November 16, 2008

Via ECFS

Ms. Marlene Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: Ex Parte Presentation in: WT Docket No. 07-293, IB Docket No. 95-91, Gen. Docket 90-357, RM No. 8610

Dear Ms. Dortch:

This letter provides notice that on November 14, 2008, Raj Singh and Ron Olexa of Horizon Wi-Com ("Horizon"), Justin Lilley of TeleMedia Policy Corp., Harold Furchtgott-Roth of Furchtgott-Roth Economic Enterprises, as well as Kurt Schaubach and Jennifer McCarthy of NextWave Wireless Inc. ("NextWave"), met with Julius Knapp and Ronald Repasi of the FCC's Office of Engineering and Technology, James Schlitchting and Roger Noel of the Wireless Telecommunications Bureau, and Helen Domenici and Robert Nelson of the International Bureau, regarding the above captioned proceedings.

The participants discussed the WCS Coalition's rule proposal and technical analyses submitted in this proceeding, as well as the importance of striking a balance between the numerous WCS licensees and Sirius XM, which recently combined to become the sole provider of satellite digital audio radio services ("SDARS") in the United States with a contiguous block of 25 MHz of spectrum. The participants proposed technical solutions that offer adequate protection to Sirius XM, while still enabling a viable two-way mobile broadband service to be deployed in the WCS bands.

Included in this discussion was the need to establish transmit power levels for both mobile (battery-powered) and fixed (A/C powered) WCS end user devices that will enable the deployment of cost-effective broadband networks. In the case of mobile end user devices, a transmit power limit of 250 mW average EIRP is appropriate and will facilitate the rapid introduction of mobile broadband services in the band. Recognizing the comments expressed by Sirius XM that overload from WCS mobile devices to Sirius XM receivers is possible when the two devices are in close proximity (within 3 unobstructed meters) and when the WCS device is operating at maximum transmit power in the C or D blocks,[1] NextWave

[1] The signal level at which an SDARS receiver overloads has been the subject of much debate in this proceeding. Sirius and XM have claimed that their receivers will overload at -55 dBm from C/D block transmissions and at -44 dBm from A/B block transmissions (*see* Comments of Sirius Satellite Radio, WT

indicated that a lower mobile transmit power level, such as 150 mW average EIRP, along with a power density limit of 50 mW/MHz, should provide additional protection to Sirius XM,[2] but still enable WCS C and D block licensees to offer a viable two-way broadband service by focusing the energy in the 3 MHz farthest from the Sirius XM band edge. A mobile transmit power level of less than 150 mW average EIRP, however, would render the deployment of a two-way broadband service in the WCS bands economically impracticable.

Also discussed was the appropriate out-of-band emission limit for WCS into the SDARS band. NextWave and Horizon Wi-Com reiterated comments made previously on the record that the WCS Coalition's proposal for a "stepped mask" of 55+10logP (for 2320-2324 and 2341-2345 MHz), 61+10logP (for 2324-2328 and 2337-2341 MHz), and 67+10logP (for 2328-2337 MHz), would provide sufficient protection of the Sirius XM receivers. Alternatively, a "flat mask" of 60+10logP, which is roughly equivalent to the WCS Coalition's stepped mask proposal, would also serve to provide adequate protection. The companies emphasized, however, that were the mask that applies to WCS end-user devices any more restrictive than a flat mask of 60+10logP, the development of handheld, battery-powered WCS devices would remain infeasible.[3]

Docket No. 07-293, at Attachment C, page 10 (filed Feb. 14, 2008) and Comments of XM Radio, WT Docket No. 07-293, at Attachment C, page 9 (filed Feb. 14, 2008)). However, the veracity of such claims is questionable. For example, the test configuration employed by XM Sirius to determine these values did not adequately filter WCS out of band emissions to ensure an unbiased test result (e.g., the 3 dB bandwidth of the transmit filter was 5.5 MHz (*see* Comments of XM Radio at Attachment C, page 7)). Further, Sirius has reported significantly different overload signal levels, ranging from –57 dBm to -43 dBm, depending on which satellite band is considered (*see* Letter from Carl R. Frank, Regulatory Counsel to Sirius Satellite Radio, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 05-256 (filed March 29, 2006).

[2] The proposed WCS C and D block power reduction from 250 to 150 mW, along with the concentration of energy 3 MHz furthest away from SDARS band edge, should further reduce the potential of interference to SDARS receivers. For example, concentrating the WCS signal in the 3 MHz farthest from the SDARS band edge should keep 3rd order products out of the SDARS band. While no test data for the proposed WCS C and D block configuration is readily available, a reasonable projection is that overload will improve by 3 to 5 dB. Further, it is important to note that vehicle-to-vehicle measurements reported by the WCS Coalition showed an average excess path loss above free space of 21.8 dB, which represents the combined effects of head-body, antenna mismatch, antenna efficiency, multipath/shadowing, and vehicle penetration losses (*see* Letter from Paul J. Sinderbrand, Counsel to WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 07-293 at page 14 (filed August 1, 2008)). Assuming a free space path loss of 49.2 dB and 21.8 dB of excess link losses, the total RF coupling loss is 71 dB. This comes very close to the minimum 71.8 dB of coupling loss necessary to protect an SDARS receiver (assuming a 5 dB improvement) from the proposed 150 mW transmission in C or D block.

[3] NextWave and Horizon also noted that adoption of a 43+10logP out-of-band emission limit for the WCS A and B blocks, which is a widely accepted mask for mobile services, will enable greater harmonization with other countries along with global economies of scale for WCS mobile devices. Given that there will be a natural roll-off of the WCS A and B block signals, it is not anticipated that the A & B block emissions will cause interference to SDARS receivers.

