TECHNICAL APPENDIX

A Study of ATC, BRS and BAS in Adjacent Spectral Allocations

December 19, 2007

1 Summary

Globalstar Inc. (Globalstar), plans to introduce an Ancillary Terrestrial Component (ATC) to its satellite network. Globalstar is authorized to use the 2483.5–2500 MHz frequency range in the S-band for Space-to-earth downlink transmissions for MSS service links. Since the Federal Communications Commission (FCC) extended the broadband radio service (BRS)/educational broadcast service (EBS) band to the range 2495–2690 MHz (including a 1 MHz guard band), Globalstar shares this spectrum with those services. BRS Channel 1 (2496–2502 MHz) is located in the spectrum overlapping Globalstar's authorization in the S-Band. If the ATC uses a technology similar to the BRS, then sharing spectrum (ATC/BRS) in the same immediate geographic area between 2496–2500 MHz could theoretically be problematic.

This appendix addresses the potential for interference between ATC Base Station (BS) transmitters using cdma2000 or Worldwide Standard for Interoperable Microwave Access (WiMAX) technologies and BRS BS receivers using WiMAX technologies where both systems are operating close to 2495 MHz with a worst-case separation of 100 meters. If the ATC BS emissions operate at the FCC limits[1/], then RF filters will be required both at the ATC BS and the BRS BS in order to suppress these interference sources. Although Globalstar's ATC assignment and the BRS channel 1 assignment are currently separated by 3 MHz, this analysis demonstrates that with proper filtering, only the existing 1 MHz guard band is required between 2495–2496 MHz to protect BRS channel 1 operations. Moreover, since BRS channel 1 is 6 MHz wide, and the bandwidth of the BRS receiver is only 4.6 MHz, as a practical matter it is likely that BRS will use a center frequency of 2499 MHz and will not use the lowest 0.7 MHz of BRS Channel 1, increasing the effective ATC/BRS guard band to 1.7 MHz.

Alternatively, if the proposed ATC system uses WiMAX Time Division Duplex (TDD) technology, and the transmissions are synchronized with those of any nearby BRS systems operating on BRS channel 1, any potential for interference can be entirely

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1/ *See* 47 C.F.R. § 25.254.

eliminated, so that *no* guard band is required. In such a case, interference to Mobile Stations (MSs) from BSs is no greater than that which occurs between adjacent Frequency Division Duplex (FDD) systems.

Finally, this analysis explains that no additional spectral separation is required at 2483.5 MHz for protection of the Broadcast Auxiliary Service (BAS) licensees operating on channel A9, so that there is no reason to prohibit or restrict ATC operations between 2483.5-2487.5 MHz.

2 Introduction

Globalstar operates a voice and data communications system using a constellation of low earth orbit (LEO) satellites. Globalstar plans to enhance the capacity and coverage of this system in urban, as well as rural and other areas unserved or underserved by terrestrial wireless, using an ATC, which incorporates terrestrial base stations to provide coverage, but shares spectrum with the satellite component.

On November 9, 2007, the FCC issued a Second Order on Reconsideration, Second Report and Order (2nd R&O), and Notice of Proposed Rulemaking (NPRM), in the matter of (among other subjects) Spectrum and Service Rules for Ancillary Terrestrial Components in the 1.6/2.4 GHz Big LEO Bands.[2/] The NPRM seeks comment on expansion of the spectrum that Globalstar and other CDMA Big LEO licensees are permitted to use for the deployment of ATC, including, in the S-band, a change from the current authorized ATC spectrum between 2487.5–2493 to all of Globalstar's unshared S-band spectrum, from 2483.5–2495 MHz. The NPRM tentatively concludes that ATC should not be authorized in the shared 2495–2500 MHz band, in order to avoid any conflict with the BRS systems that may one day operate in that band. The licensees of the BRS band are believed to be planning to deploy

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2/ *See* Spectrum and Service Rules for Ancillary Terrestrial Components in the 1.6/2.4 GHz Big LEO Bands, *Second Order on Reconsideration, Second Report and Order, and Notice of Proposed Rulemaking*, 22 FCC Rcd 19733 (2007).

TDD WiMAX technology. In addition, the BAS operates on Channel A10 between 2483.5–2500 MHz and on Channel A9 between 2467–2483.5 MHz.

Globalstar has undertaken this study of the compatibility of an ATC system using either WiMAX or cdma2000 technologies with both BRS WiMAX operations between 2496-2500 MHz and with BAS operations below 2483.5 MHz.

