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

In the Matter of	)	
	)	
Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band	)	WT Docket No. 07-195
	)	
	)	
Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands	)	WT Docket No. 04-356
	)	

COMMENTS OF NEW ICO SATELLITE SERVICES G.P.

I. INTRODUCTION

New ICO Satellite Services G.P. ("ICO") submits these comments in response to the Further Notice of Proposed Rule Making ("*FNPRM*") seeking comment on proposed service rules for Advanced Wireless Service ("AWS") spectrum in the 1915-1920 MHz, 1995-2000 MHz, and 2155-2180 MHz bands. ICO supports the Commission's efforts to "promote the deployment and ubiquitous availability of broadband services across the country and to facilitate the use of AWS spectrum for the benefit of consumers."[1] At the same time, ICO urges the Commission to provide adequate protection from interference to mobile satellite service ("MSS") and ancillary terrestrial component ("ATC") communications in bands adjacent to the AWS bands, and to consider alternative rules that mitigate interference to MSS operations consistent with the Commission's goals in this proceeding. ICO includes a detailed technical analysis with these comments, identifying and explaining the nature and severity of interference that MSS/ATC systems would receive from adjacent-band AWS systems operating under the

[1] *Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band*, Further Notice of Proposed Rulemaking, FCC 08-158, 23 FCC Rcd 9859, ¶ 1 (2008) ("*FNPRM*").

Commission's proposed rules.[2] In the interest of further supplementing the AWS-2 and AWS-3 record for the Commission's comprehensive assessment, ICO identifies an alternate band plan that would alleviate many of the interference scenarios outlined in the record, while at the same time preserving the availability of valuable AWS spectrum for broadband and other advanced uses.

II. BACKGROUND

ICO is authorized to provide MSS in 20 megahertz of spectrum in the 2000-2020 MHz and 2180-2200 MHz bands.[3] ICO has selected the 2010-2020 MHz and the 2180-2190 MHz bands for its operations.[4] ICO successfully launched its satellite, ICO G1, into orbit on April 14, 2008, and has met all of its milestone requirements.[5] When in-orbit testing is complete, ICO G1 will be capable of providing its advanced communications and public safety services throughout all 50 states, Puerto Rico, and the U.S. Virgin Islands. ICO also has applied to provide ATC services that would operate in the same frequencies. ICO is in the process of building out and testing its ATC facilities. ICO has also contracted with vendors to build various MSS and MSS/ATC handsets and other mobile devices that will be tested in the 2 GHz band in numerous trials throughout 2008 and into 2009.

III. AWS IN 1995-2000 MHz MUST PROTECT ADJACENT MSS AND ATC OPERATIONS FROM HARMFUL INTERFERENCE

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[2] *See* ICO White Paper, *AWS-2 and AWS-3 Interference to 2 GHz MSS/ATC*, July 25, 2008 ("White Paper"), attached as Exhibit A.

[3] *See Use of Returned Spectrum in the 2 GHz Mobile Satellite Service Frequency Bands*, 20 FCC Rcd 19696 (2005).

[4] *See Policy Branch Information: Actions Taken*, 23 FCC Rcd 8551, 8551 (IB 2008).

[5] *Id.*

ICO urges the Commission to ensure that AWS in the 1995-2000 MHz band provides adequate protection to adjacent MSS and ATC operations from harmful interference. The Commission's proposed rules for the 1995-2000 MHz AWS frequency band would allow for AWS base station transmissions in a band immediately adjacent to MSS satellite reception and MSS/ATC base station reception frequencies. AWS base stations operating at the levels proposed in the *FNPRM* would cause interference to ICO's satellite and planned ATC base stations.[6]

A. Guard Band and Strict Power Limits are Necessary to Protect MSS

AWS base station operations in the 1995-2000 MHz band at the levels proposed in the *FNPRM* would create harmful interference to MSS satellites that cannot be mitigated at ICO's G1 satellite. Consistent with the Commission's rules governing 2 GHz MSS, ICO constructed its satellite to be capable of operating across the entire 2 GHz MSS spectrum allocation.[7] Because this spectrum coverage extends from 2000 MHz to 2020 MHz, AWS transmissions in the upper end of the 1995-2000 MHz frequency band would appear inside the satellite filter roll-off and would interfere with satellite reception.[8] As described in detail in the attached technical exhibit, interference from high power AWS base station transmissions originating in the 1.5 megahertz below 2000 MHz (i.e., 1998.5-2000 MHz) raise power levels at the satellite's feeder link –

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[6] *See* White Paper at 10-13 (describing the interference mechanisms involved with the AWS/MSS spectrum interface at 2000 MHz).

[7] *See The Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band,* 15 FCC Rcd 16127, ¶ 52 (2000).

[8] In-band interference to the satellite cannot be corrected with a receive filter, as the satellite has been launched and is in geostationary orbit. In-band interference can only be alleviated through AWS base station power reductions and the creation of a guard band. There is no way to "coordinate" AWS base station usage as applied to the satellite. The Commission's proposed AWS base station emission and power levels proposed are insufficient to protect MSS/ATC.

resulting in substantially degraded satellite performance. To avoid saturation, the feeder power amplifier will reduce gain, thus reducing satellite return coverage by several dB, with the reduction in satellite return coverage increasing proportionately as the number of AWS base stations deployed increases.

Therefore, the adjacent frequency band must include a guard band of at least 1 megahertz in width at 1999-2000 MHz to protect MSS operations, and the aggregate EIRP for AWS base stations in the 1995-1999 MHz band must not exceed 32 dBW per sector. ICO has proposed a tiered power scheme mirroring industry proposals for mobile operations in 1915-1920 MHz.[9] Although the *FNPRM* does not propose to solve the mobile-to-mobile interference or intermodulation issues in the 1915-1920 MHz band through power reduction or guard band, these AWS base station power mitigation measures remain critical to protect adjacent-band MSS operations.

B. Stricter Out-of-Band Emission Limits Must Be Employed to Protect MSS/ATC

Because the proposed AWS base station transmitters and ATC base station receivers will operate in directly adjacent frequency bands, appropriate out-of-band emissions ("OOBE") limits must be placed on AWS base station transmitters. ICO proposes OOBE limits for AWS base stations, based upon base station separation distances, as follows:

- Base-to-base station separation distances greater than 1.5 km: OOBE of 70 + 10 log P at 3 MHz from the channel edge
- Base-to-base station separation less than 1.5 km: OOBE of 70 + 10 log P – 20 log (Dkm/1.5) at 3 MHz from the channel edge
- When co-located, limit the undesired signal level at the ATC base station receiver to no more than -109 dBm/4 MHz (scaled to the appropriate bandwidth)

[9] *See* ICO, *AWS-3 and AWS-2*, at 12, May, 30, 2008, attached to Ex Parte Letter from Suzanne Hutchings Malloy, Sr. V.P. Reg. Affairs, ICO, to Marlene H. Dortch, Secretary, FCC, May 30, 2008 ("May 30 ICO Ex Parte").

Similar separation-distance-based rules have been applied in the BRS/EBS service rules to permit dissimilar services to operate in adjacent bands. With respect to the interface between the 1995-2000 MHz block and the MSS band at 2000-2020 MHz, base transmit is directly adjacent to base receive, which presents an interference case more severe than a BRS deployment with asynchronous TDD systems being adjacent.[10]

Adopting the separation-distance approach also will allow the interfering AWS operator to install more stringent filters only where required. AWS base stations that are not in a position to interfere may employ less rigid filters, delivering lower cost of deployment and better performance since the insertion loss is lower.

IV. THE AWS-3 BAND MUST NOT EXPAND BEYOND 2155-2175 MHz

ICO has supported flexible use of AWS-3 spectrum, provided that guard bands for uplink communications are internalized in the AWS-3 band and that proper AWS rules are employed. However, the proposal to expand the 2155-2175 MHz AWS-3 band to include the 2175-2180 MHz AWS-2 spectrum raises at least two immediate concerns. First, ICO is concerned that eliminating the frequency separation between sensitive MSS satellite downlink communications and proposed AWS uplink communications would cause harmful interference to MSS communications that cannot be reasonably mitigated by MSS equipment design or filtering. Second, ICO is concerned that assigning the 2175-2180 MHz band to AWS-3 licensees is not justified, and would preclude new service offerings that could develop over the proposed AWS-2 J Block paired bands at 2020-2025 MHz and 2175-2180 MHz.

[10] For example, if asynchronous TDD system timing is not aligned, then sometimes operator A's base stations transmit when operator B's are listening, and interfere; but because both systems switch in time, there is likely a portion of time where they are aligned and not interfering. In the AWS base transmit to MSS/ATC base receive interference scenario, MSS/ATC would be receiving all of the time, and AWS in the 1995-2000 MHz would be transmitting all of the time, so the interference is constant.