Finally, the participants also discussed the probability of interference from a WCS device to a Sirius XM receiver under real world operating conditions, such as in a highway usage case. NextWave and Horizon Wi-Com reiterated comments made by the WCS Coalition regarding the low probability that a WCS device and a Sirius XM receiver will operate under the conditions necessary for interference to occur. For example, the WCS Coalition has noted that a WCS mobile device will transmit at or near full power (the condition under which interference might occur when the devices are within 3 meters of one another) less than 1% of the time. Furthermore, in most cases, due to mobile network system design, a WCS mobile is likely to transmit at or near full power only when it is located indoors at the cell edge. Under these circumstances, it is highly improbable that an indoor WCS device will be within sufficient proximity to cause any interference to a Sirius XM receiver.

Attached is an analysis prepared in response to a Sirius XM September 8, 2008, Ex Parte, further illuminating the low probability that under real world conditions a WCS device will cause harmful interference to a Sirius XM receiver. The attached analysis identifies several major flaws in the Sirius XM study, which together exaggerate the probability of interference from WCS to Sirius XM by several orders of magnitude.

Given the Commission's recent decision to approve the merger of the Sirius XM companies and their future operation as a single licensee with a contiguous block of 25 MHz of nationwide spectrum - the only such commercial allocation to a single company - the opportunity exists today for the Commission to incent Sirius XM to enhance its receiver design (*e.g.*, by including additional filtering) to be more tolerant of adjacent band WCS operations. Furthermore, with the establishment of permanent repeater rules, it will be easier for Sirius XM to supplement its repeater network as needed to fill in weak satellite coverage areas, which will also boost the resistance of Sirius XM receivers to interference from WCS.

NextWave and Horizon Wi-Com look forward to working with the FCC Commissioners and staff to bring this rulemaking to a conclusion and enable both Sirius XM and WCS licensees to move forward and advance their service offerings in the public interest.

Respectfully submitted,

/Jennifer M. McCarthy/

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Technical Analysis of Sirius XM *Ex Parte* Presentation of September 8, 2008

November 16, 2008

1) Executive Summary

In an *Ex Parte* dated September 8, 2008,[1] Sirius XM Radio Inc. ("Sirius XM") provided comments intended to further illuminate its concerns over the rule proposal made by the WCS Coalition.[2] Included in the Sirius XM submission is a technical analysis aimed at showing that unacceptably high levels of interference will occur under certain scenarios, such as regular highway travel, due in large part to its assertion that transmit power control and duty cycle do not provide any benefit in mitigating the interference potential of WCS mobile transmissions to satellite radio receiver operations.

In this response, the technical analysis provided by Sirius XM is investigated and several major flaws identified. In short, the findings are:

1) Sirius XM's highway use case study relies on exaggerated input values to arrive at the conclusion that there is as high as a 25% chance that satellite radio reception will experience interference from WCS mobile transmissions. In fact, had Sirius XM used appropriate input values and properly portrayed the characteristics and deployment models of the two-way broadband technology that the WCS licensees have indicated they intend to use, the study would have likely yielded results *several orders of magnitude lower* than predicted.

2) Sirius XM wrongly dismisses the interference reduction benefits achieved with transmit power control (TPC). Its conclusion is based on the notion that the because of the configurable features of WiMAX technology, network operators will be motivated to maximize user transmit power to maximize network capacity. In fact, the opposite holds true. To maximize network capacity, it is desirable for user terminals to always *transmit with the minimum power necessary* to overcome propagation loss. Further, the notion that the "configurable features" of WiMAX enable network operators to directly control user terminal transmit power levels is poorly conceived. The so called configurable features are collectively known as link adaptation, or the matching of the modulation, coding, and other signal and protocol parameters to the conditions on the radio link. Link adaptation is integral to proper functioning of WiMAX and any attempts made by the network operator to control it would be arbitrary and lead to unreliable performance.

3) Sirius XM confuses user terminal transmission "duty cycle," which is largely influenced by application type and radio link conditions, with "user activity," the periods of time over which an individual user has data to send. Through mistaken linkages and unrelated computations, it concludes that a high terminal duty cycle is inevitable because it is necessary to provide adequate network capacity, the two of which are not directly related. Further, it concludes that a high duty cycle is more likely to cause harm, despite measurement data supplied by the WCS Coalition and Sirius XM itself demonstrating that the user terminal transmission duty was not relevant to the incidence of interference.[3] In its analysis, Sirius XM attempts to obscure the obvious – that WCS

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[1] *See* Letter from James S. Blitz, Vice President, Regulatory Counsel, Sirius XM Radio, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 07-293 (filed September 8, 2008) ("Ex Parte").

[2] *See* Letter from Paul J. Sinderbrand, Counsel to WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 07-293 (filed July 22, 2008) ("WCS Coalition Rule Proposal").

[3] Based on data submitted by the WCS Coalition, transmission duty cycle has been shown to have no effect on OOBE-based interference opportunities, and while some benefits are expected for overload-based interference opportunities, the data submitted by Sirius and XM independently found little to no difference in impact distances regardless of duty cycle used. This discrepancy is believed to be related to the impact of the near band signal on the SDARS receiver's AGC loop, which is optimized for a 100% duty cycle signal.

> terminals will not transmit that often. When a WCS device is transmitting, factors including its location, transmit power level, proximity to SDARS receivers, frequency block of operation, etc. will be the key determinants of interference probability. Contrary to Sirius XM's claims, transmission duty cycle is not a factor that contributes to interference potential.