3 Parameters of the Study

This study analyzes the parameters of the interfering and victim systems. For this analysis, we consider ATC WiMAX with 3.5 MHz bandwidth and ATC cdma2000 with 1.25 MHz bandwidth. We consider BRS in Channel 1 as WiMAX with 5 MHz bandwidth (4.6 MHz occupied bandwidth). Finally, we consider BAS in Channels A9 and A10 with 16.5 MHz bandwidth or digitized into a 12 MHz bandwidth.

Potential interference scenarios between ATC and BRS include BS-to-BS interference (both directions), BS-to-MS interference, MS-to-BS interference, and MS-to-MS interference. The most serious interference potential is BS-to-BS, since the BSs emit higher EIRP than the MSs, the BS receivers are designed for greater sensitivity to detect low power mobile signals, and all MSs using a particular base station could experience degraded performance due to interference at the BS receiver. The impact of mutual interference depends on both the affected BS receiver characteristics (including receiver sensitivity, low noise amplifier compression point, and input filtering) and the interfering BS transmitter's emissions mask. If the BS transmitter's filtering and resulting emissions mask are not sufficient to meet interference limits, more frequency separation between ATC and BRS BSs and more antenna isolation (greater antenna separation or off-pointing) may be needed to mitigate interference.[3/]

Since BSs are usually sited on towers, with high gain antennas and large transmit powers compared with MSs, the dominant interference paths tends to be between BS transmitters of one system and the BS receivers of the victim system operating in nearby

[3/] This applies to TDD or FDD ATC systems.

spectrum as shown in Figure 1. For the purposes of this study, we shall first consider the ATC carrier operating on the highest frequency in the allocation and BRS WiMAX operating on the lowest carrier per the scenarios below.

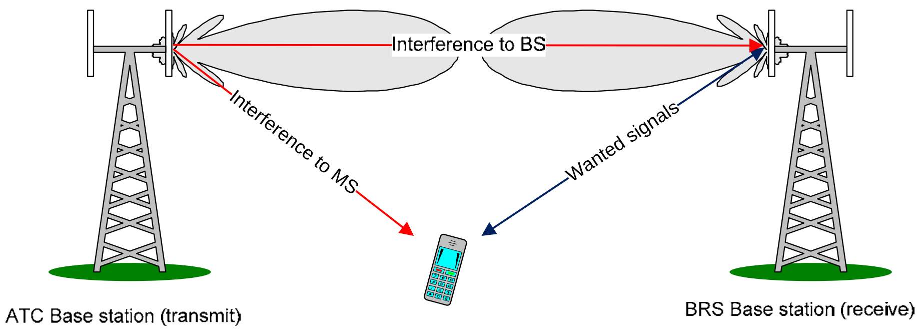

Figure 1 Interference paths for BRS as victim.

3.1 Parameters of WiMAX operating in the BRS

The WiMAX Forum introduced mobile WiMAX into the International Mobile Telecommunications 2000 (IMT-2000) family of third generation (3G) radio technologies and a considerable amount of information has been published relating to WiMAX operations in the frequency range 2496–2690 MHz with bandwidths of 5 and 10 MHz (WiMAX Profile 3A)[4/]. In this study we shall assume for BRS channel 1 a 5 MHz nominal bandwidth (4.6 MHz occupied bandwidth) with a center frequency of 2499 MHz per current WiMAX profiles, and a BS with the parameters shown in Table 1. The relationships between the channel bandwidth and the number of subcarriers in the WiMAX signal are shown in Figure 2. The emissions mask defined by the WiMAX Forum is shown in Table 2.

4/ WiMAX Forum, “WiMAX Forum™ Mobile System Profile Release 1.0 Approved Specification”, Revision 1.2., 17 November 2006.

Parameter	Value	Notes
Base station height	30 m	
Antenna gain	18 dBi	
Transmit power	36 dBm	
1st adjacent channel leakage ratio (ACLR)	45 dB	5 MHz offset
2nd ACLR	55 dB	10 MHz offset
1st adjacent channel selectivity (ACS)	70 dB	5 MHz offset
2nd ACS	70 dB	10 MHz offset
Interference threshold	−110 dBm/5 MHz	Assumes an interference-to-noise-ratio (I/N) of −6 dB and a noise figure of 5 dB.
Receiver bandwidth	4.6 MHz	Assumes the Partial Usage of SubChannels (PUSC) structure for the uplink. Note that the downlink bandwidth is 4.75 MHz for PUSC.
FFT Size	512	
Sampling Rate	5.6 MHz	(28/25) × channel bandwidth
Number of subcarriers used	421 (downlink PUSC) [5/] 409 (uplink PUSC)	Includes DC carrier