A. AWS Uplink Transmissions Within The 2170-2180 MHz Band Cannot Protect MSS

MSS user equipment in the 2180-2200 MHz MSS uplink band will be more susceptible to harmful interference from neighboring bands than PCS and cellular-like user equipment.[11] This extra sensitivity is created because the user equipment must communicate with a geosynchronous orbit satellite over 22,000 miles away. As ICO has demonstrated in recent *ex parte* presentations, and as supported by the study ICO submits with these comments,[12] uplink communications in the 2170-2180 MHz portion of the proposed AWS-3 block would cause receiver overload to MSS user terminals due to the sensitive front-end receiver required by satellite terminals.

As ICO stated in an earlier filing,[13] 2 GHz MSS/ATC user terminals contain higher-gain Low Noise Amplifiers ("LNA") than typical PCS/AWS devices in order to improve satellite signal reception. This design reduces receiver blocking performance within 10 MHz of the receive band, making the MSS/ATC terminals more susceptible to interference than PCS/AWS devices. In addition, MSS/ATC devices will need to communicate with the satellite wherever the satellite signal is available, greatly increasing the percentage of time that these devices will be receiving at their minimum sensitivity level when an AWS-3 device is transmitting near maximum power. To mitigate this receiver overload threat, additional guard band frequencies are needed more by MSS terminals than AWS terminals, to provide sufficient frequency separation to achieve the required receiver filtering attenuation. Since AWS downlink transmissions would not be as problematic to MSS devices receiving in the adjacent band, ICO

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[11] *See* White Paper at 6-10.

[12] *See* May30 ICO Ex Parte; *see also* White Paper at 6-9.

[13] May 30 ICO Ex Parte at 6.

requests that the Commission adopt its original proposal to establish an AWS-2 "J Block" for downlink transmissions in 2175-2180 MHz (paired with uplink transmissions at 2020-2025 MHz). ICO further requests that the Commission allocate the 2170-2175 MHz band as downlink-only to provide adequate frequency separation between sensitive 2 GHz MSS devices and the AWS-3 uplink device transmissions.

In response to the Commission's proposal for uplink/downlink AWS-3 service, ICO conducted studies to determine the effect of mobile devices operating in the AWS-3 band. Although ICO's MSS/ATC devices are not designed to specifically accommodate any mobile usage in the AWS-3 band, preliminary research indicates that receiver filtering necessary for MSS communications could also achieve a blocking level of -56 dBm in 2170-2180 MHz. Combined with the isolation provided by 3 meters of minimum separation, ICO concludes that MSS/ATC devices will require 10 megahertz of guard band from uplink transmissions in the AWS-3 band.

In addition, an OOBE level of 90 + 10 log (P) at 2180 MHz is necessary to reduce interference to below the user terminal's noise floor, when the interfering AWS mobile terminal closely approaches the ICO MSS/ATC terminal. Higher emissions will elevate the noise floor, increasing bit error rates and disrupting reception from the satellite or ATC base station.[14]

[14] Taking into account a 2.5 – 3 megahertz guard band internal to the 2155-2175 MHz band, by leveraging state-of-the-art filters to better reject the AWS-3 signals and increasing the minimum separation distance (with a significantly higher probability of interference) to 3 meters, ICO previously indicated its support for a device EIRP in 2155-2172 MHz of 250 mW, but limiting EIRP to 1 mW from 2172-2180 MHz. ICO's initial view was overly optimistic in terms of filtering performance achievable while still meeting the satellite coverage objectives. Based on the analysis provided in the attached exhibit, the minimum guard band requirement is demonstrated to be 10 MHz. Accounting for a 10 megahertz guard band, ICO can support mobiles operating at 200 mW outside of the 2170-2180 MHz band.

B. Proponents of Uplink/Downlink AWS-3 Operations Have Not Demonstrated a Need for 25 Megahertz of Spectrum

Proponents of uplink/downlink operations offer no discernible justification for expansion of AWS-3 operations from 20 megahertz to 25 megahertz. While M2Z, the most vocal proponent of uplink/downlink communications, has long claimed that its operations can protect adjacent band incumbents from interference, its latest filings drop this pretense. When initially identifying the 2155-2175 MHz band for service, M2Z proposed to provide its service within the 20 megahertz of spectrum in the 2155-2175 MHz frequency band, and committed to find ways to increase throughput on its own to meet future increases in demand or the use requirements of future applications.[15] M2Z made numerous guarantees to protect adjacent services using existing technologies, and claimed to have a large number of interference mitigation tools.[16]

In May, however, M2Z asserted that it could meet increased download speeds only if the Commission grants its request to adopt more lenient service rules, shift interference mitigation obligations to adjacent licensees, and employ a probabilistic analysis for mobile-to-mobile

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[15] Comments of M2Z Networks, Inc., GN Docket No. 07-45, at 16 (May 16, 2007) (*citing* Consolidated Opposition of M2Z Networks, Inc. to Petitions to Deny, WT Docket Nos. 07-16 & 07-30 at 99-100 (Mar. 26, 2007)) (submitted to the record of WT 07-16 by M2Z on May 17, 2007.)

[16] *See* M2Z Networks, Inc. Application for License and Authority to Provide National Broadband Radio Service in the 2155-2175 MHz Band, WT Docket No. 07-16, at 21(May 5, 2006) ("M2Z will employ a multiplicity of methods to address any potential out-of-band harmful [emissions], including filtering, OFDMA, and AAS."). *See also* M2Z Networks, Inc. Ex Parte Response to Replies and Oppositions, WT Docket Nos. 07-16, 07-30 at 26 (Apr. 16, 2007); Consolidated Opposition of M2Z Networks, Inc. to Petitions to Deny, WT Dockets 07-16, 07-30 at 98 (Mar. 26, 2007) ("M2Z Consolidated Opposition"); Affidavit of Michael J. Marcusat 4-5 (Mar. 23, 2007) attached to M2Z Consolidated Opposition (adaptive antennas and novel application of cognitive radio technologies).

interference.[17] Contrary to its earlier claim that it would "employ a multiplicity of methods to address any potential harmful out-of-band emissions," M2Z now states that an increase in download speeds would burden adjacent-band licensees with greater interference. Neither M2Z nor any other proponent of uplink/downlink communications demonstrates why the introduction of broadband service in the AWS-3 band requires the appropriation of J Block spectrum at 2175-2180 MHz (and thereby breaking up a valuable AWS pairing). Such an expansion should not be undertaken to accommodate the needs of a particular business model or indeterminate goal of "more robust" broadband.

C. The Paired J Block at 2020-2025 MHz and 2175-2180 MHz Should be Preserved

Although the ability of a nationwide licensee to provide nearly ubiquitous broadband service in the AWS-3 band is debatable, the potential value of a paired FDD block at 2020-2025 MHz and 2175-2180 MHz is undeniable, especially given the many services that could be offered in the public interest. When the J Block was allocated to AWS, the Commission noted that "AWS entrants may also benefit from the introduction of terrestrial services in the adjacent MSS band under MSS/ATC authority."[18] AWS entrants in the proposed J Block at 2020-2025 MHz with 2175-2180 MHz would benefit from the design of adjacent-band MSS/ATC user equipment which in turn would allow for potential economies of scale and generally promote the more rapid deployment of new service offerings.[19] As ICO stated in its previous AWS-3

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[17] Ex Parte Letter from Uzoma C. Onyeije, M2Z Networks, Inc. to Marlene H. Dortch, Secretary, FCC, at 10 (May 5, 2008).

[18] *Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems*, 19 FCC Rcd 20720, ¶ 46 (2004).

[19] *See id.*

comments, ICO also supports licensing of the J Block spectrum on the largest geographic basis in order to facilitate deployment of nationwide wireless broadband and public safety services.[20]

V. ICO SUPPORTS AN ALTERNATE PROPOSAL FOR AWS-2 AND AWS-3 SPECTRUM

ICO supports an alternate proposal for AWS-2 and AWS-3 that would avoid the numerous interference concerns raised in the record to date. For example, the mobile-to-mobile interference issues presented by the introduction of mobile communications in the 1915-1920 MHz band have been contentious for years and still draw opposition from the carriers currently providing service in adjacent bands to millions of users. Further, the *FNPRM* does not acknowledge interference that MSS satellites and base stations will receive from AWS base stations operating in the 1995-2000 MHz band. Finally, the introduction of uplink communications in the proposed 2155-2175 MHz, or in the 2155-2180 MHz band, will create spectrum inefficiencies and impose service limitations on pre-existing and developing services in adjacent bands.

ICO therefore supports the alternate band plan ("Alternate Band Plan") submitted by Wireless Strategy on July 3, 2008.[21] With modifications to the Commission's AWS band plan proposals to date, an alternate band plan can be created that meets the Commission's goals of promoting broadband deployment and competition, at the same time eliminating the numerous interference concerns on the record. As depicted below, by rearranging the proposed AWS-2 "H Block" and J Block pairings, and including the AWS-3 spectrum, the Commission can create additional AWS pairings for auction that can encourage competitive broadband deployment.