Unfortunately, while the Sirius XM *Ex Parte* continues to highlight SDARS ill-founded claims that WCS mobiles will introduce widespread interference, it does little to advance the technical record on WCS/SDARS coexistence. Indeed the plain facts regarding WCS to SDARS coexistence are:

WCS user terminals do not transmit that often. Even for extraordinary amount of uplink data, a given WCS user terminal will on average transmit for <u>just 2 minutes out of every hour</u> (i.e., with an activity factor of 0.029). The vast majority of the time, a WCS user terminal will pose no threat whatsoever to an SDARS receiver because it is not transmitting.

The location of WCS users relative to SDARS receivers is what matters most. The impact of WCS terminals operating at a distance of 3 meters or less from an SDARS receiver is the subject of this proceeding. Simulation studies that rely on interference from users up to 196 feet away on a crowded highway are misleading and unreliable.

Even at close distances, significant path loss isolation will protect SDARS receivers. Recent measurement data submitted by the WCS Coalition shows that vehicle-to-vehicle path loss, even when measured over very short distances, is typically 5 – 15 dB greater than the path loss when the WCS user is assumed to be a pedestrian, and is as much as 27 dB greater than free space path loss when the WCS device operates from within the confines of a vehicle.

WCS devices will infrequently transmit at full power. The WCS Coalition's study of transmit power control indicates that <u>99% of the time a device will transmit 3 dB below its maximum power level</u>. Combined with the path loss isolation, WCS mobile transmission power levels will be significantly lower than the maximum allowed, which further decreases the likelihood of interference to SDARS receivers.

When maximum transmit power is necessary, it will occur in locations least likely to cause harm to SDARS subscribers. WCS users located within buildings, out at the edges of network coverage, are the users most likely to operate at full power. Given the extra link margin necessary to ensure reliable communications to indoor users, the WCS users located within vehicles or on street, which are operating in a less attenuative environment, naturally require less link margin, and so are unlikely to operate at full power. This is true even under cell edge conditions.

Additional factors beyond terminal activity, path loss, and transmit power also reduce the chance of interference. The WCS terminal's operating frequency, the SDARS service type (i.e., Sirius or XM), and the SDARS receiver technology are all factors that govern the potential for interference. Only certain combinations, for example a D-Block WCS device to an XM receiver or a C-Block WCS device to a Sirius receiver, is interference possible. These additional factors together contribute significantly to the very low possibility of WCS to SDARS interference.

2) Review of Highway Use Case Probability Analysis

In Exhibit A Section 2 of the *Ex Par*te, Sirius XM presents findings of a simulation study for a highway use case of both WCS and SDARS operations. Sirius XM claims, "this simple but 'real world' analysis illustrates that…the number of customers traveling on this sort of highway who will experience service disruption will increase from zero to over 12% in the near term and up to almost 25% in the longer term." Regrettably, the study submitted by Sirius XM is anything but "real world." Sirius XM has relied on a number of exaggerated input values and has fundamental flaws in its simulation methodology that lead to this erroneous conclusion.

The flawed assumptions include:

- 10 times the expected WCS subscriber penetration rate;
- 4 times over counting of simulated WCS subscribers;
- 4 times the subscriber terminal activity factor;
- 1.1 to 1.2 times more highway traffic than would occur even under the most extreme cases;
- Interference distances of up to 196 feet on a crowded highway;
- No consideration of transmit power control or penetration margin, assuming that the mobile always transmits at full power;
- No consideration of required separation distances for vehicles located in the same traffic lane.

Even with such fundamental flaws, the Sirius XM analysis in actuality shows a rather low probability of interference when the condition of greatest interest and import – the probability of interference at a 3 meter separation distance – is examined. In their most basic form, the green bars in Figures 2 and 3 of the Sirius XM *Ex Parte* illustrate the probability of an transmitter WCS mobile and SDARS receiver being within 6 meters of each other. These green bars suggest that the probability of an active WCS mobile being within 6 meters of an active SDARS receiver on a crowded highway is merely 1% to 2%. Surely, an accurate simulation with appropriate input values would indicate a probability of interference that is at least an order of magnitude less than what was concluded in the Sirius XM study.

More detailed observations of the Sirius XM highway use case analysis are as follows:

a. The assumed vehicle traffic volume is an extreme case.

Sirius XM relies on traffic statistics for one of the most well traveled freeways in the nation, the New Jersey Turnpike. Yet, in computing the traffic volume to apply in the simulation study, Sirius XM assumes all of the traffic occurs in merely 8 hours of the day, and that during the other 16 hours the freeway is completely empty. Undoubtedly, the traffic volume computed by Sirius XM and applied in the analysis is an extreme case.

b. The WCS subscriber penetration rate is exaggerated.

Sirius XM claims that the assumed penetration rates in its study are "conservative values."[4] However, at its core, the Sirius XM study assumes that WCS networks alone will serve at least 20% to as much as 41% of the total wireless broadband subscriber base in the United States.[5]

These assumed penetration rates are anything but conservative. In reality, subscriber penetration for WCS networks is more likely to be an order of magnitude less. Actual market research suggests that the there will be 15 million mobile WiMAX subscribers in North America by 2012 with a compound annual growth rate of 55% from 2009 – 2012.[6] Using this growth rate, predictions indicate that there will be approximately 55 million total WiMAX subscribers in North America by 2015.

Such market projections contemplate the deployment of WiMAX networks in multiple frequency blocks, including the 2.5 GHz EBS/BRS, AWS and 700 MHz bands. Since the 2.3 GHz WCS spectrum accounts for at most 20% of the spectrum available for wireless broadband deployments in the United States,[7] mature WiMAX networks operating in the WCS bands would *together* serve an estimated 11 million subscribers in 2015, accounting for a mere 3% - 4% of the total U.S. population in that timeframe.[8] Therefore, on a per WCS frequency block basis, the average subscriber penetration rate can be expected to be closer to an average of 1% for a mature network. As such, the subscriber penetration rate of 10.4% per WCS frequency block that Sirius XM applied in its study is at least 10 times greater than what real market data would predict.

c. All WCS subscribers are presumed to be "in vehicle" users.