Table 1 Parameters of WiMAX operating in the BRS[6/],[7/]

[5/] WiMAX includes many different subcarrier allocations, so the parameters of the mandatory PUSC zones are given. Other zones use different values for the number of subcarriers used, e.g., the possibilities for the downlink are 419 subcarriers for the preamble, 427 subcarriers for Full Usage of SubChannels (FUSC), 409 subcarriers for Tile Usage of SubChannels TUSC1 (downlink), and 433 subcarriers for the optional FUSC, optional PUSC and TUSC2 zones. Optional PUSC may be used for the uplink, which uses 433 subcarriers (rather than 409).

[6/] *See* ITU-R Report M.2116, "Characteristics of broadband wireless access systems operating in the land mobile service for use in sharing studies," 2007.

[7/] *See* IEEE 802.16e-2005, "IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands and Corrigendum 1," December 2005.

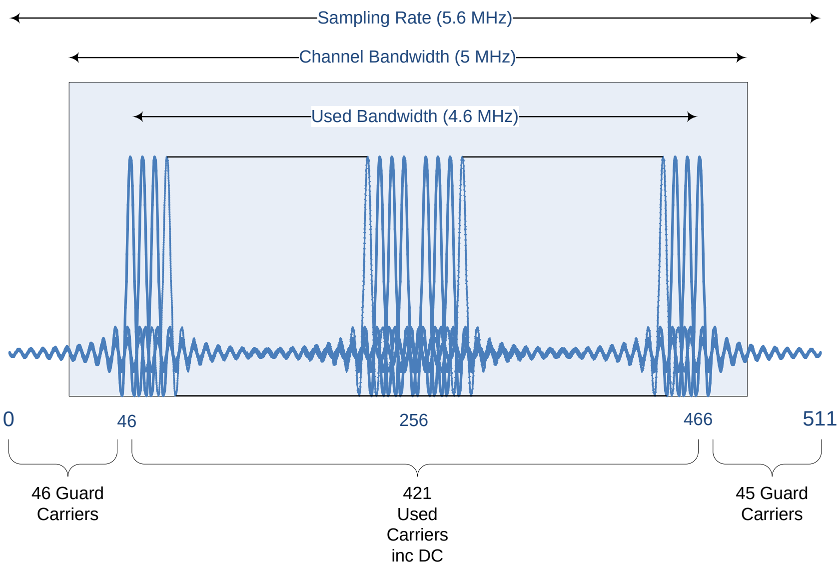

Figure 2 Signal bandwidth and number of subcarriers used for downlink with PUSC.

Offset from centre frequency	Level	Measurement bandwidth
2.5-3.5 MHz	−13 dBm	50 kHz
3.5-12.5 MHz	−13 dBm	1 MHz

Table 2 Emissions limit for 5 MHz WiMAX.[8/]

Beyond 12.5 MHz offset, the International Telecommunications Union (ITU) Category A limits apply, i.e. -13 dBm/MHz for frequencies above 1 GHz.

3.2 Parameters of cdma2000 ATC

In the analysis, the BS will transmit on Globalstar Channel 9, occupying 1.23 MHz centered on 2494.23 MHz. Note that the BS receiver operates in the region of 1.6 GHz, and

8/ *See* ITU-R Recommendation M.1580-2, "Generic unwanted emission characteristics of base stations using the terrestrial radio interfaces of IMT-2000," October 2007.

therefore it is ignored in this analysis. The parameters for the cdma2000 transmitter are shown in Table 3.

Parameter	Value	Notes
Base station height	30 m	
Antenna gain	17 dBi	
Transmit power	40 dBm	
1st ACLR	50.8 dB	At 3.75 MHz offset
2nd ACLR	67.2 dB	At 8.75 MHz offset

Table 3 Parameters of cdma2000 BS transmitter operating in the ATC[9/].

The ATC operating frequency band is not one of the standard band classes listed in Third Generation Partnership Project 2 (3GPP2) C.S0057[10/], but we infer that the emissions would be similar to Band Class 6[11/]. The emissions are given by 3GPP2 specification C.S0010[12/] and ITU-R Report M.1580[13/]. These are replicated in Table 4. Beyond 4 MHz, the ITU Category A limits apply, i.e., −13 dBm/MHz for frequencies above 1 GHz.