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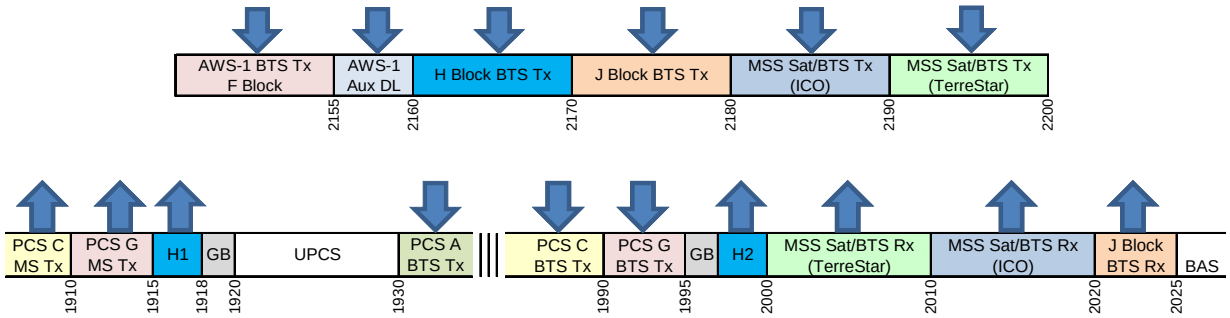
[20] ICO Comments, WT Docket No. 07-195 at 5 (Dec. 14, 2007).

[21] Ex Parte Letter from Douglas Hyslop, Wireless Strategy, LLC to Marlene H. Dortch, Secretary, FCC WT Docket No. 07-195 (July 3, 2008) (attached as Exhibit B).

Because more than one viable pairing is created, the plan enables the Commission to advance any objectives to support a broadband provider to provide partially free, open, and "family friendly" service, while at the same time providing spectrum for the introduction of innovative new services over the second pairing.



A. More Spectrum is Made Available for New Broadband Services

The Alternate Band Plan provides far superior capacity for broadband communications than the proposals in the *FNPRM*. The *FNPRM* proposal delivers only 25 megahertz of usable spectrum (out of 40 megahertz). The *FNPRM* proposal would break up the proposed AWS-2 J Block at 2020-2025/2175-2180 MHz to increase the size of the AWS-3 block to 25 megahertz to accommodate uplink communications in the band. However, with an implied guard band requirement of at least 5 megahertz per band edge to achieve the Commission's proposed emissions limits at the band's edges, AWS-3 will yield only 15 megahertz of usable spectrum capacity.[22] The proposed H Block at 1915-1920/1995-2000 MHz would provide at most an additional 10 megahertz of capacity, but very likely less when necessary interference coordination measures are considered. The 2020-2025 MHz J Block is left with no immediate

[22] As described above and in Exhibit A, a 5 megahertz guard band and OOBE limit as proposed in the *FNRPM* would not be sufficient to protect ICO's operations above 2180 MHz.

use for advanced wireless services, effectively resulting in an additional 5 megahertz of unused spectrum.

In contrast, the Alternate Band Plan delivers 36 megahertz of usable spectrum capacity (out of 40 megahertz). An AWS auxiliary downlink of 5 megahertz at 2155-2160 MHz will complement PCS or AWS spectrum and engender competition in new advanced services. The new 10+5 megahertz J Block provides 15 megahertz and the new 10+3+3 megahertz H Block provides 16 megahertz for broadband. Accounting for H1 and H2 guard bands of 2 megahertz each, the Alternate Band Plan provides 11 megahertz more spectrum capacity than the Commission's proposal in the *FNPRM*, and allows for more opportunities for broadband and other advanced wireless services.

The resulting two paired blocks of 15 megahertz and 16 megahertz, along with the 5 megahertz downlink block, can be auctioned and put to use in a more spectrally efficient manner than the proposed AWS-3 uplink/downlink block, while also creating economies of scale and eliminating interference across the entire AWS and MSS/ATC bands. Because there are two viable spectrum pairings for wireless broadband service, the Commission can conduct the auction to achieve a free, family-friendly block as proposed in the *FNPRM* as well as a second block for competitive entry, or for other broadband use.

B. Interference Concerns Are Reduced

The Alternate Band Plan also addresses the numerous concerns on the record regarding interference. The H Block mobile-mobile interference issues are resolved through guard bands, and the protection could be further adjusted through proper emissions and power levels.[23] The H

[23] The Alternate Band Plan reduces 1915-1920 MHz intermodulation interference through the 2 MHz guard band, providing the PCS device duplexers additional frequency spacing to attenuate the H Block transmissions. In 1995-2000 MHz, intermodulation interference is not a problem

block base-to-base and base-to-satellite interference issue affecting MSS/ATC operations (which cannot be mitigated by 2 GHz MSS licensees) is completely eliminated by permitting only mobile or other low-power use in the band. The AWS-3 interference issues hotly contested in the record are also resolved by permitting only base-station transmissions in the band.

VI. CONCLUSION

The Commission's proposal in the *FNPRM* does not take into account the specific operational needs of satellite communications, or address the interference to MSS created by AWS base stations in the 1995-2000 MHz band and by nationwide (potentially ubiquitous, and free) operations in the AWS-3 band. ICO urges the Commission to adopt the necessary rules to provide interference protections and allow for successful MSS and ATC operations in the 2 GHz band. If using uplink/downlink technologies to provide broadband is desired for the 20 megahertz of spectrum in the 2155-2175 MHz band, an additional 5 megahertz should not be speculatively added to the band at the expense of a valuable AWS J Block pairing. Moreover, other AWS spectrum configurations such as the Alternate Band Plan could provide even more opportunities for broadband communications while also abating numerous interference concerns.

Respectfully submitted,

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given the frequency spacing. Receiver overload and OOBE are potential concerns which may be mitigated through appropriate H2 Block regulations.

Exhibit A

AWS-2 and AWS-3 Interference to 2 GHz MSS/ATC

July 25, 2008

Table of Contents

1. Introduction 3

2. Interference Mechanisms 4

2.1 Receiver Overload 5

2.2 Out-of-band Emissions 5

2.3 Intermodulation Interference 5

3. AWS-3 Interference to MSS/ATC Terminals 6

3.1 MSS/ATC Receiver Overload 6

3.2 MSS/ATC Device Noise Rise 9

4. AWS-2 Interference to ATC Base Stations 10

5. AWS-2 Interference to the MSS Satellite Receiver 11

6. Conclusions 13

1. Introduction

In the AWS-3 proceeding, ICO expressed support for flexible use of the 2155-2175 MHz band to allow for the broadest range of opportunities for innovation and deployment of new services. ICO's support came along with the assumption of reasonable device power limitations given the surrounding mobile receive bands, the preservation of the harmonized J Block from 2175-2180 MHz, and sufficient additional guard band to provide adequate frequency spacing between AWS-3 device transmissions and MSS/ATC device reception. Satellite communication involves very long distances in excess of 35,000 km, resulting in a communications link where the device regularly operates at the minimum receiver sensitivity. MSS/ATC devices will leverage the satellite for coverage throughout the continental United States. Therefore, MSS/ATC devices will operate over a very large area at minimum signal reception. Unlike terrestrial systems where mobile-mobile interference rarely occurs given the density of base stations, device power control, and other mitigation measures, MSS/ATC devices will regularly suffer from severe interference from AWS-3 device transmissions. ICO's requested regulatory measures are essential for successful MSS/ATC operation.

In the June 20, 2008 FNPRM, the Commission proposed expanding the AWS-3 allocation to 2155-2180 MHz, allowing TDD within the full allocation, and recommended power and OOBE levels that would result in severe interference to 2 GHz MSS/ATC devices.

The nature and severity of the AWS-3 TDD interference is described in section 3 below. Figure 1 illustrates the proposed TDD implementation and interference to the surrounding bands.

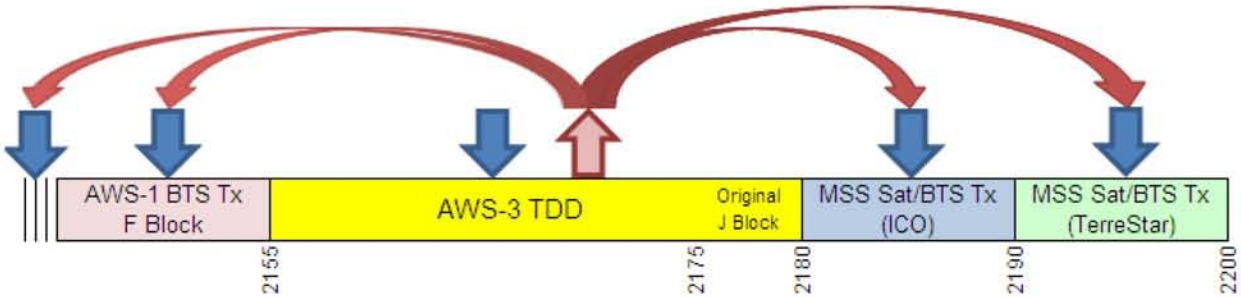

Figure 1: AWS-3 TDD Interference to Neighboring Bands

In the FNPRM, the Commission also proposed to auction the 5+5 MHz H Block with full base station transmit power throughout 1995-2000 MHz and OOBE limit of 43 + 10 log P.. Since the downlink transmit portion of the H Block is adjacent to the MSS/ATC uplink receive blocks, ICO is concerned about interference to both the sensitive satellite receiver and the ATC base stations, as described in Sections 4 and 5 and illustrated in Figure 2 below.

