2 kW EIRP sites with omni antennas 1 2 kW EIRP site with panel antenna 1 2 kW EIRP site with panel antenna	159 square miles

Indianapolis RF Network Configuration	-45dBmi Exclusion Zone Area Based on Freespace + RMD
Current Design configuration: 1 20 kW EIRP site with omni antenna	81 square miles
Low Power Design Configuration: 11 2 kW EIRP sites with omni antennas	88 square miles

Table 4. Exclusion Zones for Current Network Versus 2 kW EIRP Limit Network

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This paper was prepared with contributions from the following members of XM radio's technical team:

Stel Patsiokas, Senior Vice President, Technology. Previously, Dr. Patsiokas was with Motorola, Inc., where he served in a variety of consumer electronics design and development roles since 1979. Since 1996, Dr. Patsiokas was Director of Product Development for Motorola's Messaging Systems Product Group, where he was involved with developing the PageWriter™ 2000 two-way messaging device. Dr. Patsiokas holds 24 United States patents.

Phil Barsky, Spectrum Management and Regulatory Engineer, has over 30 years experience with advanced wireless communications systems, including systems engineering.

Derek de Bastos, Vice President, Space Segment, has over 14 years of experience with space-based, wireless communications systems.

Paul Marko, Vice President, Subscriber Technology, has 18 years of experience at Motorola, most recently as a Principal Member of the Technical Staff and Director of Strategic Systems for the company's Core Technology and Systems Operations (CTSO). An Engineering graduate of the University of Florida, Mr. Marko has extensive experience directing IC chipset development for advanced digital receiver platforms and developing the architecture, algorithms and IC partitioning for highly integrated receiver and controller platforms. Mr. Marko holds 36 US Patents.

Craig Wadin, Senior Member, Technical Staff, has been at XM Radio for over two years, focusing on consumer product chipset design and the terrestrial RF network design. Mr. Wadin has 25 years experience with Motorola in the area of system level RF digital communication system design. He holds 19 issued U.S. patents.

ATTACHMENT B

SATELLITE
RADIO

August 7, 2001

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Federal Communications Commission
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Mr. Thomas Sugrue
Chief, Wireless Telecommunications Bureau
Federal Communications Commission
445 12th Street, S.W.
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Re: DARS Terrestrial Repeaters

Dear Gentlemen:

On behalf of XM Radio, this letter will put into context the concerns expressed in a recent letter to the Commission from a group of Wireless Communications Service licensees. Letter of AT&T Wireless Services, Inc., BellSouth Corporation, Metricom Inc., Verizon Wireless Inc., and WorldCom, Inc. (July 27, 2001). Contrary to their complaints, these companies have had ample opportunity to comment on the use of terrestrial repeaters by the Digital Audio Radio Service ("DARS") licensees, but have failed to participate in a timely or constructive manner. The Commission has been conducting a rulemaking on DARS repeaters for which there were three deadlines for the submission of comments, in June 1997, January 1998, and February 2000. None of the parties to the July 27 letter met those deadlines to express their concern or present evidence that DARS repeaters operating above 2 kW would cause interference to their WCS operations. To date, the WCS licensees still have not provided substantial information about their systems.

The DARS licensees have been and will continue to cooperate to try to resolve WCS licensee concerns, but we are entitled to expect the Commission to enforce its deadlines for the development of a record for reasoned rulemaking. The risk we took in building our repeater network was the risk that we would be able to resolve issues of record raised in a timely manner. We accept that risk and we believe all issues raised by those who participated in a timely manner have been successfully resolved. But we do not accept the risk that parties who failed to participate in the development of a timely record can turn things upside down at the last minute. The late-filing parties must accept that risk and the attendant consequences.

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The United States is about to experience a wonderful new communications service that will demonstrate the foresight of the FCC and the vision and energy of the private sector. When XM Radio and Sirius begin providing digital audio satellite service in the next few months (XM Radio will begin in selected markets September 12), millions of Americans will be thrilled by the ability to receive an extraordinary variety of high-quality audio. Between the two companies, nearly 200 channels of music, news, talk, and foreign-language programming will be available nationwide. A process that began in 1990 with the Commission's processing of an innovative application will have reached fruition.