9/ ITU-R Report M.2039, "Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses", 2004.

10/ 3GPP2, C.S0057-B, "Band Class Specifications for cdma2000 Spread Spectrum Base Stations," Release B, Version 1, August 2006.

11/ Uplink: 1920 – 1980 MHz; downlink: 2110 – 2170 MHz

12/ *See* 3GPP2, C.S0010-C, "Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Base Stations," Release C, version 2, February 2006.

13/ *See* note 8, above.

Offset of the closest edge of measurement filter from centre frequency	**Level**	**Measurement bandwidth**
885 kHz to 1.25 MHz	–45 dBc	30 kHz
1.25 to 1.45 MHz	–13 dBm	30 kHz
1.45 to 2.25 MHz	$-[13 + 17 \times (\Delta f - 1.45\ \text{MHz})]$ dBm	30 kHz
2.25 to 4.00 MHz	–13 dBm	1 MHz

Table 4 Emissions limit for cdma2000[14/],[15/]

The FCC applies special rules for ATC networks, set forth in Part 25 Section 254, which require that the transmitted effective isotropic radiated power (EIRP) spectral density may not exceed 32 dBW/1.25 MHz and that the EIRP outside the mobile satellite service (MSS) authorized bandwidth may not exceed −44.1 dBW/30 kHz[16/]. This equates to an EIRP spectral density of −14.1 dBm/30 kHz.

3.3 Parameters of WiMAX ATC

The WiMAX ATC is assumed to operate with a nominal bandwidth of 3.5 MHz in TDD mode with similar emissions to the 5 MHz WiMAX system described above. For the purposes of interference analysis, the center frequency of operation will be assumed to be 2493.25 MHz. The parameters to be used in the analysis are given in Table 5.

14/ *Id.*

15/ *See* note 12, above.

16/ *See* 47 C.F.R. § 254.

Parameter	Value	Notes
Base station height	30 m	
Antenna gain	18 dBi	
Transmit power	36 dBm	
1st ACLR	45 dB	3.5 MHz offset
2nd ACLR	55 dB	7 MHz offset
1st ACS	70 dB	
Interference threshold	−111.25 dBm/3.5 MHz	Assumes I/N of −6 dB and a noise figure of 5 dB.
FFT Size	512	
Sampling Rate	4 MHz	(8/7) × channel bandwidth
Number of subcarriers used	421 (downlink PUSC) 409 (uplink PUSC)	Includes DC carrier

Table 5 Parameters of WiMAX operating in the ATC.

Offset from centre frequency	Level	Measurement bandwidth
1.75-2.75 MHz	−13 dBm	35 kHz (1% of WiMAX bandwidth)
2.75-8.75 MHz	−13 dBm	1 MHz

Table 6 Emissions limit for 3.5 MHz WiMAX operating in the ATC.

Beyond 8.75 MHz offset, the ITU Category A limits apply, i.e., −13 dBm/MHz for frequencies above 1 GHz.

4 Analysis

4.1 Methodology

When ATC networks and WiMAX networks operating in the BRS bands are deployed in urban areas, where it is assumed that there will be relatively high BS sites and small cells and that the WiMAX BS receivers are likely to have (without regard to any antenna discrimination) line of sight to ATC BS transmitters, and so free space path loss is used. Free-space path loss, L_{FSPL}, is given by[17/]

$$L_{FSPL} = 20\log d + 20\log f + 32.44 \text{ dB}$$

where f is the operating frequency in megahertz and d is the distance in kilometers between the transmitting and receiving antennas.

The approach taken is to assume that the antennas are separated by at least 100 m with the antennas pointing directly at each other. This represents a worst-case uncoordinated situation. Below this distance and for collocated sites, engineering measures will be taken to ensure that sufficient isolation is achieved.

When addressing interference between BSs of one system with the reception of MSs of the other system, we also consider the worst case. When computing the worst-case condition, minimum coupling loss (MCL) and direct line-of-sight conditions are assumed between antennas. The MCL is the minimum of the combination of the BS antenna gain and free-space path loss. In Figure 3 we show the coupling loss variation with separation between a MS and BS with heights of 1.5 m and 30 m, respectively, for downtilt angles of 0, 2 and 4 degrees. According to ITU radio communications sector (ITU-R) report M.2039[18/], a downtilt of 2.5 degrees for cdma2000 is recommended for use in sharing studies, and this would yield a MCL of 75 dB.