While satellite radio is intended primarily (if not exclusively) for use within automobiles, wireless broadband use will by no means be restricted to "in vehicle" uses as Sirius XM suggests. Market data suggests that currently 30% of all cell phone calls and 70% of data usage take place indoors.[9] While it is expected that wireless data usage within vehicles will grow in the coming years, there is no plausible reason to believe that it will eventually account for 100% of all wireless data usage. Assuming future data usage mirrors current mobile voice usage models, it would be more appropriate to consider 70% of the total WCS subscriber penetration in the highway use case example.

d. The WCS subscriber user activity factor is exaggerated.

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4 It is instructive to note that the mobile WiMAX deployment scenario studied in the white paper referenced by Sirius XM, "A Comparative Analysis of Mobile WiMAX Deployment Alternatives," is described as 'hypothetical,' *see p. 6*. The 10.4% penetration rate that appears in the white paper is "assumed" (*see p. 10 -11*) and there is no market data to support this assumption.

5 While this is not stated so plainly in the Sirius XM submission, it is apparent from the description of the simulation methodology on p. 7 – 8 of the *Ex Parte* that the penetration rate is applied uniformly to each WCS frequency block.

6 ABI Research, "WiMAX Market Analysis and Forecasts, The Opportunity for Base Stations, CPE, and Mobile Devices," *see Chart 5.7 on pp. 44*.

7 The Lower 700 MHz, Upper 700 MHz, AWS, BRS/EBS, and WCS bands together account for more than 340 MHz of spectrum, of which the WCS band represents a mere 30 MHz.

8 Assuming a U.S. population of 314 million by 2015, as can be extrapolated from U.S. Census Bureau statistics.

9 Quote from Stuart Carlaw, an analyst with London-based ABI Research, in "Cellphone companies looking to conquer the great indoors," by Tricia Duryee, The Seattle Times, May 21, 2007.

Sirius XM claims to use a conservative user terminal activity level in its simulation, yet provides no data to support such a claim.[10] In reality, the assumed subscriber activity level is anything but conservative.

At a macro level, the user activity level represents the probability that, at a given instant, a WCS subscriber is engaged in sending data over the network. Said another way, it is the percentage of time that the WCS subscriber is transmitting data.

The Sirius XM assumed activity factor of 0.13 suggests that a WCS subscriber is transmitting for 468 seconds (nearly 8 minutes) out of every hour. If an average user burst rate of 1 Mbit/sec is considered,[11] along with an activity factor of 0.13, then each WCS subscriber would be sending 468 Mbits of data per hour or 58.5 MBytes of data per hour. Further, if it assumed that the subscriber is "connected," meaning that the subscriber is using his wireless data device (but not necessarily sending data) for 4 hours per day[12] and for 20 days per month,[13] it follows that a given WCS subscriber will be transmitting, or uploading, over 4.5 GBytes of data per month.

In assuming an equivalent 4.5 GBytes of *upsteam* traffic per month, Sirius XM claims that mobile broadband use by WCS subscribers will far exceed the current *download* traffic consumption for residential fixed broadband services. As of 2006, the average residential fixed broadband subscriber was consuming 2 GBytes of downstream traffic per month,[14] and in March 2008, analyst reports predicted that residential usage was 3 GBytes of traffic per month.[15]

While limited data is available on the relative proportion of downstream and upstream data consumed by a wireless subscriber, it is likely that downstream traffic dominates as it does with fixed residential broadband.[16] As such, the asymmetry for wireless broadband traffic could reasonably be expected to be 3:1 or greater.

Analyst reports suggest that today an average mobile data user consumes 10 MBytes of data per month.[17] Considering the enhanced performance that WiMAX offers over wireless broadband technologies, mobile data usage could be expected to grow dramatically from today's 10 MByte level and begin to approach current residential fixed consumption levels.

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[10] While it is not apparent how Sirius XM derived an activity factor of .13 from underlying data Table 3 in its reference, it is useful to note that the author states that the values in that table are "not based on any statistical evidence or surveys but felt to be reasonable for illustrative purposes," in "A Comparative Analysis of Mobile WiMAX Deployment Alternatives", *at footnote 3 page 13*.

[11] XOHM has launched a commercial mobile WiMAX network using 2.5 GHz spectrum in Baltimore, MD metropolitan area. They advertise average download speeds of 2 - 4 Mbps and upload speeds of 0.5 - 1.5 Mbps, with speed claims based on network speed tests (http://www.xohm.com/en_US/learn/our-technology/).

[12] Subscriber usage statistics can be found in "WiMAX Forum-AWG: Real-World Traffic Benchmark," presentation by Bong Ho Kim, WiMAX Forum Application Working Group, 2004.

[13] Assuming 5 working or "commute" days per week and 4 weeks per month.

[14] "OFC: BellSouth Chief Architect warns of HD VOD costs," TelephonyOnline, March 7, 2006.

[15] "The Dollars and Sense of Broadband Wireless," Volume 2, Signals Research Group, March 2008, *see* pages *48 – 49*.

[16] This follows from the observation that most ADSL, DSL, and Cable services are provisioned with more downstream than upstream bandwidth. Even the study that Sirius XM has relied on so heavily notes that, "With data-centric traffic, downlink traffic is expected to dominate," in "A Comparative Analysis of Mobile WiMAX Deployment Alternatives," *see page 12*.

[17] "The Dollars and Sense of Broadband Wireless," Volume 2, Signals Research Group, March 2008, *see* pages 48 – 49.