XM Radio and Sirius received their licenses in 1997 by auction at which they paid together over $170 million. Immediately after receiving their licenses, both companies went into high gear, designing their systems and taking the steps needed to make the service a reality. The two companies have raised a total of approximately $3 billion and successfully launched five satellites. XM Radio's investors include General Motors, Clear Channel, DirecTV, and Honda. Over twenty companies are building radios that are DARS-compatible, including Alpine, Audiovox, Clarion, Delphi Automotive Systems, Kenwood, Pioneer, Panasonic, Sony, and Visteon. Many of the major car manufacturers have joined forces with the DARS licensees to install satellite radios in new cars.

Since well before the two companies received their licenses, it was understood that the systems would need to use terrestrial repeaters to provide reliable service in urban areas where the satellite signal would be blocked. As far back as the initial 1990 DARS application, the proposals have included repeaters operating at sufficiently high power levels, on the order of 40 kilowatts, to overcome blocking in urban areas.

To have the repeater networks in place in time to meet the Commission's own milestones for the DARS licensees, the companies had to make key design decisions and begin to procure equipment and implement our networks based on those decisions. High-power repeaters as a small percentage of the overall repeater networks have been a key part of XM Radio's system design for a number of reasons. The most important is that they reduce the complexity and cost of the repeater network in a city. A single higher-power repeater can replace many lower-power repeaters. This simplicity is particularly important in a single frequency broadcast network, since all of the repeaters in a given area must be precisely timed and coordinated with one another in order to provide reliable, high-quality service. The higher-power repeaters effectively become a keystone for managing the synchronization of the overall repeater network in a city. (This is unlike a cellular system in which each transmitter acts independently of one another and precise timing considerations are not a concern.)

The licensees' plans for repeaters have remained remarkably consistent, particularly for a new technology. In November 1997, XM Radio stated that it planned to operate over 1000 repeaters at power levels approaching 20 kW. Two years later, we filed a description of our repeater networks indicating that it would operate up to 1500 repeaters, including medium power repeaters that would operate at between 2-5 kW and 150 high power repeaters that would operate at 6-40 kW. At an FCC meeting with WCS and wireless cable licensees in January 2001, XM Radio, based on design information available at that time, informed the Commission that it would operate approximately 150 repeaters above 2 kW, with a maximum power of 31.7 kW. XM Radio revised this information in an April 2001 filing that explained that without changing the input power to the antennas we were shifting some of our 2 kW repeaters from omnidirectional antennas to sectorized antennas, which has resulted in a class of repeaters operating between 2 kW and 10 kW. By substituting these directional antennas, typically with beamwidths of no more than 90 degrees, these redesigned repeaters reduce by up to forty-eight percent the area in which there is a potential interference risk to WCS licensees relative to 2 kW transmitters with omnidirectional antennas.

Sirius' repeater plans have also been consistent throughout. Sirius is the successor to the initial applicant that proposed roughly 40 kW repeaters in 1990. In 1997, Sirius stated that it would operate up to 150 repeaters, some at power levels well in excess of 40 kW. In January 2000, Sirius stated that it would need high-power repeaters operating at 105 sites at power levels up to 40 kW.

The licensees have proceeded pursuant to full Commission authority. No explicit authority is required to construct either satellites or repeaters, but the licensees acquired all necessary and appropriate authorizations, including those required for experimental operations. The experimental licenses currently held by the licensees authorize tests of repeaters at up to 50 kW. To our knowledge, there has been no actual interference caused by any of the repeaters deployed under the experimental licenses. Testing has been ongoing in such cities as New York, Los Angeles, Dallas, Washington, D.C., Miami, Detroit, Pittsburgh, San Diego, and Las Vegas.

The public has been given an opportunity to comment on DARS repeaters several times, beginning in June 1995 with the initial DARS NPRM. The Commission issued a Further NPRM in March 1997, in which it solicited comment on a proposal to allow DARS licensees to deploy repeaters. No WCS licensees participated in that proceeding. In December 1997, the FCC put on public notice information supplied by the DARS licensees regarding the number and power levels of their proposed repeaters. No WCS licensees responded to that public notice. In January 2000, the Commission again solicited comment on the DARS licensees' repeater plans. Only one WCS licensee, Metricom, filed comments

(only in the reply round) indicating that a repeater power limit might be needed to protect its WCS operations. Its filing was very brief and contained no technical analysis. Metricom failed to respond to follow up efforts from XM Radio for more details. BellSouth and WorldCom participated in the same proceeding and filed comments focusing on their MMDS operations and requested power limits on DARS repeaters only in connection with protecting wireless cable. BellSouth expressed concern with out-of-band emissions from DARS repeaters possibly affecting WCS systems, but neither BellSouth nor WorldCom advocated any need for power limits on repeaters in order to protect their planned WCS operations.