We note that the potential for interference described above is virtually nonexistent when ATC is deployed in rural and remote areas, where a significant geographic distance is likely between ATC and BRS BSs, and where BRS deployment is not anticipated for quite some time (if at all).

When using the FCC ATC out-of-band emission limits, the analyses converge independent of the ATC technology deployed, i.e., the different scenarios outlined below

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17/ Parsons D, “The Mobile Radio Propagation Channel”, Pentech Press, London, 1992.

18/ *See* ITU-R Report M.2039, “Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses”, 2004.

yield the same results. However, the optimal interference mitigation solution may differ based on the deployed technology.

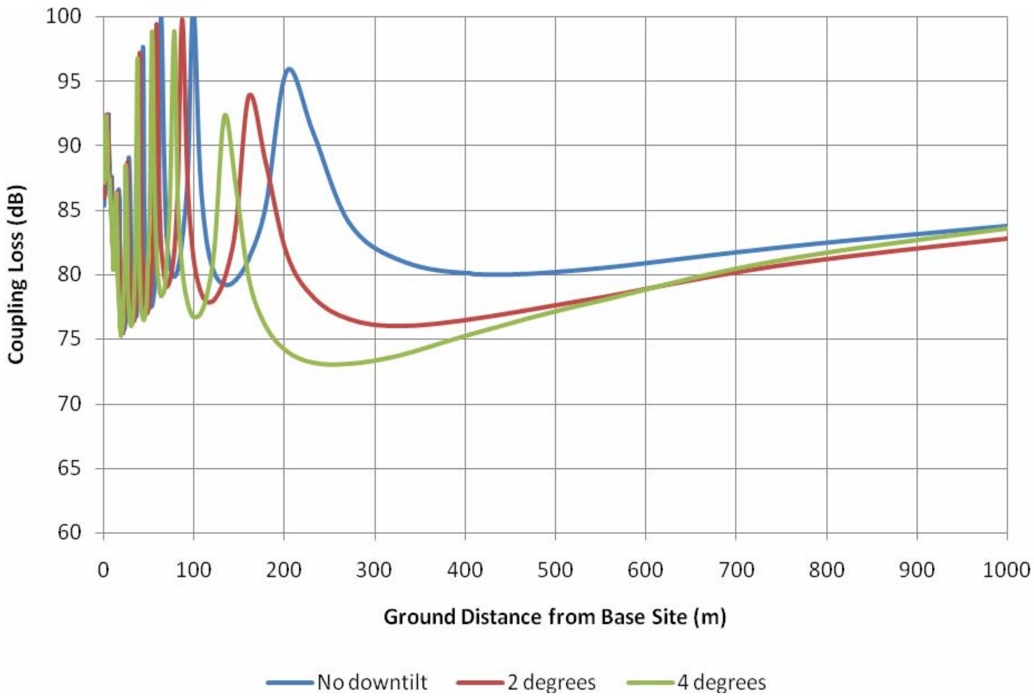

Figure 3 Coupling loss values as a function of separation and downtilt.

4.2 Scenario 1: cdma2000 ATC

First, we calculate the emissions from the cdma2000 ATC BS into the BRS WiMAX BS. With a cdma2000 center frequency of 2494.23 MHz, and a WiMAX center frequency of 2499 MHz as shown in Figure 4, the frequency offset to the lowest used subcarrier of the WiMAX system is 2.534 MHz (and to the highest, 7.001 MHz). The emissions level throughout this region is specified at −13 dBm/MHz per Table 4, but will be assumed to be -14.1 dBm/MHz, since the FCC requires an ATC out of band EIRP of −44.1 dBW/MHz.

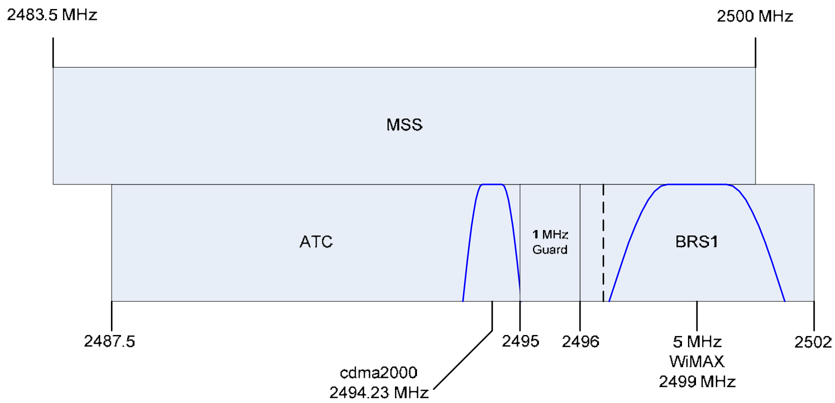

Figure 4 Locations of highest cdma2000 ATC signal and lowest WiMAX BRS signal in the band plan.