However, if it is assumed that an average wireless broadband subscriber consumes 3 GBytes of downstream data and that there is a 3:1 relationship between downstream and upstream usage, the average wireless subscriber would generate 1 GBytes of upload data per month. Working backwards, this is an activity factor of just 0.029, which is less than one quarter of the activity factor assumed in the Sirius XM simulation.

e. The interference distances claimed by Sirius XM are exaggerated.

The Sirius XM study applies previously documented path loss relationships to the crowded highway simulation. It is well know that the path loss figures that Sirius XM relies upon are based on the worst case scenario of an unobstructed propagation path between a WCS transmitter and SDARS receiver. Furthermore, the tests cited by Sirius XM were conducted to simulate the pedestrian WCS user to SDARS receiver scenario, not the vehicle-to-vehicle scenario simulated by Sirius XM in its September 8, 2008 submission.

Unfortunately, Sirius XM chooses to ignore these important details in its study and instead assumes that unobstructed propagation paths of up to 196 feet between a WCS device and an SDARS receiver will routinely occur. Considering that the average length of a full size car is approximately 16 feet, the so called "unobstructed propagation path" proposed by Sirius XM would easily span eight or more intervening vehicles at the traffic volumes contemplated in its analysis. Intuitively, there is no reason to believe that such large unobstructed distances are practical in any highway traffic scenario.

The overstatement of interference distances by Sirius XM is further exacerbated by the application of path loss models derived for a pedestrian WCS use case. Recent measurement data submitted by the WCS Coalition shows that vehicle-to-vehicle path loss, even when measured over very short distances and with no obstructions, is typically 5 – 15 dB greater than the path loss when the WCS user is assumed to be a pedestrian.

f. The Sirius XM simulation does not appear to account for the physical length of a vehicle or a minimum separation distance between vehicles.

Sirius XM makes no mention of whether the realities of highway driving are considered in its simulation. Given that Sirius XM chose to model moderate (30 mph) to fast (60 mph) driving speeds, it would seem necessary for a minimum vehicle-to-vehicle separation distance to be considered. However, no such distance was specified.

There is also no mention of a minimum vehicle length, so it also appears questionable whether separation distances that would otherwise be physically impossible to achieve were appropriately removed from the analysis. It seems that Sirius XM simulated conditions where cars are piled on top of each other.

In a highway use case probability analysis, the positioning of vehicles *both across* multiple traffic lanes and *within* individual traffic lanes must be carefully considered. While it is apparent that Sirius XM considered the placement of vehicles in across traffic lanes, there appears to be no consideration of how vehicles would be situated within traffic lanes.

In reality, cars in a given lane of traffic will have a finite number of locations they can occupy. Vehicles obviously can not be situated on top of each other - some separation between vehicles is necessary to allow for braking.

The Sirius XM simulation should have developed a matrix of the random vehicle placements based upon reasonable safe follow distances encountered in real life traffic at the speeds noted, and for each subsequent placement, the validity of that location should have been tested against those already "stored" in the matrix. Such a test would have accounted for both a minimum vehicle length and separation distance for vehicles in the same traffic lane.

By not testing the validity of the random vehicle placement in the simulation, the separation statistics reported by Sirius XM are unduly biased by the inclusion of vehicle geometries that could not occur in the "real world."

g. For the proposed use case both the effects of transmit power control and vehicle penetration loss should have been included, but were not.

Sirius XM does not provide any allowance for transmit power control in its analysis because "the likely real benefits of transmit power control are highly variable and impossible to accurately quantify."[18] Again, Sirius XM chose to model the worst case of worst cases by making the impractical assumption that a mobile device will transmit at full power 100% of the time.

Sirius XM further claims that, due to "additional vehicle penetration losses," considering transmit power control would be a form of "double counting."[19] Sirius XM ignores the fact that WiMAX networks are designed with both a fade margin and a penetration margin. In the case where the WiMAX service is designed exclusively for in-vehicle use, the mobile transmit power may vary by 10 dB or more to compensate for the basic shadowing effects of nearby obstructions.

However, it is unlikely that a WiMAX network will be designed for vehicular service alone. Hence the network will be designed with additional penetration margin, above what is required to serve users within vehicles, to also serve users within buildings. This additional margin will range from 3 to 25 dB depending on the degree of urbanization.

Therefore, for the in-vehicle scenario modeled by Sirius XM, it is improbable that the WCS mobile device will transmit at maximum power given that the link margin for an in-vehicle device will be 3 to 25 dB better than it would were the device located inside a building at the same distance from the serving cell.

h. Sirius XM over counts the number of potential WCS interferers in its simulation.

The description of Sirius XM simulation methodology states that a distance separation matrix from all satellite radio receivers to all WCS mobiles is calculated, and for each of the 4 separation distances, the number of WCS transmitters that fall within the given distance are considered potential interferers. Only after the number of potential interferers is determined is the probability of a WCS mobile being engaged in transmission contemplated.

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[18] *Ex Parte*, *see* page 6 of Exhibit A.
[19] *Ex Parte*, *see* page 6 of Exhibit A.

By conducting the simulation in this way, Sirius XM created a paradigm in which each WCS mobile location had the potential to interfere with an SDARS receiver in up to four different ways. For example, consider a scenario where an SDARS receiver and WCS mobile have a simulated separation of 12 meters. Since this WCS mobile falls within multiple separation distances, such as the 19 meter A/B-block overload distance and the 40 meter C/D-block overload distance prescribed by Sirius XM, it would have been considered a potential interferer for all four WCS frequency blocks. There is no possibility that a WCS mobile will transmit on all four WCS frequency blocks simultaneously.

To avoid over counting, Sirius XM should have: a.) simulated the random placement of WCS mobiles; b.) randomly assigned a frequency block of operation to each WCS mobile; c.) calculated the probability that the WCS mobile was transmitting; d) assigned a power reduction based upon power control loops; and e.) for those transmitting WCS mobiles, compare the separation distances with the associated interference distance.