The Wireless Communications Service was established in 1997 using 25 MHz of spectrum that initially had been intended for DARS. Shortly after the DARS auction, this spectrum was auctioned for less than $14 million for a broad range of uses, including broadband data services, fixed terrestrial use, and wireless local loop. The low price for the spectrum, relative to DARS, was widely understood to reflect the nascent nature of WCS and the limitations on successfully deploying facilities in the near future. WCS licensees are not required to notify the FCC when they build and operate facilities, and the record in this proceeding contains no evidence of the extent of any actual deployment of such facilities.

Other than Metricom's brief filing in March 2000, December 2000 was the first time that any WCS licensee requested a limit on the power of DARS repeaters in order to protect WCS operations and supplied any technical information to support its concern. AT&T Wireless first noted any concern with potential interference from repeaters in February 2001. Verizon and WorldCom have never contacted XM Radio about their concerns for protecting their WCS operations. Verizon's first indication that it had any concern was in a filing it submitted only late last month. (Verizon and WorldCom hold only WCS A and B block licenses, which are not adjacent to the frequencies used by either XM Radio or Sirius, which should make it even easier for them to design systems that will not receive interference from DARS repeaters.)

Even worse than the dilatory nature of their filings is the extent to which WCS licensees have been unwilling or unable to provide specific information about their system characteristics sufficient to permit reasoned resolution of their concerns. After Metricom, BellSouth, and WorldCom submitted comments in the repeater proceeding in early 2000, XM Radio made repeated efforts to engage those entities in a constructive dialogue, but they were unwilling to share information. There are various coordination techniques that might substantially ameliorate any potential interference, including the use of filters and relative antenna placement, polarization, and pattern discrimination, but the WCS licensees have never been willing to share the information needed to conduct such discussions. In contrast, XM Radio and Sirius have long ago worked out the ability to co-exist with repeaters in

adjacent bands. More recently, XM Radio and Sirius engaged AFTRCC in coordination discussions, pursuant to which the companies shared relevant repeater information with AFTRCC months ago – thus privately resolving the matter to the satisfaction of all concerned. In an effort to facilitate discussions with WCS and wireless cable licensees, XM Radio and Sirius unilaterally made available their preliminary repeater information for three cities. WCS and wireless cable licensees critiqued that information in a public filing to the FCC (and substantially mischaracterized it), but continued to provide virtually no information about the characteristics of their own systems or the location of their own facilities. The WCS licensees repeatedly told us that they were not ready to share such information.

The WCS licensees have refused all attempts at compromise. XM Radio and Sirius have proposed to limit the highest power repeaters to 40 kW and to limit the number of such repeaters that will be grandfathered and permitted to continue operating without coordination. XM Radio has proposed specific terms for coordination and has offered to provide at no charge to WCS licensees filters for their base-station receivers that we have shown would substantially attenuate any interference.

The only WCS licensee to have shared any material system-level information with the DARS licensees is Metricom and then only in recent months. That information indicates a very low likelihood of interference to Metricom operations from DARS repeaters operating at up to 40 kW. Metricom has relatively robust receivers and operates its network receivers at heights that will almost always be shielded from DARS repeaters. XM Radio and Sirius have produced actual repeater drive-test data showing that Metricom will almost never receive any harmful interference from repeaters. Other WCS licensees have claimed that their receivers require protection to much lower power levels. The information available from these licensees indicates that they have not made any reasonable effort to design systems or build receivers that are mindful of the potential for interference from DARS repeaters. For instance, it appears that many of the receivers contain front ends that are not designed to filter out the DARS frequencies, a simple and inexpensive measure that would reduce their potential for receiving interference.