Mutual operation with the worst case antenna orientation and an antenna separation of 100 m, corresponds to 80.4 dB free space path loss at 2499 MHz. Applying the FCC limit at frequencies above 2496 MHz, the isolation required is:

Limit – Path Loss + Receive Antenna Gain = −14.1 – 80.4 + 18 = −76.5 dBm/MHz or −70 dBm in a bandwidth of 4.6 MHz.

Assuming that the maximum tolerable level of interference is −110 dBm (from Table 1), then there is a shortfall of 40 dB. Note that the spurious emissions limit is the same for all frequency offsets, and so increasing the spectral separation would not offer any benefit.

For physical separation to resolve the interference, the transceivers would need to be separated by approximately 10 km, assuming free space path loss. Bear in mind that this uses worst-case assumptions that are unlikely in practice, and that losses will be greater than free space at this range. For distances shorter than 10 km, additional antenna isolation, such as titling or sectorization, or BS transmitter filtering would be required to meet the limit.

Finally, where there is a documented interference complaint, the FCC proposes to apply section 27.53 of its rules, under which the party that causes the interference must attenuate by $67 + 10 \times \log_{10} P$ dB, where P is the transmit power in watts, at offsets of 3 MHz or greater from the edge of the allocation, provided that the separation exceeds 1.5 km. This means that their emissions should be reduced to 40 – (67 + 10) = −37 dBm/MHz. If the distance is less than 1.5 km, then the emissions should be reduced in proportion to free space loss. The additional loss moving from 100 m to 1.5 km is 23.5 dB. Thus, adherence to Part 27 of the FCC's rules would provide an additional -46.4 dB (= −37 – (-14.1) - 23.5) of protection at least 3 MHz from the ATC carrier edge, compensating for the 40 dB shortfall even if no transmit filtering was added.

To protect the WiMAX receiver from blocking signals at all distances, additional filtering is required. Since WiMAX uses TDD, a tight radio frequency (RF) filter on each antenna can be used both to protect the BS receiver from blocking signals and to protect adjacent services. Extra filtering at the BS is discussed in Section 5.

With regard to interference from a cdma2000 ATC BS to a WiMAX BRS MS, an MCL on the order of 75 dB is possible (as demonstrated in Section 4.1), with a tolerable interference level of −108 dBm[19/]. In this case, the −13 dBm/MHz level (or −6.5 dBm/5 MHz channel) would translate to levels in the region of −81.5 dBm in 5 MHz. This leaves a shortfall of some 26.5 dB; however, although this could have a severe effect on the MS, in practice there are many mitigating circumstances that would lessen the impact. For example, link budgets are usually designed with fading margin and building penetration margin, and so the median outdoor signal strength at the cell edge may well be 21 dB greater. In addition, it is also unlikely that the MS would have line of sight to the interfering BS, which results in a lower coupling loss than otherwise expected. As a result, in practice this type of interference is generally tolerated in networks operating on adjacent channels.

4.3 Scenario 2: WiMAX ATC

We now calculate the emissions from a WiMAX ATC BS into the WiMAX BRS BS with the band plan shown in Figure 5. With a WiMAX ATC center frequency of 2493.25 MHz, and a WiMAX BRS center frequency of 2499 MHz, the frequency offset to the lowest used subcarrier of the WiMAX system is 3.554 MHz (and to the highest, 8.021 MHz). The emissions level throughout this region is specified at −13 dBm/MHz per Table 6, but will be assumed to be -14.1 dBm/MHz, since the FCC requires an ATC out of band EIRP of −44.1 dBW/MHz.

19/ *See* ITU-R Report M.2116, "Characteristics of broadband wireless access systems operating in the land mobile service for use in sharing studies," 2007.