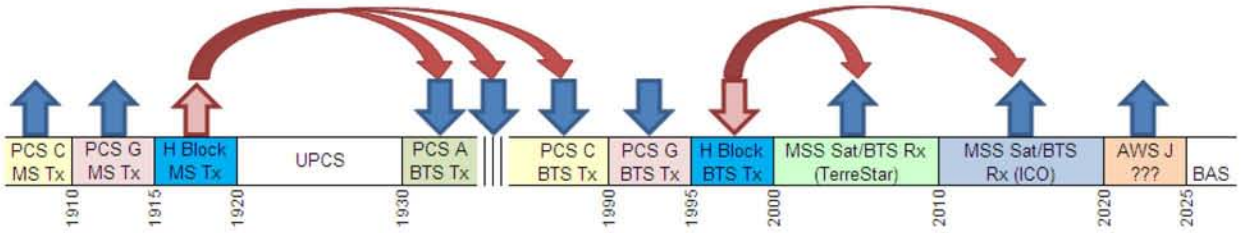

Figure 2: AWS-2 H Block Interference to Neighboring Bands

Note that both mobile transmit and base transmit allocations of the AWS-2 H Block pose serious interference concerns.

Based on the engineering analyses provided below, ICO requests protection for MSS/ATC devices through the following regulatory measures:

- Maintain 2175-2180 MHz as the J Block downlink to provide mobile-mobile frequency separation
- If TDD operation is allowed within 2155-2175 MHz, then establish 2170-2175 MHz as downlink only operation, restricting device transmission to provide a total of 10 MHz mobile-mobile frequency separation to MSS/ATC mobile receive, and to provide 5 MHz frequency separation to J Block mobiles given their less sensitive terrestrial receivers
- Set OOBE at 2180 MHz to 90 + 10 log P with a 1 MHz measurement bandwidth
- Limit AWS-3 TDD device transmissions to 23 dBm EIRP below 2170 MHz

As for AWS-2, ICO requests that the 1995-2000 MHz portion of H Block be used for mobile transmit instead of mobile receive, as proposed in the alternate FDD band plan submitted in the 07-195 and 04-356 dockets. However, in the event that the upper H Block is used for base station transmit, ICO requests protection for the satellite receiver and ATC base station receivers through the following regulatory measures:

- Establish 1999-2000 MHz as guard band, preventing base station transmissions
- Limit aggregate base station EIRP per sector in 1995-1999 MHz to 32 dBW
- Set OOBE to the below levels, with a 1 MHz measurement bandwidth:
    - BTS-BTS separation distances greater than 1.5 km: OOBE of 70 + 10 log P at 3 MHz from the channel edge
    - BTS-BTS separation less than 1.5 km: OOBE of 70 + 10 log P – 20 log (Dkm/1.5) at 3 MHz from the channel edge
    - When co-located, limit the undesired signal level at the ATC base station receiver to no more than -114 dBm/MHz

2. Interference Mechanisms

In order to gain a complete understanding of the interference presented to 2 GHz MSS/ATC by the FNPRM proposed rules for AWS-2 and AWS-3, we must first review the main interference mechanisms

encountered when a transition boundary occurs from mobile transmit to base transmit. Interference at a transition boundary may consist of three mechanisms: receiver overload, OOBE, and intermodulation interference.

2.1 Receiver Overload

Receiver overload occurs when a strong signal in an adjacent frequency band appears at the receiver of a victim base station or device, with sufficient amplitude to disrupt communications. Victim receiver filtering provides attenuation of strong neighboring signals, but the level of attenuation provided is a function of the frequency separation between the desired and the interfering signals. Frequencies close to the desired signal undergo very little attenuation. Frequency spacing is essential to provide the filter with sufficient room to roll off and attenuate interfering signals. The amount of frequency separation required to adequately protect the receiver depends on the filter response curve and the receiver design, which dictates the receiver blocking level. The receiver blocking level defines the acceptable interfering signal strength as a function of frequency separation from the edge of the receive band. When the receiver characteristics are known, then we may calculate the necessary frequency separation, or guard band, to protect from a given interfering signal.

Interfering signals that exceed the receiver blocking level will cause receiver de-sensitization, impacting coverage, causing dropped calls, and increasing data error rates.

Mitigation measures include distance separation to achieve isolation, where possible; reductions in the offending transmitter power, and establishment of guard band to provide a minimum level of protection.

2.2 Out-of-band Emissions

The second interference mechanism is out-of-band emissions. The transmitter places most of the energy within the desired transmission bandwidth, but a significant amount of energy is transmitted in the neighboring frequencies, and is attenuated by signal roll-off characteristics and transmitter filtering. Interference from OOBE is received within the desired channel and cannot be filtered out by the receiver. Therefore, the interfering device must contain sufficient transmit filtering to ensure the emissions level into the victim receiver's pass band is well below the noise floor when the interfering mobile is within a few meters of the victim terminal. Higher emissions will elevate the noise floor, reducing call quality or disrupting reception altogether. The regulatory approach to protect from OOBE is specification of a conducted power level at the edge of the victim receive band, providing flexibility for the interferer to mitigate the interference through either transmit power reduction, more stringent transmit filtering, guard band, or a combination of the three measures.

2.3 Intermodulation Interference

Intermodulation interference occurs when two or more transmit signals mix and create products on new frequencies. For example, transmit frequencies x and y may mix and create the following third order

intermodulation products: 2x+y, 2x-y, 2y+x, 2y-x. If these intermodulation products are strong enough and fall on a desired receive frequency, then the resulting interference will disrupt communications.

It is worth noting that the mobile transmit block from 1915-1920 MHz elicited significant opposition and comment in the H Block proceeding given concerns of intermodulation interference to the PCS B Block devices, and the potential for receiver overload and out-of-band emissions (OOBE) interference to PCS devices. While receiver overload and OOBE are common concerns at the transition boundary from mobile transmit to base transmit, the intermodulation issue is unique to the PCS H Block given the frequency spacing of the B Block device transmit and receive, and the location of the H Block transmissions. As an example, the B Block transmit frequency of 1879 MHz would mix with the H Block transmit frequency of 1919 MHz as 2y-x, yielding a third order intermodulation product on 1959 MHz, the corresponding B Block receive frequency. An H Block device transmitting near a B Block device operating in full duplex mode would generate third-order intermodulation interference on the B Block receive frequency. Full use of the 1915-1920 MHz block is problematic given the duplexer attenuation of the existing PCS devices; H Block transmissions near 1920 MHz undergo less filtering attenuation than frequencies close to 1915 MHz. Transmitting over the entire 1915-1920 MHz block increases the magnitude of the intermodulation interference presented to the B Block receiver.

To adequately protect incumbent licensees from intermodulation interference, FCC regulations may need to include power limitations or frequency restrictions – limiting H Block transmissions to a portion of the 1915-1920 MHz block would greatly reduce the magnitude of the intermodulation interference.

The AWS-3 and AWS-2 interference scenarios impacting MSS/ATC user equipment are explored in more detail in sections 3 and 4.

3. AWS-3 Interference to MSS/ATC Terminals

Permitting TDD operation in AWS-3 will cause mobile-to-mobile interference to ICO's MSS/ATC devices if not properly contained. The causes of mobile-mobile interference include both receiver overload and OOBE. ICO's previous filings requested regulatory protection in the form of mobile transmitter power limitations, guard band, and OOBE restrictions. The engineering analyses supporting ICO's requests are provided below.

3.1 MSS/ATC Receiver Overload

ICO's devices are designed with a sensitive front-end receive chain to maximize reception from the geostationary satellite. When compared with a typical terrestrial handset as shown in figure 2, the architectural differences are clear – the front-end LNA is of higher gain, and a second cascaded LNA is included in the user terminal to lower the overall noise figure. The resulting device is highly sensitive in order to effectively receive the satellite communications signal. Similarly, filter insertion loss must be minimized to maintain satellite coverage, limiting the device's ability to attenuate strong interfering signals. Thus, the device is susceptible to strong signals in neighboring bands – approximately 30 dB more sensitive in terms of receiver blocking level than PCS/cellular handsets.