Throughout these discussions, a key issue has been the extent to which the relief that WCS licensees seek – a 2 kW limit on the power of any single DARS repeater – will in fact result in any significant improvement in the interference environment for WCS receivers. No one disputes that there will be exclusion zones of some size around virtually every WCS or DARS transmitter. WCS licensees will cause some interference to each other and XM Radio and Sirius will cause some interference to each other (although the DARS licensees have taken the care to design and build receivers that are more immune from such interference than most WCS receivers). The DARS licensees have shown that in many cases, the elimination

of a relatively high-power repeater will require its replacement with many more lower-power repeaters, to the point where the new exclusion zones are much bigger in the aggregate than any exclusion zone from a single higher power repeater. For instance, in the Los Angeles area, XM Radio has been able to eliminate roughly thirty lower-power repeaters by using a single 40 kW repeater on Mt. Harvard. The most WCS licensees have been able to claim is that an absolute limit on repeater power of 2 kW is a modest decrease in any exclusion zone. For instance, AT&T calculated for Atlanta that replacing all the higher power repeaters proposed by XM Radio and Sirius with 2 kW repeaters would reduce the exclusion zones by only 43.2 percent. For its customer units, AT&T calculated that there would be no improvement from the substitution of 2 kW repeaters. We disagree with AT&T's worst-case analysis (in fact, our analysis indicates that greater use of lower power repeaters often will increase the potential for interference), but AT&T's analysis does highlight the extent to which WCS is prepared to advocate imposing enormous costs on DARS licensees for what is objectively at best only a modest reduction in potential interference.

Despite the belligerence of the WCS licensees, XM Radio has continued to move forward in as cooperative a manner as possible. In an effort to be completely candid and identify any areas of actual interference that might be coordinated, XM Radio supplied as part of its application for Special Temporary Authority a complete list of all repeaters its proposes to operate above 2 kW in the 70 markets in which it initially will operate repeaters. This information was the result of system design refinements that occurred in the second quarter of 2001, as XM Radio engineers for the first time were able to test repeater networks with two operational satellites. Those refinements included the greater use of sectorized antennas, which reduce the potential for interference to WCS receivers. The basics of the repeater network, however, remain essentially unchanged from that which has been described in public filings since 1997. The day of the filing, XM Radio provided copies to the Wireless Telecommunications Bureau staff with the explicit understanding that the staff would be providing copies to WCS licensees in advance of any public notice, so that they could begin immediately identifying any specific areas that require coordination to prevent interference.

The July 27 letter is both irresponsible and disingenuous when it accuses us of withholding information from the WCS licensees and from the Commission. The truth is just the opposite. The DARS licensees have been entirely candid throughout a prolonged process in which we have undertaken enormous risk in order to bring this new service to the American public. It is our accusers who have ignored public notices, our filings and proposed system designs, joint meetings, and offers to coordinate and have waited until the last minute to raise their newfound concerns. They have shown no appreciation of the burden they are imposing on DARS systems and no willingness to compromise, and have insisted on raising

the most theoretical concerns rather than providing the information needed for a constructive dialogue that can resolve real-world problems.

It is critical that we have both a short-term and long-term resolution of this issue. In both cases, the guiding principle for the Commission as the spectrum manager should be to do no harm to licensees that have been deploying systems based on and consistent with reasonable assumptions about the manner in which they will be permitted to operate, particularly in the absence of any evidence that such operations will harm another licensee's existing operations. There should be a presumption, based on the ample notice that WCS licensees have had of the kind of repeater operation to be deployed by DARS licensees and the WCS licensees' failure to object until three years after they first received notice, that at least the initial deployment of repeater networks will be permitted to go forward and that DARS licensees will not be required to make costly changes to those networks in the future.

The burden that the WCS licensees seek to put on XM Radio and Sirius at this late date is enormous and inappropriate. If XM Radio were required to reduce its use of high-power repeaters, there would be tremendous disruption to its service. It would have to redesign and reconstruct repeater networks in most cities and add hundreds of additional repeaters. In each of these cities, XM Radio would have to re-engineer the entire repeater network, locate and procure new sites, and construct and test the new networks while operating the existing networks. That process would take several years from beginning to end and would cost hundreds of millions of dollars. Moreover, until WCS licensees begin to provide us specific information about their own networks, which they have refused to do so far, no rational redesign work could begin.

This is the last remaining unresolved regulatory matter that stands in the way of the rollout of satellite DARS. XM Radio and Sirius are essentially in agreement on the rules that should be adopted. Issues that were raised by those parties that timely participated in the rulemaking, including broadcasters, wireless cable operators, AFTRCC, and the Mexican and Canadian governments, all appear to have been resolved. No further notice is required for the Commission to adopt Part 25 repeater rules. While there may be an indirect impact on WCS licensees, they have had ample notice and no Part 27 rules need to be changed.

We want and intend to go forward with the deployment of our systems in a manner that is responsible and accommodates all reasonable concerns. We appreciate the opportunity the FCC has provided us to provide service. The time has come for all of us to concentrate our efforts on working out solutions.