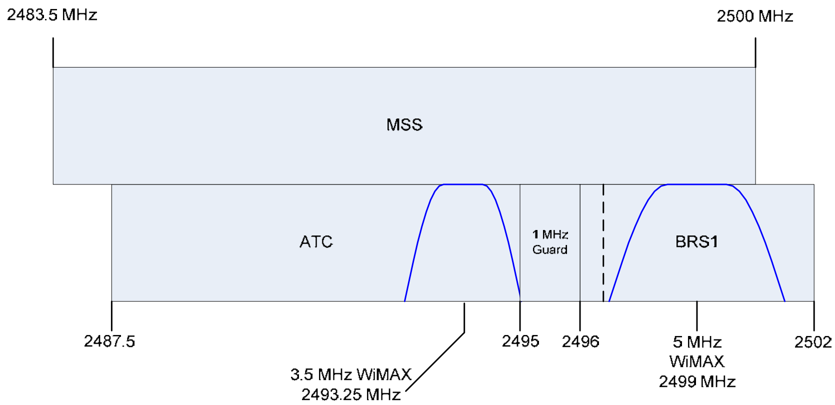

Figure 5 Locations of the highest WiMAX ATC carrier and the lowest BRS carrier in the band plan.

If the FCC's limit is applied at frequencies above 2496 MHz, then the isolation required is −14.1 – 80.4 + 18 = −76.5 dBm/MHz, resulting in the same 40 dB shortfall as cdma2000 ATC.

Assuming free space path loss, the maximum tolerable interference level would require a separation of approximately 10 km. Once again, this uses worst-case assumptions that are unlikely in practice and losses will be greater than free space at this range. As described in Section 4.2, adherence to Part 27 of the FCC's rules would provide an additional 36 – (67 + 10) – (-14.1) - 23.5 = −50.4 dB of protection at a separation distance of 100 m provided there was a 3 MHz separation from the ATC carrier edge, compensating for the 40 dB shortfall even if no transmit filtering was added.

In contrast to a cdma2000 ATC, the BSs of a WiMAX TDD ATC will suffer interference from the BRS service. However, if a filter is used to contain the ATC emissions, it will also improve the receiver selectivity.

Interference from the WiMAX ATC BSs to the WiMAX BRS MSs will be similar to the cdma2000 case outlined above. The interference will be dominated by the selectivity of the mobiles. This form of interference is tolerated in adjacent networks, however, because it is intermittent, and the worst case scenario is unlikely.

5 Mitigation of Interference

Any interference caused by out-of-band emissions from ATC BSs could potentially be resolved by RF filtering at the ATC BSs. Note that the transition band for such a filter would be 1.7 MHz (assuming the center frequencies outlined above). In ITU-R Report M.2045[20/], it is claimed that transmit (or receive filtering) can offer 35 dB enhancement with a 1 MHz guard band and 71 dB with a 2 MHz guard band. This filter response has been based on scaling an eight section cavity filter centred on 1907.5 MHz. This filter has a claimed insertion loss of 2 dB. Using the characteristic plotted in Annex 5 of M.2045, it appears that the transition from 2 dB to 65 dB is achieved in 980 kHz, and so at 2.5 GHz this would imply a transition band of 1.28 MHz. Note that such a filter would more than adequately compensate for any additional antenna isolation required. Even with a less selective filter, only the existing 1 MHz guard band is required between 2495–2496 MHz to protect BRS channel 1 operations. Moreover, since BRS channel 1 is 6 MHz wide (2496–2502 MHz), and the bandwidth of the BRS receiver is only 4.6 MHz, it is likely that BRS will use a center frequency of 2499 MHz and will not use the lowest 0.7 MHz of BRS Channel 1, increasing the effective ATC/BRS guard band from 1 MHz, as set forth in the current band plan, to 1.7 MHz, offering additional protection to the BRS receivers.

To protect the WiMAX BRS receiver from blocking signals (i.e. ATC BS transmissions irrespective of technology), another filter is required at the BS receiver. Since WiMAX uses TDD, an RF filter on each antenna can be used to protect the BS receiver from blocking signals and this filter will also provide protection to adjacent services such as ATC BS receivers. The filter attenuation needed to sufficiently improve the selectivity of the BRS BS receiver is not as great as that required to adequately contain the emissions of the ATC BS as discussed in Section 4.2.

If the proposed ATC system uses WiMAX TDD technology, there is a second mitigation approach, namely synchronization. Although WiMAX systems operating in 3.5

[20/] *See* ITU-R Report M.2045, “Mitigating techniques to address coexistence between IMT-2000 time division duplex and frequency division duplex radio interface technologies within the frequency range 2500–2690 MHz operating in adjacent bands and in the same geographical area,” 2004.