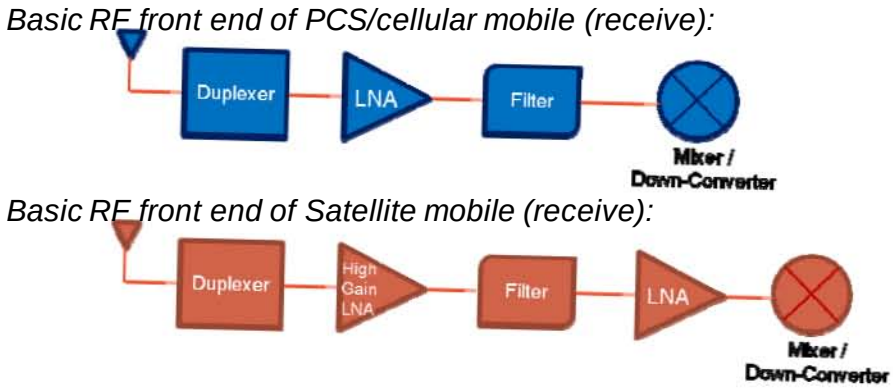

Figure 2: Comparison of Satellite and PCS/Cellular Architecture

Although ICO user terminals will be sensitive to base station transmissions from other ATC and AWS operators, this situation will be similar to the classic near-far interference scenario, and will be mitigated in similar fashion – near-location of base stations where possible, and overall a limited number of interference cases to manage given the relatively limited number of base stations deployed within a city.

AWS-3 TDD device transmissions, however, will occur on the order of millions of devices, will not be restricted to defined locations, and cannot be managed through coordination. The FNPRM proposed 23 dBm as the TDD device EIRP for AWS-3. To prevent receiver overload to MSS/ATC devices, a guard band must also be specified. The minimum guard band may be calculated by assessing the additional attenuation needed to reduce the interfering TDD signal to below the receiver blocking level, when the AWS-3 device is transmitting within a few meters of the satellite terminal. Mobile-to-mobile interference is probabilistic, requiring the occurrence of a strong transmission at the same time that a nearby device is receiving a weak signal. By limiting device transmit powers to levels such that interference will only occur when the two devices are within a few meters of each other, the low probability of occurrence mitigates the overall impact to the victim operator's subscriber base.

First, we calculated the amount of isolation provided as a function of distance separation between the two devices. The isolation calculation used the free space path loss (FSPL) formula:

$$FSPL = 32.44 + 20 \log f + 20 \log d, \text{ where f is frequency in MHz and d is distance in km}$$

Solving the frequency term for 2170 MHz yields $FSPL = 99.2 + 20 \log d$.

The amount of isolation provided by FSPL as a function of distance is shown in table 1 below:

Distance (m)	Isolation (dB)
1	39
3	49
5	53
10	59
25	67
50	73
75	77
100	79

Table 1: Isolation versus Distance using FSPL

While ICO devices are not designed to specifically accommodate mobile usage in the AWS-3 band, preliminary research indicates that receiver filtering necessary for MSS communications could achieve a blocking level of -56 dBm with modified filtering. This blocking level is worse than that of PCS or AWS-1 devices, given the more sensitive receiver design to maximize satellite coverage. As a result, the AWS-3 interference to ICO's user terminals will be much more severe than that experienced by the PCS devices from the H Block, and more severe than the interference AWS-1 devices will experience from AWS-3. Moreover, PCS/cellular networks have been built with many base stations such that a device will rarely be operating at the minimum receiver sensitivity, significantly lowering the probability of interference to such systems. In contrast, the MSS/ATC devices will need to communicate with the satellite wherever the satellite signal is available; this greatly increases the percentage of time that such a device will be receiving at its minimum sensitivity level when an AWS-3 device is transmitting near maximum power. Without adequate regulatory protection, AWS-3 TDD transmissions will regularly cause interference to MSS/ATC devices. A robust guard band is essential to protect the 2 GHz satellite communications.

The guard band calculation is shown in Table 2 below. The delta between the device transmit power of 23 dBm and the MSS/ATC receiver blocking level of -56 dBm demonstrates a need for 79 dB of isolation. Assuming 3 meters of separation and applying the free space path loss formula yields 49 dB of attenuation. The amount of additional loss varies with the situation and includes effects of antenna performance, body loss, and other obstructions between the transmitter and receiver. We have used 9 dB to represent considerable additional loss, consisting of 1.5 dBi antenna gain per device and 6 dB of hand, body, or other obstruction loss applied to both the transmitting and receiving devices (1.5+1.5–6–6 = -9 dB). The amount of attenuation that the receiver filter must provide is calculated as 21 dB. From typical filter response curves for mobile devices such as those filed in the record by Agilent Technologies, the minimum guard band to protect MSS/ATC devices from AWS-3 transmissions is 10 MHz.

AWS-3 Device Tx Level:	23	dBm	a: From FNPRM
MSS/ATC Receiver Blocking Level:	-56	dBm	b: level at 2170 MHz
Isolation Required:	79		c=a-b
Isolation from 3 m Separation:	49	dB	d: from FSPL formula
Additional Losses:	9	dB	e
Filtering Attenuation Required:	21	dB	f=c-d-e
Minimum Guard Band:	**10**	**MHz**	g: from filter rolloff

Table 2: AWS-3 Guard Band from 2180 MHz

Therefore, to provide adequate protection of MSS/ATC device reception, 2170-2180 MHz must be allocated as downlink only operation.

3.2 MSS/ATC Device Noise Rise

Energy from OOBE is received within the desired channel and cannot be filtered out by the receiver. Therefore, the interfering device must contain sufficient transmitter filtering to ensure the emissions level into ICO's receive band will not significantly elevate the noise floor when the interferer and victim devices are in close proximity. If transmitter filtering is insufficient, then the higher emissions will elevate the noise floor, increasing bit error rates and disrupting reception from the satellite or ATC base station.

The appropriate OOBE limit is derived from the receiver sensitivity of the victim terminal and the isolation resulting from the minimum separation distance. ICO's satellite system is capable of supporting a range of advanced technologies, with the flexibility to adapt to meet consumer demand and business needs. A common two-way data and voice protocol optimized for satellite communications is GEO-Mobile Radio, or GMR. ICO will be assessing this technology this year in upcoming trials in Las Vegas and Raleigh-Durham. The calculations deriving the OOBE limit based on GMR are provided in Table 3 below.

Thermal noise:	-174	dBm/Hz	a=10*log(1.38*10^-23)+10*log(290)+30
Noise bandwidth:	156.25	kHz	b=GMR carrier bandwidth
Noise power:	-122.0	dBm/156.25 kHz	c=a+10*log(b*1000)
Receiver noise figure:	1.9	dB	d
Receiver noise floor:	-120.1	dBm	e=c+d
Interference degradation limit:	1	dB	f=acceptable noise rise
Maximum interfering signal:	-126.0	dBm	g=(e+f)lin - e lin
Isolation from 3 m separation:	49	dB	h=free space path loss in 3 m
Additional losses:	9	dB	i
OOBE Power at 2180 MHz:	-59.9	dBm/MHz	j=g+h+i+10*log(1000/156.25)

Table 3: OOBE Power Level at 2180 MHz

Thus, the OOBE power level must fall below -60 dBm/MHz. This power level is translated to an OOBE limit by determining the additional attenuation below the FNPRM-recommended level of -13 dBm/MHz.

An additional 47 dB of attenuation is required (60-13=47); thus, the OOBE level at 2180 MHz must be set to 90 + 10 log P.

Note that the calculation to protect other MSS/ATC technologies will result in the same OOBE level when normalized for a 1 MHz bandwidth since the main driver is the device receiver noise figure, a constant given the MSS/ATC device receiver design. Differences in victim receive bandwidth are normalized by the specification of OOBE within a 1 MHz guard band. Therefore, 90 + 10 log P will be the appropriate protection level regardless of the MSS/ATC technology deployed.

The device noise figure is calculated from the gains and losses of each component in the receive system and cascading the result to the antenna port. A sample calculation for cascaded noise figure is provided in table 4:

	Gain (dB)	NF (dB)	Gain (linear)	NF (linear)
Cascaded to Input		**1.9**		1.54
Duplexer	-1.5	1.5	0.71	1.41
LNA 1	16	1.6	39.81	1.45
Filter	-3	3	0.50	2.00
LNA 2	12	2	15.85	1.58
IF/Baseband	-10	10	0.1	10

Table 4: Sample Cascaded Noise Figure Calculation

Table 4 employs the below formula to calculate the system noise figure in the linear scale:

$$\text{System noise figure } nf_s = nf_1 + (nf_2-1)/(g_1) + (nf_3-1)/(g_1*g_2) + (nf_4-1)/(g_1*g_2*g_3) + \ldots$$

where nf_1 = noise figure of the first stage, g_1 = gain of the first stage, etc.