Very truly yours,

Lon C. Levin

cc: Office of the Secretary (IB Docket No. 95-91; File Nos. SAT-STA-20010712-00063; SAT-STA-20010724-00064)
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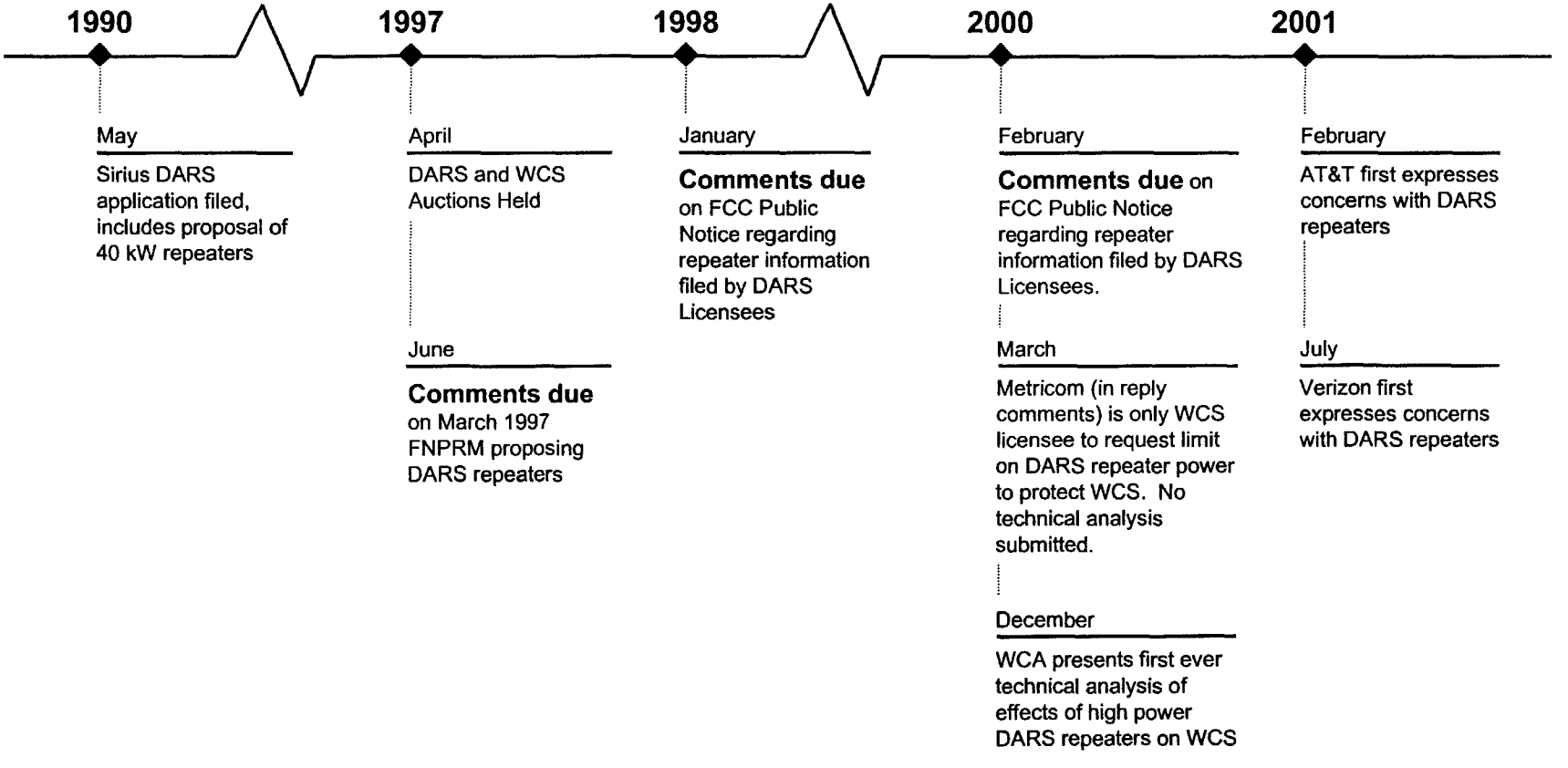
Chronology of DARS Repeater Proceeding



CERTIFICATE OF SERVICE

I, Renee Williams, a secretary to the law firm of Shaw Pittman LLP, hereby certify that on this 31st day of August 2001, I caused copies of the foregoing Reply Comments to be mailed via first-class postage prepaid mail to the following:

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