3) Terminal Activity Model and Transmit Power Control

In the *Ex Parte*, Sirius XM proposes a simplified terminal activity model for mobile WiMAX. The activity model attempts to characterize the effects of duty cycle, application data rates, transmit power control, modulation and coding scheme selection over the cell coverage area (also known as "rate adaptation"), and downlink-to-uplink subframe ratio on the frequency of WiMAX mobile terminal transmissions. In applying its model, Sirius XM effectively concludes that, "it is most likely that user terminals will operate at the highest duty cycles permitted…to provide adequate capacity,"[20] and "the WCS Coalition's analysis that is based on a low duty cycle of 6 percent is flawed."[21]

Regrettably, Sirius XM accomplishes little with its analysis except to obfuscate the real issue at hand in a user activity model analysis, which is the likelihood that a WCS mobile will be transmitting in a manner sufficient to cause interference to an active SDARS receiver. Further, it is Sirius XM, not the WCS Coalition, that provides a flawed analysis of the impact of duty cycle.

a. Duty Cycle

Field tests submitted by the WCS Coalition, Sirius, and XM in this proceeding have attempted to characterize the effect of the duty cycle of a simulated WiMAX mobile transmitter on SDARS reception. For example, the WCS Coalition provided test results for both 6% and 43% transmitter duty cycles.[22] The WCS Coalition's intent in performing the field tests in this manner was to test the effects of duty cycle associated with different *applications*. Since WiMAX is flexible in its assignment of resources over the OFDM symbols (time) and OFDMA subcarriers (frequency), and since WiMAX will enable a broad range of application types, it was necessary to conduct tests at both "low duty cycle" (6% as could occur with a VoIP call) and "high duty cycle" (43% as could occur during a file transfer session) to ensure that the coexistence did not depend on a specific application type or transmitter duty cycle.

WiMAX equipment operates with a 5 millisecond time division duplexed radio frame.[23] This frame is subdivided into a downlink subframe, uplink subframe, and guard interval. In the time domain, each subframe is further subdivided into 48 OFDM symbols which each have a duration of 102.9 microseconds. To simulate duty cycle in the tests, the WCS Coalition configured the signal generator to transmit a burst corresponding to the length of time equal to the product of the duty cycle, the total number of OFDM symbols per WiMAX frame, and the symbol duration. For example, the 6% duty cycle tests utilized a transmission burst that was (.06) * (48) * (102.9 µsec) = 296.4 µsec in length. This burst transmission was repeated every 5 msec to simulate continuous operation of the device over the test. The 43% duty cycle tests used a 2.12 msec long burst repeated every 5 msec.

For the WCS Coalition tests, it was implicit that the WCS transmitter was transmitting in every available uplink subframe for the test duration. In this way, the WCS Coalition tests reflected the worst case scenario, i.e., that the WCS transmitter and SDARS receiver were in close proximity, there was an unobstructed propagation link, and the WCS device was transmitting continuously.

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[20] *Ex Parte see* page 8.
[21] *Ex Parte see* page 9.
[22] *See* Reply Comments of WCS Coalition, WT Docket No. 07-293, at Attachment B, page 3 (filed Mar. 17, 2008).
[23] While the 802.16e standard permits variable frame lengths from 2 msec to 20 msec, initially all equipment will support a 5 msec frame.

As evidenced in the WCS Coalition test data, duty cycle did not have a direct consequence on coexistence.[24] In only 1 of 12 tests conducted with different SDARS receivers and different WCS device transmit duty cycles resulted in an OOBE level sufficient to audibly mute an SDARS receiver at a 3 meter separation. Even for this one exception, the additional margin necessary to mitigate muting was a mere 0.8 dB. Sirius XM's claim that, "a low duty cycle of six percent … underestimates the potential for interference"[25] is without merit as it is not supported with test data.

b. User Activity Model

The WCS Coalition has argued that the amount of time during which a WCS device will actually have data to transmit is quite low.[26] There will be long periods of time when the device is inactive, such as when the user is viewing a web page or email, or when the device is downloading data such as video clip or file transfer. It is difficult to conceive of a variety of applications that require significant upload data transmission. Further, considering the memory limitations of a mobile device, there are also practical limits on the ability to serve up large data volumes. The intuitive aspects of wireless broadband usage – that there are periods of inactivity and download-centric nature of applications – are the real issue at hand in a user activity model analysis.

Despite this conventional wisdom, Sirius XM asserts that WiMAX mobile terminal devices will need to be in constant operation to achieve competitive user throughputs. Sirius XM confuses user terminal transmission "duty cycle," which is largely influenced by the application type and radio link conditions, with "user activity," the periods of time during which an individual user has data to send. Sirius XM subsequently assumes that network capacity is directly related of the terminal duty cycle, when in fact there is no direct relationship. As will be shown in this section, the data rates and capacity of a WiMAX network are a function of the uplink symbol allocation, the modulation and coding scheme area distributions, and the number of subchannels assigned per user.

In its analysis, Sirius XM makes a number of critical errors, which lead to its flawed conclusion:

- Assuming that the user data rate is fixed at the lowest WiMAX modulation and coding scheme over the entire cell area;
- Confusing application duty cycle with the downlink-to-uplink symbol allocation and failing to apply a practical symbol allocation in the computations;
- Failing to recognize that a mobile device is far more likely to be receiving data rather than transmitting large files
- Drawing no distinction between active and dormant users; and
- Confusing long term average data rates (i.e., a rate that is on the order of tens of kilobits per second) with instantaneous user burst rates.

There is simply no way to reconcile this Sirius XM analysis as a valid WCS user activity model.