The above analysis demonstrates the necessity for an OOBE level of 90 + 10 log P to protect MSS/ATC device reception. Recall that the analysis allowed 3 meters of separation and 9 dB of additional losses, increasing the device separation criteria at which interference would occur. Combined with the regularity of MSS/ATC operation at the minimum receive sensitivity level given the satellite component, the requested level is essential to protect the integrity of MSS/ATC device operation.

4. AWS-2 Interference to ATC Base Stations

In the FNPRM, the proposed AWS-2 H Block base station transmissions are immediately adjacent to the MSS/ATC base station receive band. H Block emission levels above 2000 MHz must be controlled to prevent noise rise at the ATC base station receiver. The extent of necessary protection depends on several factors: the distance between the base stations, antenna orientation, antenna gain, cable loss, and sensitivity of the ATC base station receiver.

The extent of the interference presented to an ATC base station receiver is calculated in Table 5 below, along with the derived recommendation of BRS-like rules for the H Block base station OOBE limit. Rows a through g calculate the interfering signal strength corresponding to a 1 dB noise rise at the victim

ATC base station receiver. Rows h through m calculate the resulting OOBE interference at the ATC receiver from an H Block base station complying with the FNPRM-recommended OOBE limit of 43 + 10 log P. The minimum separation distance in row o demonstrates the considerable distance at which an H Block base station would cause interference to an ATC base station if the antennas were in a line-of-sight condition – 37 km, a distance that is impossible to coordinate in a deployment. Row p calculates the additional attenuation required to reduce the interference radius to 1.5 km. And finally, in row q, the OOBE limit corresponding to a separation distance of 1.5 km is demonstrated to be 70 + 10 log P. This represents the minimum OOBE attenuation that should be regulated for the H Block to prevent interference to ATC base stations. For H Block base stations installed with separation distances of less than 1.5 km from ATC base stations, additional attenuation is required, as indicated by the distance formula in the EBS/BRS rules. ICO requests similar consideration for the H Block to protect ATC base station receivers.

ATC BTS Receiver	Thermal noise:	-174	dBm/Hz	a=10*log(1.38*10^-23)+10*log(290)+30
	Noise bandwidth:	3.84	MHz	b=UMTS carrier bandwidth
	Noise power:	-108	dBm/3.84 MHz	c=a+10*log(b*1000)
	Receiver noise figure:	5.0	dB	d
	Receiver noise floor:	-103.1	dBm	e=c+d
	Interference degradation limit:	1	dB	f=acceptable BTS noise rise
	Max interfering signal at receiver:	-109.0	dBm/3.84 MHz	$g=(e+f)_{lin} - e_{lin}$
H Block BTS Interferer	OOBE of 43 + 10 log P:	-13	dBm/MHz	h=FNPRM proposal
	H Block BTS cable loss:	3	dB	i
	H Block BTS antenna gain:	17	dBi	j
	ATC BTS antenna gain:	17	dBi	k
	ATC BTS cable loss:	3	dB	l
	H Block interference at ATC receiver:	15	dBm	m=h-i+j+k-l
Isolation Calculations	Required Over-air Isolation:	129.8	dB/MHz	n=m-g+10*log(3.84)
	Minimum Separation Distance:	37	km	o (using Free Space Path Loss)
	Isolation for 1.5 km Separation:	28	dB	p (using FSPL)
	OOBE Limit at 1.5 km separation:	**70.8**	dB/MHz	q=43+p

Table 5: H Block OOBE Calculation

5. AWS-2 Interference to the MSS Satellite Receiver

ICO's G1 satellite is in orbit and undergoing system testing. As required by the Commission, the satellite has been designed to receive across the entire 20 MHz MSS allocation of 2000-2020 MHz. Consequently, the satellite receiver filter will not be able to reject energy from the upper portion of the H Block allocation. H Block base station transmit power within 1998.5-2000 MHz will be received by the satellite and treated as in-band energy within the 2000-2020 MHz receive band. The satellite receiver translates this energy to the Ka band feeder link for transmission to the earth station, along with the desired signals from MSS user terminals. Given the high power level transmitted by the H Block base stations, a relatively small number of base stations contribute a disruptive level of interference to the satellite. This energy raises the noise floor at the satellite, causing the feeder link power amplifier to lower its gain, with a resulting loss in desired signal reception of several dB. The base station energy is additive across the country – as the number of H Block base stations increases, the total power presented to the satellite receiver increases, with a corresponding increase in the noise rise at the satellite.

ICO performed simulations to determine the resulting power flux densities at the satellite from a nationwide deployment of H Block base stations with power levels consistent with the FNPRM recommendation. The simulations accounted for sector antenna directionality, reduced antenna gain in the direction of the satellite, and line-of-sight to the satellite since the majority of base station antenna platforms are installed above local clutter. The satellite performance parameters are proprietary and ITAR controlled, and may not be disclosed in a public forum, but a relative comparison of the magnitude of base station power to mobile transmit power demonstrates the significant degradation that would be experienced, as shown in tables 6, 7 and 8.

Sector EIRP (main beam):	32	dBW/MHz
Antenna gain reduction in satellite elevation:	-20	dB
Sector EIRP (satellite elevation angle):	12	dBW/MHz
# sectors/site toward satellite:	1	
Sector EIRP in 5 MHz to sat:	19	dBW/5 MHz
Total sites nationwide:	20,000	
Spreading loss:	162.91	dB
Clutter loss:	0	dB
Power flux density at satellite antenna:	**-100.9**	**dBW/m^2**

Table 6: H Block Base Station Interference with FNPRM Rules

Sector EIRP (main beam):	32	dBW/sector
Antenna gain reduction in satellite elevation:	-20	dB
Sector EIRP (satellite elevation angle):	12	dBW/sector
# sectors/site toward satellite:	1	
Total sites nationwide:	20,000	
Spreading loss:	162.91	dB
Clutter loss:	0	dB
Power flux density at satellite antenna:	**-107.9**	**dBW/m^2**

Table 7: H Block Base Station Interference with Power Limits

Device transmit power maximum:	0.2	W
Average level of Tx power control:	-10	dB
Average device EIRP:	-17	dBW
# of nationwide subscribers:	20,000,000	
% of subscribers transmitting simultaneously:	15%	
Spreading loss:	162.91	dB
Clutter loss:	10	dB
Power flux density at satellite antenna:	**-125.1**	**dBW/m^2**

Table 8: Mobile Transmit Analysis

Table 6 demonstrates the considerable interference presented by the FNPRM recommendation, with a power flux density of -100.9 dBW/m^2 at the satellite antenna. Adopting ICO's requested H Block transmit limitations lowers this signal level by 7 dB, as shown in Table 7. Equally important, the 1 MHz guard band provides room for the satellite filter to further attenuate the interference, effectively reducing the power flux density by a further 10+ dB relative to the Table 6 scenario.

In Table 8, allocating 1995-2000 MHz for mobile transmit would reduce the interference level by 24 dB relative to the FNPRM approach.

The parameters included in Table 8 are relatively high values for a commercial wireless system. For instance, device power control generally delivers an average transmit power of 0 dBm, significantly below the 10 dB reduction shown. Similarly, 15% of a customer base actively transmitting at any instant of time is on the high side, with typical numbers being well less than 10%. The device clutter loss of 10 dB is consistent with the loss that would be seen from in-vehicle operation, light suburban building loss, or transmission behind an obstruction such as terrain or foliage.

The analysis presented in Table 8 is also demonstrative of the relatively minor impact that millions of ATC devices have on satellite reception. The additive power of terrestrial mobile transmissions is of such a low magnitude that satellite operation within the band is not affected.

Clearly, the placement of a terrestrial base station transmit allocation directly adjacent to a satellite receive allocation is a significant concern. If the spectrum in 1995-2000 MHz were used for mobile transmit, the significantly lower power level of devices combined with the benefits of transmit power control and clutter losses would reduce the H block power levels to well below the satellite noise floor.

If the 1995-2000 MHz block is used for base station transmit, then a 1 MHz minimum guard band must be established from 1999-2000 MHz restricting transmissions to reduce the interference seen by the satellite receiver. Furthermore, overall sector EIRP must be limited to a total of 32 dBW from 1995-1999 MHz to control the total noise rise presented to the satellite receiver.

6. Conclusions

While ICO supports the most flexible use of the AWS-3 band, certain restrictions must be placed on device power levels, frequencies of operation, and OOBE to protect MSS/ATC user terminal operation. Setting OOBE limits higher than shown by ICO's engineering analyses, or permitting AWS-3 device transmissions closer than 2170 MHz, will cause severe interference to the MSS/ATC terminals. In summary, ICO's studies have shown a need for the following regulatory provisions:

- Maintain 2175-2180 MHz as the J Block downlink to provide mobile-mobile guard band
- If TDD operation is allowed within 2155-2175 MHz, then establish 2170-2175 MHz as downlink only operation, restricting device transmission to provide a total of 10 MHz mobile-mobile guard band
- Set OOBE attenuation at 2180 MHz to 90 + 10 log P with a 1 MHz measurement bandwidth
- Limit AWS-3 TDD device transmissions to 23 dBm EIRP below 2170 MHz

As for AWS-2, the FNPRM-proposed use of 1995-2000 MHz for base station transmission will cause a significant reduction in satellite and ATC base station performance. ICO recommends adoption of the alternate FDD band plan which would establish 1997-2000 MHz as mobile transmit only, eliminating the interference concerns to the 2 GHz MSS/ATC satellite/base station receive band.