MHz bandwidth and 5 MHz bandwidths have different symbol rates, both can use 5 msec frames, and by synchronizing the frames and judicious selection of the downlink/uplink ratio (for example, using 28 downlink symbols for the 5 MHz system and 20 downlink symbols for the 3.5 MHz system), they can be configured such that for most of the frame, neither BS is transmitting while the other needs to receive. In this manner, BS-to-BS interference can be virtually eliminated, without any guard band at all. Many WiMAX systems plan to use such synchronization techniques to avoid interference to adjacent channels without the need for any guard band; there is no technical reason why an ATC WiMAX system and a BRS WiMAX system operating in adjacent spectrum could not do the same.

6 BAS

The FCC repeatedly has acknowledged that ATC and BAS operations can successfully operate in the same band (2487.5–2493 MHz) through coordination. Applying the same BS emission limits to ATC operations down to 2483.5 MHz does not change this conclusion or alter the amount of protection that ATC operations must provide to BAS operations in Channel A10, since Channel A10 already overlaps the entire 2483.5–2500 MHz MSS allocation. As a result, it would be no more difficult for Globalstar to coordinate its ATC operations in all of its unshared S-band spectrum between 2483.5–2495 MHz than it is to coordinate in Globalstar's current ATC spectrum authorization. Moreover, as the FCC has observed,[21/] the number of active BAS licensees using Channel A10 is relatively small and should not increase since no new licenses will be issued, making the need for coordination small and diminishing.

For BAS operating in Channel A9 (2467–2483.5 MHz), Globalstar's ATC operations must meet the FCC required out of band EIRP of −44.1 dBW/MHz for all frequency offsets from the edge of the licensed assignment. Therefore, BAS in Channel A9 will be afforded

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21/ According to the FCC, in 2005 there were only 77 BAS licensees authorized to operate on channel A10. *See* Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands, *Memorandum Opinion and Order and Second Order on Reconsideration*, 20 FCC Rcd 4616 (2005) at ¶ 93.

the same protection from ATC BS emissions regardless of whether the ATC lower band edge is 2487.5 MHz or 2483.5 MHz. In addition, if the BAS licensee were to deploy digitized equipment (which is more and more likely to be the case going forward), then only 12 MHz of bandwidth would be required for that channel, effectively creating 2.25 of guard band.

7 Conclusion

ATC and BRS base stations can operate in adjacent spectrum separated by no more than the existing 1 MHz guard band between 2495–2496 MHz free of harmful interference without coordination or synchronization if the ATC/BRS BS separation is 10 km or more. For base stations in closer proximity to one another, additional antenna isolation, such as titling or sectorization, or RF filters with sharp roll-off may be used at both the ATC network BS and the BRS BS in order to enable both systems to operate with higher spectrum efficiency. Such filters would need to attenuate the out-of-band emissions by of the order of 40 dB in the receive band of the victim BS if the systems are operating at worst-case parameters, no additional path loss exists beyond free space, and no additional antenna isolation can be implemented. By using improved filtering at the ATC BS transmitter, the necessary emission limits can be met, and ATC operations will be possible up to 2495 MHz, without the need for additional antenna isolation or any guard band larger than 1 MHz.[22/] In addition, to the extent that both the ATC and BRS systems use WiMAX technologies, any threatened interference can be virtually eliminated through synchronization. If the adjacent ATC and BRS systems operated as synchronized TDD systems, no guard band would be required and BS-to-BS interference would be eliminated.

Finally, BAS in Channel A9 will be afforded the same protection from ATC BS emissions whether the ATC lower band edge is 2487.5 MHz or 2483.5 MHz because ATC systems must meet the FCC required out of band EIRP of −44.1 dBW/MHz for all frequency offsets from its licensed band edge. As a result, there will be no greater threat of interference to BAS licensees operating on Channel A9 from expanded ATC operations between 2483.5 – 2487.5 MHz than is already the case under Globalstar's existing ATC authorization.

22/ *See* UK WP8F WP(04)026 contribution: 60 dB of antenna isolation can be met by sharing the same antenna tower with appropriate vertical separation.

Engineering Certification

I hereby certify under penalty of perjury that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing "Technical Appendix"; that I am familiar with the relevant sections of the FCC's rules and the information contained in the Technical Appendix; and that the information in the Technical Appendix is true and correct to the best of my knowledge and belief.

Signed this 19th day of December, 2007

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Paul A. Monte,
Vice President, Engineering & Product Development
Globalstar, Inc.