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[24] *See* Reply Comments of WCS Coalition, WT Docket No. 07-293, at Attachment C, page 5 (filed Mar. 17, 2008).
[25] *Ex Parte see* page 9.
[26] *See* Reply Comments of WCS Coalition, WT Docket No. 07-293, at Attachment C, pages 6-7 (filed Mar. 17, 2008). Note that the data was adjusted to compensate for the benefits of TPC.

Wireless user activity stems from an assumption of how much data a user will consume over some period of time, like a week or a month. As shown in Section 2 above, WCS user activity is projected to be less than 0.03 even assuming data usage that is significantly higher than current levels. This means that there is a less than 3% chance that at a given instant a WCS terminal will have data to transmit. This is far less than the near continuous operation that Sirius XM suggests.

Sirius XM concludes from calculations of system level throughput that "full uplink per user rates of less than 9.6 kbps" would be supported in a 5 MHz WiMAX system. These calculations are only possible assuming the worst case scenario where only a single uplink slot is available for user data (i.e., a "worst case" 44:3 symbol rate) at a fixed modulation and coding scheme (i.e., QPSK-1/2). In short, Sirius XM concludes from a computation for the lowest possible data transmission rate per user (regardless of the user location or RF channel conditions) with the least amount of resources available for uplink capacity that WCS user terminals will need to transmit nearly all of the time. Considering these skewed assumptions, it should be no surprise that the analysis would lead to such a conclusion.

There is no direct linkage between user terminal duty cycle, user data transfer rates and network capacity. In the uplink, WiMAX is flexible in its assignment of resources over time and frequency, so small data transactions – such as a TCP/IP ACK message or VoIP packet – can be transmitted through partial use of the symbols in a given subcarrier. This is especially true at the higher data burst rates.

Representative data transfer rates for a more typical system configuration than provided by Sirius XM are provided in Table 1 below. For a 5 MHz WiMAX system, a user should expect to experience an average data transfer rate of 2 Mbits/sec in the downlink and 1 Mbits/sec in the uplink.

		5 MHz PUSC, SIMO, 27:18 DL:UL Symbol Rate							
		Downlink Rate	Uplink Rate	Downlink Rate	Uplink Rate				
WiMAX Modulation Coding Scheme (MCS)	Net bits per symbol	All Subchannels (bps)	All Subchannels (bps)	Per Subchannel (bps)	Per Subchannel (bps)	# Subchannels Assigned Per User	Ratio of Sector Area Served with MCS*	Weighted Downlink Per User Rate (bps)	Weighted Uplink Per User Rate (bps)
QPSK1/2 Rep6	0.17	324,000	163,200	21600	9600	3	0.000	-	-
QPSK1/2 Rep4	0.25	486,000	244,800	32400	14400	3	0.000	-	-
QPSK1/2 Rep2	0.50	972,000	489,600	64800	28800	3	0.000	-	-
QPSK1/2	1.00	1,944,000	979,200	129600	57600	3	0.112	43,546	19,354
QPSK3/4	1.50	2,916,000	1,468,800	194400	86400	3	0.290	169,128	75,168
16QAM1/2	2.00	3,888,000	1,958,400	259200	115200	6	0.120	186,624	82,944
16QAM3/4	3.00	5,832,000	2,937,600	388800	172800	6	0.199	464,227	206,323
64QAM1/2	3.00	5,832,000	2,937,600	388800	172800	9	0.033	115,474	51,322
64QAM2/3	4.00	7,776,000	3,916,800	518400	230400	9	0.091	425,503	189,112
64QAM3/4	4.50	8,748,000	4,406,400	583200	259200	9	0.137	719,086	319,594
							Average Rate Per User	**2,123,587**	**943,816**

* Based on WiMAX system level simulation data

Table 1. Computed Average Per User Data Rates for a Typical 5 MHz WiMAX Configuration

These average data transfer rates, not duty cycle, are of primary importance in determining the activity factor for a typical user. For example, at an average data transfer rate of 1 Mbits/sec it will take on average 16 seconds to transmit a large 2 Mbyte file (e.g., an email attachment). However, at the average data transfer rate of 9.6 kbits/sec suggested by Sirius XM, it will take over 27 minutes to send the same

attachment.[27] Clearly, if the user terminal is assumed to have an unreasonably low data transfer rate it will be necessary for it to operate persistently to transmit even modest amounts of data. However, such is not the case with WiMAX, which has the ability to deliver multi-megabit data transfer rates to users which, in turn, translates to the need for a device to operate only sporadically.

c. Transmit Power Control (TPC)

System level simulation data submitted by the WCS Coalition clearly shows how use of TPC in a WiMAX system reduces the potential for interference to SDARS. The results show that 99% of the time, a WCS mobile transmits 3 dB below its allowable maximum.[28] The 3 dB power control benefit was applied to the OOBE measurements that in only 1 of 12 test cases could the resulting OOBE from the WCS device have the potential to mute SDARS reception.[29]

Despite these quantitative findings, Sirius XM claims that the "configurable" features of WiMAX negate any benefits that TPC could provide,[30] alleging that WiMAX network operators will be motivated to maximize capacity and thereby maximize the transmit power utilized by the user terminals.[31] Unfortunately, Sirius XM misses some key details related to the application of TPC in a WiMAX network:

i. Maximizing user terminal transmit power does not maximize network capacity. In fact, maximizing user terminal transmit power has the opposite effect - to *decrease* overall capacity. The fundamental principal of TPC is to transmit with only as much power as is required to overcome propagation loss. If a user terminal transmits with more power than is required, it increases the amount of "intra-system" or "co-channel" interference in the system and thereby decreases overall capacity. Further, operating at excess transmit power levels reduces the available battery life of the user terminal. Network operators are motivated to reduce the transmit power utilized by a user terminal, not to increase it.