AWS-2 and AWS-3 Interference to 2 GHz MSS/ATC

If the alternate FDD band plan is not adopted, then the following regulations should be established to protect 2 GHz MSS/ATC operation from H Block base station interference:

- Dedicate 1999-2000 MHz as guard band, restricting base station transmissions, to protect 2 GHz MSS satellite reception
- Limit aggregate base station EIRP per sector in 1995-1999 MHz to 32 dBW
- Set OOBE attenuation to the below levels, with a 1 MHz measurement bandwidth:
    - BTS-BTS separation distances greater than 1.5 km: OOBE of 70 + 10 log P at 3 MHz from the channel edge
    - BTS-BTS separation less than 1.5 km: OOBE of 70 + 10 log P – 20 log (Dkm/1.5) at 3 MHz from the channel edge
    - When co-located, limit the undesired signal level at the ATC base station receiver to no more than -114 dBm/MHz

Success in the nascent 2 GHz MSS market hinges on the Commission ensuring adequate protection for MSS/ATC base station, satellite, and user terminal receivers. ICO continues to support the innovative and flexible use of spectrum, but seeks certain minimum protection levels to ensure that asymmetric interference situations will not prove harmful to MSS/ATC operation.

Exhibit B

wireless strategy

July 3, 2008

By Electronic Filing

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band, WT Docket No. 07-195 and Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and the 2175-2180 MHz Bands, WT Docket No. 04-356

Dear Ms. Dortch:

Wireless Strategy, LLC provides business and technology consulting services to wireless operators and vendors. We have years of experience in designing, deploying, and operating wireless networks, and have held executive positions with tier-1 wireless operators in the areas of technology research and development.

We have recently supported ICO in filings with the Commission and have evaluated the FNPRM-proposed band plan for the AWS-2 and AWS-3 spectrum.

After thorough review of studies and measurements filed by neighboring licensees, we have developed a revised band plan that resolves the majority of the interference issues, delivers higher spectral efficiency to licensees, and establishes two paired blocks of spectrum that may be auctioned to foster wireless broadband competition.

Under our proposal, the Commission's goals of supporting a free family friendly wireless broadband network would be enhanced through greater capacity and lower cost of ownership relative to the FNPRM approach.

Furthermore, through the availability of two new blocks of paired spectrum, each capable of supporting a new wireless entrant, our proposal should deliver greater auction revenue than the FNPRM proposal.

We respectfully submit this proposal for consideration by the Commission.

Douglas A. Hyslop
Partner
Wireless Strategy, LLC

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McLean, VA 22101

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wireless strategy

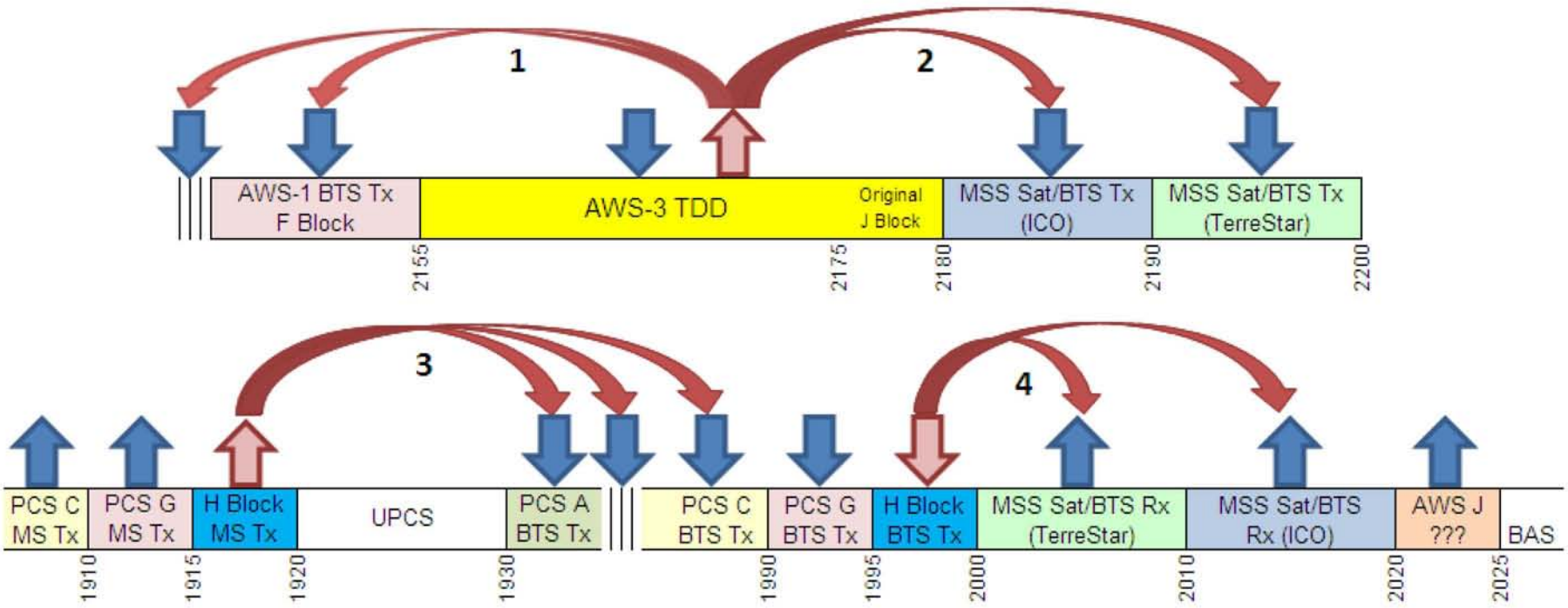
the business of wireless technology

Affordable Family Friendly Broadband
Alternate FDD Proposal

July 3, 2008

FNPRM Band Plan

- The June 20, 2008 FNPRM seeks comment on proposed rules for the AWS-2 and AWS-3 blocks (H Block, J Block, and AWS-3)
- In previous filings, licensees documented the likelihood and extent of interference from the proposal
- Red arrows denote interference from AWS-3 and H Block, totaling four interference boundaries:



Interference Concerns with FNPRM Plan

- AWS-3 TDD interference concerns:
  - AWS-3 device transmit will cause brute force overload and OOBE interference to the AWS-1 and MSS/ATC device receivers (boundaries 1 and 2)
  - Stringent filtering, guard bands, EIRP and OOBE limits are required to mitigate the interference
  - Such measures reduce spectral efficiency and increase deployment cost for all operators through greater filter insertion loss (AWS-1, AWS-3 and MSS/ATC)
- H Block interference concerns:
  - Intermodulation interference to the PCS B block devices will occur if the entire 1915-1920 MHz block is used for mobile device transmission (boundary 3)
    - In 2005, carriers described intermodulation as the primary interference concern, yet the FNPRM proposes full use of the block
  - H Block device power levels and OOBE should be controlled to reduce probability of receiver overload and noise rise (boundary 3)
  - H Block base station transmissions will interfere with MSS satellites and ATC base station receivers in the 2000-2020 MHz blocks (boundary 4)