ii. The so called "configurable" features are not configurable. WiMAX, as well as other wireless broadband technologies, employ link adaptation to optimize the selection of the modulation and coding scheme of user terminal transmissions.[32] Link adaptation is the matching of the modulation, coding, and other signal and protocol parameters to the conditions on the radio link (e.g. the path loss, the interference due to signals coming from other transmitters, the sensitivity of the receiver, the available transmitter power margin, etc.). In short, link adaptation is used to compensate for the factors that are outside of the network operator's control. The network operator cannot arbitrarily control or restrict the selection of different modulation and coding schemes, this resource management is performed automatically by the network infrastructure.

iii. The user terminals most likely to operate at maximum transmit power are least likely to interfere with SDARS receivers. In its analysis, Sirius XM fail to account for the overall system

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27 If user throughputs of WiMAX are incapable of achieving the user experience of dial up date services commonly available in the early 1980's, then WiMAX will be a commercial failure.

28 *See* Comments of WCS Coalition, WT Docket No. 07-293 at Attachment B, page 6 (filed February 14, 2008).

29 *See* Reply Comments of WCS Coalition, WT Docket No. 07-293, Attachment C, page 5 (filed Mar. 17, 2008).

30 *Ex Parte see* page 14.

31 *Ex Parte see* page 13.

32 This includes technologies such as LTE, UMTS TD-CDMA, HSPA, EVDO, and even GSM EDGE.

design of the typical WiMAX system, which like other 2G and 3G mobile systems they will be competing with, will include a significant margin in the system design link budget to allow users inside of buildings to receive service. Without this margin, users in buildings would have a different coverage footprint than outside users, which would not be acceptable in an era of ubiquitous wireless coverage. This building penetration margin is assumed in network design in addition to the fade margin used to combat log normal "slow" fading. For the WCS band, the building penetration margin will be on the order of 15 – 30 dB, depending upon the amount of urbanization, to provide a high probability of coverage at the cell edge for indoor users. This assumption has to be made if a new WCS entrant is to compete with entrenched operators already providing indoor coverage.

Consider the difference in path loss to the serving cell site between an indoor user and an outdoor user, when both are at a handover boundary (i.e. cell edge) in a multicell network with contiguous coverage provided by a network of cell sites. The outdoor user would experience no building penetration loss. Thus, for the cell edge user case, the path loss between this outdoor user and the serving cell site would be 15 - 30 dB less than for a similarly distant indoor user and his serving cell site. Obviously, for non-cell edge users, the additional path loss margin for the outdoor user will be even greater than 15 – 30 dB, owing to reduced distance-based path attenuation compared to the cell edge user.

This extra margin of at least 15 - 30 dB will allow the outdoor cell edge users' modulation order to be increased from the two bits per symbol QPSK-based formats to the four bits per symbol 16QAM formats or even the six bits per symbol 64QAM formats, depending on the distance-based path loss to the serving cell and the degree of path blockage, multipath and fast fading. But even the maximum adjustment of the modulation format will account for only approximately 10 dB of this 20 dB of excess path loss margin available on the uplink, leaving at least 10 dB of transmit power control and/or equivalent reduction in the duty cycle necessary to transmit a fixed uplink bit rate.

So, it can be concluded that the user terminals most likely to operate at maximum transmit power, namely the user terminals located within buildings at cell edge, are those that are least likely to interfere with SDARS receivers. As a result of the excess margin presented to on-street or in-vehicle users, these user classes are likely to operate at power levels far below the maximum available. Indeed, the TPC simulation performed by the WCS Coalition did not account for the variability of user classes. Such variability would have likely increased the overall benefit provided by TPC. The WCS Coalition's use of a 3 dB benefit from TPC is thus a conservative assumption.

Considering the discussion above, Sirius XM's dismissal of TPC based on the rationale that "the likely real benefits of transmitter power control are highly variable and impossible to accurately quantify" and that "transmitter power control will generally act to compensate for additional vehicle penetration losses"[33] is evasive and completely unfounded.

[33] *Ex Parte see* page 6 of Exhibit A.

4) Conclusion

It has been illustrated that the Sirius XM simulation study for a highway use case of both WCS and SDARS operations is anything but 'real world.' Sirius XM has relied on a number of exaggerated input values and has fundamental flaws in its simulation methodology that lead to the erroneous conclusion that there is a high chance that WCS mobile devices will cause interference to SDARS receivers.

The flaws in the Sirius XM study include:

- 10 times the expected WCS subscriber penetration rate;
- 4 times over counting of simulated WCS subscribers;
- 4 times the subscriber terminal activity factor;
- 1.1 to 1.2 times more highway traffic than would occur even under the most extreme cases;
- Interference distances of up to 196 feet on a crowded highway;
- No consideration of transmit power control or penetration margin, assume that the mobile always transmits at full power;
- No consideration of required separation distances for vehicles located in the same traffic lane.

Had Sirius XM used appropriate input values, the study would have likely yielded probabilities several orders of magnitude lower than predicted.

It has also been shown that Sirius XM's claims that WCS transmit power control and user activity factor provide no benefit in mitigating interference are patently false.

- Sirius XM wrongly dismisses the benefits of transmit power control on coexistence based on the notion that the configurable features of WiMAX technology extinguish the interference reduction benefits of TPC. Contrary to basic wireless network principles, Sirius XM argues that WCS network operators will be motivated to maximize user transmit power to maximize network capacity. In fact, the opposite holds true.
- Sirius XM confuses "duty cycle" with "user activity" and then mistakenly links user terminal duty cycle, which is dictated largely by application, with network capacity to arrive at the flawed conclusion that WCS user terminals will need to transmit nearly all of the time. In fact, WCS terminals will need to transmit less than 2 minutes per hour.