Family Friendly Broadband is at Risk

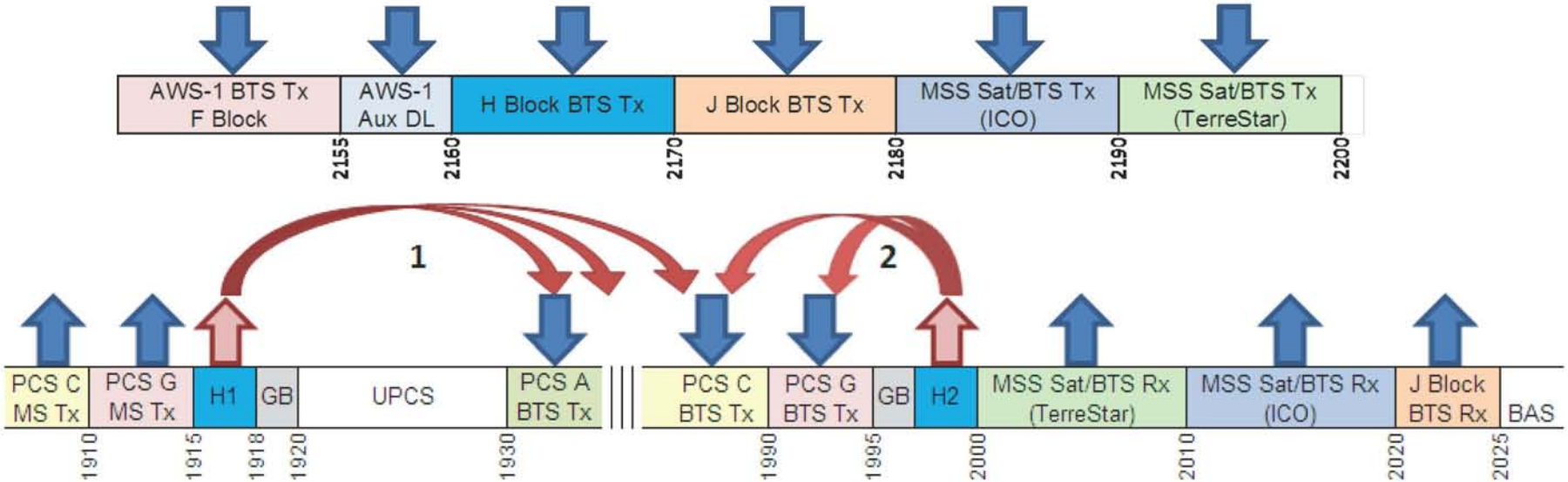
- Global economies of scale will not materialize
  - United States allocation of 2155-2175 MHz for TDD will be the only allocation globally
  - TDD base stations must be specially designed for one operator in one country
  - Devices similarly will be unique for this one customer
  - Lack of scale will drive up cost of devices and network equipment
- Free Family Friendly Wireless Broadband will be Expensive!

Alternate FDD Proposal

- An Alternate FDD band plan will deliver the following benefits:
  - Provide spectrum for two new wireless entrants, one of which may offer free wireless broadband
  - Lower the cost of deploying free family friendly broadband
  - Eliminate AWS-1 and MSS/ATC interference concerns related to the AWS-2 and AWS-3 bands
  - Mitigate interference to PCS mobiles from the H Block
  - Restore harmony with AWS-3 international spectrum allocations

Alternate FDD Proposal

- Pairing the 2155-2180 MHz spectrum with other blocks eliminates AWS-3 interference to the neighboring licensees:



- Alternate FDD plan produces paired spectrum:
  - J Block is expanded to 10 MHz downlink and paired with the existing 5 MHz uplink (2020-2025 MHz)
  - H Block downlink is moved to 2160-2170 MHz and paired with two 3 MHz blocks (H1: 1915-1918 MHz and H2: 1997-2000 MHz)
  - 2155-2160 MHz becomes unpaired auxiliary downlink
  - Appropriate measures may be applied to H1 and H2 to avoid interference to PCS mobiles
- Interference is reduced from four boundaries to two, with guard band to protect PCS

Greater Capacity

- Of the 40 MHz, the FNPRM proposal delivers no more than 25 MHz of usable capacity
  - AWS-3 size increases to 25 MHz for TDD
    - With an implied guard band requirement of 5 MHz per edge, this negates a minimum of 10 MHz
    - Yields 15 MHz of usable capacity
  - H Block 5+5 MHz provides 10 MHz, realistically less depending on interference protection measures
  - J Block lower half is stranded with no clear use, 5 MHz of unused spectrum
- Alternative FDD increases the usable spectrum to 36 MHz
  - AWS Auxiliary Downlink of 5 MHz
  - New 10+5 MHz J Block is 15 MHz
  - New 10+3+3 MHz H Block provides 16 MHz
  - H1 and H2 guard bands of 2 MHz each are not used, 4 MHz
- The Alternative FDD proposal provides 11 MHz more capacity than the FNPRM approach

Performance Comparison

	Parameter	FNPRM Approach		Alternate FDD		
	Band	AWS-3	H Block	New H Block	New J Block	Aux. Downlink
	Structure	TDD	FDD	FDD	FDD	Unpaired DL
	Total Spectrum (MHz)	25	10	20	15	5
Downlink Analysis	Guard Band (MHz)	10*	0**	0	0	0
	Usable Spectrum (MHz)	15	5	10	10	5
	Time Division Duplexing	60%	100%	100%	100%	100%
	bps/Hz	1.4	1.4	1.4	1.4	1.4
	Capacity (Mbps)	12.6	7	14	14	7
	Total DL Capacity (Mbps)	19.6		35		
Uplink Analysis	Guard Band (MHz)	10	0	4	0	0
	Usable Spectrum (MHz)	15	5	6	5	0
	Time Division Duplexing	40%	100%	100%	100%	100%
	bps/Hz	0.8	0.8	0.8	0.8	0.8
	Capacity (Mbps)	4.8	4	4.8	4	0
	Total UL Capacity (Mbps)	8.8		8.8		

- Alternate FDD delivers greater capacity than the FNPRM approach
  - Compare new H Block to FNPRM AWS-3 numbers in Blue
  - Greater downlink capacity (14 versus 12.6 Mbps) and equivalent uplink capacity (4.8 Mbps)
- Peak downlink rates in the new H Block will be greater than FNPRM TDD rates
  - New H Block: 10 MHz downlink channel active for 100% of the time
  - FNPRM TDD: 15 MHz downlink active for typically 60% of the time (approx. 9 MHz equivalent)
- Commission should apply the family friendly broadband requirements to the new H Block to deliver similar capacity performance

*Assumes 5 MHz guard band per side to meet the FNPRM OOBE and filtering requirements, proceeding comments indicate larger guard bands may be required

**Old H Block calculation is optimistic, guard band may be required to mitigate neighboring licensees' interference concerns

New J Block Technology Approach

- 4G OFDMA technologies are well positioned to support asymmetrical FDD operation
  - Flexible channel bandwidths - for example, 3GPP LTE standard supports 1.4, 3, 5, 10, 15 and 20 MHz channels
  - LTE could be modified to include support for different uplink and downlink channel bandwidths
- New J Block could use a 10 MHz downlink channel and a 5 MHz uplink channel
- Wireless broadband services typically require 3X to 5X more downlink capacity than uplink
  - E-mail, file transfers, video streaming and web browsing are highly asymmetrical, consuming 5X to 10X more downlink capacity
  - Gaming, VoIP, and video telephony are more evenly balanced, as are peer-to-peer communications
- Dedicating more spectrum for downlink than uplink provides balanced capacity for the FDD wireless broadband system

New H Block Technology Approach

- The segregated uplink is an unusual configuration but is conducive to multiple technologies. For example, with an LTE deployment:
  - New H Block could use a 10 MHz downlink LTE channel paired with two 3 MHz uplink channels (additional standards work required)
  - Devices would transmit in either H1 or H2 at a given time
  - The H1 and H2 blocks would behave as Auxiliary Uplink, the mirror image of Auxiliary Downlink
- The Family Friendly Wireless Broadband licensee could reduce device cost by constraining H1 or H2 band support:
  - Free broadband service is capped at 25% of system capacity, so the free devices may be designed to transmit in only the H1 block, using half of the capacity in that block
  - Lower-tier paying devices may be designed to transmit in only the H2 block
  - Higher-tier paying devices may be designed to transmit in either of H1 or H2, maximizing the available capacity within a base station
- The segregated uplink will provide RACH channel congestion protection
  - In a sector with one RF carrier, a large number of free customers may create congestion on the random access channel, preventing paying customers from accessing the system
  - The dual-uplink blocks would enable dual RACH access to the system, preventing RACH overload
- Designating the new H Block for family friendly wireless broadband will foster new broadband competition and minimize its deployment cost through reduced filtering and greater capacity relative to the FNPRM TDD approach

Affordable Family Friendly Broadband

- The New H Block operator may leverage PCS and AWS scale
  - H1 devices may use frequency-shifted PCS transmitters and filters, and AWS international allocation receivers
  - H2 devices may use MSS/ATC frequency-shifted transmitters, and AWS international allocation receivers
  - New H base stations will be harmonized with AWS-1 and may use AWS-1 base station transmitters, power amplifiers, and filters
  - New H base station receivers would be slightly modified PCS and MSS/ATC receivers to cover H1 and H2
- Leveraging PCS/AWS economies of scale will greatly reduce network deployment cost
- Device cost will be significantly lower than a standalone TDD technology, an essential requirement to delivering free family friendly wireless broadband

Summary

- Alternate FDD provides greater spectral efficiency with less interference than the FNPRM proposal
- New H and J blocks may each support a new wireless broadband entrant
  - H is well suited for family friendly wireless broadband
  - J may support a new competitive entrant or provide capacity expansion for a smaller existing company
- The 5 MHz block of auxiliary downlink spectrum will provide additional capacity to foster broadband deployment
- Cost to deploy AWS-1, AWS-3 and MSS ATC systems will be lower
- The US spectrum in 2155-2180 MHz will match International allocations of base station transmit, facilitating economies of scale