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
	)	

COMMENTS OF ARRAYCOMM LLC

ArrayComm LLC (hereinafter ArrayComm) hereby submits comments in response to the Notice of Proposed Rulemaking (hereinafter Notice) in the captioned proceeding[1] which proposes service rules for Advanced Wireless Services in the 2155-2175 MHz band ("AWS-3"). ArrayComm is the world leader in multi-antenna signal processing (hereinafter MAS) software for wireless systems. ArrayComm's A-MAS™ software improves network economics and user experiences through gains in coverage, client data rates, and capacity for all wireless communications protocols, in base station, client device, or MIMO architectures. A-MAS implementations include W-CDMA, HSDPA, WiMAX, PHS, GSM, and HC-SDMA networks and are operating in many commercial deployments today for some of these protocols.

As demand for wireless broadband services continues to increase, wireless service providers will need additional spectrum to offer next generation services. The auctioning of the AWS-3 band will provide the wireless industry some of the additional spectrum it needs to provide consumers with exciting high-speed data services, including Internet access, gaming, and location-based services. Therefore, ArrayComm is pleased the Commission has initiated this rulemaking to establish service rules for the AWS-3 band.

[1] *Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band*, WT Docket No. 07-195, *Notice of Proposed Rulemaking*, FCC 07-164 (rel. Sept. 19, 2007).

I. INTRODUCTION

Over the past seven years, the Commission has adopted various Reports and Orders that made certain spectrum available for advanced wireless services ("AWS"), including Third Generation ("3G") systems. In Docket No. 02-353, the Commission made available the 1.7 GHz and 2.1 GHz bands and adopted service rules for those bands (AWS-1). In other dockets, the Commission made additional spectrum available for AWS between 2020 MHz and 2180 MHz (AWS-2). Service rules were proposed for these sections of spectrum, but not for the 20 MHz at issue in this proceeding.

The 2155-2175 MHz band was the subject of the Fifth Notice of Proposed Rule Making in ET Docket No. 00-258.[2] The record on that proceeding, which includes Comments and Reply Comments by ArrayComm, focused on two possibilities: 1) make the 20 MHz available for time division duplexing (TDD) type systems, or 2) allow this spectrum to be paired with some portion of the 1710-1755 MHz band, which would have made the 20 MHz the base station part of an frequency division duplexing (FDD) allocation.

While the Commission assessed these choices, other would-be service providers submitted applications seeking licenses. Confronted with a variety of offerings that deviated to a greater or lesser degree from the aforementioned choices, the Commission elected to dismiss these applications, and, in effect, seek de novo input on the disposition of this 20 MHz of contiguous spectrum, now referred to as AWS-3. This time, this Docket sets forth three possibilities:

1) Make the 20 MHz available for base/mobile operations on the same frequency. Categorized as the "uplink/downlink approach," ArrayComm regards this as an approach that would allow TDD.

[2] 20 FCC Rcd 15866 (2005).

2) Allow both base and mobile operations in the band, but only on portions designated by the Commission, seemingly to mitigate potential interference. This is labeled the "structured uplink/downlink approach."

3) Allow only base station transmissions in the 2155-2175 MHz band, paired with mobiles from a number of already allocated AWS bands below 2155 MHz. This is labeled by the Commission as the "downlink approach" and by ArrayComm as an FDD solution.

The Commission asks for comment on a number of questions that would impact on each of the alternatives, but the key questions focus primarily on: how best to handle interference, particularly to and from adjacent AWS-1 and AWS-2 systems, and how to obtain the most efficient use of this AWS-3 spectrum. ArrayComm addresses the Commission's questions regarding spectral efficiency and interference of the three approaches offered in the Notice.

II. WHAT IS ARRAYCOMM'S INTEREST IN 2155-2175 MHz?

ArrayComm has participated in rule making proceedings since 1994, particularly those relating to the allocation of spectrum. ArrayComm's position has remained consistent even as technological innovations and improvements have emerged – to provide advice and guidance to foster the development of the most spectrally efficient wireless systems at an affordable price. MAS technology is well suited to achieve this objective.[3] The technology can be applied to any two way radio system and involves the use of two or more antennas at either end of such a system, along with signal processing that combines the antenna inputs and outputs in such a way that reception of desired signals and rejection of undesired signals are improved.

[3] Other terms used to describe MAS include "smart antennas," adaptive antennas arrays, MIMO, SDMA, spatial processing, and space-time multiplexing.

MAS technology improves spectral efficiency for both FDD and TDD.[4] More specifically, and depending on the variations of MAS that are used, MAS technology can increase capacity (i.e., the number of users served in a given area), increase data speeds delivered to these users, increase the coverage area, and/or reduce interference. These benefits can also be achieved by adding more base stations, more spectrum, or both. However, the improvements from MAS technology can be achieved at a lower cost per subscriber served and with less spectrum. In addition, adoption of MAS technology serves to reduce the infrastructure necessary to cover a given geographical area resulting in more rapid achievement of build out requirements. Recognizing these benefits, standards setting organizations have embedded MAS technology requirements in the standards of all fourth generation wireless systems.[5]

III. THE UPLINK/DOWNLINK USE APPROACH WOULD ALLOW FOR THE MOST SPECTRALLY EFFICIENT USE OF THE AWS-3 BAND

In the Notice, the Commission states that its "objective is to allow for the most effective and efficient use of the spectrum in this band, while also encouraging the development of robust wireless services."[6] The Commission seeks to achieve this goal by permitting as many types of technologies in the band as possible while "providing the necessary protections against interference."[7] ArrayComm supports this goal.

A. TDD in the AWS-3 band will promote spectral efficiency

ArrayComm has a long history of supporting efforts to maximize the efficient use of spectrum. The primary benefit of MAS technology is that it helps wireless networks operate

[4] ArrayComm's A-MAS technology is now deployed worldwide in approximately 300,000 base stations serving tens of millions of subscribers.

[5] For example, on September 26, 2005, ATIS announced its HC-SDMA radio standard for wireless broadband access (ATIS-0700004-2005). The interface, which provides wide-area broadband wireless IP data-connectivity for fixed, portable, and mobile computing devices and appliances, is designed to be implemented with smart antenna array techniques to substantially improve the radio frequency (RF) coverage, capacity, and performance for the system.

[6] *Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band*, WT Docket No. 07-195, *Notice of Proposed Rulemaking*, FCC 07-164 (rel. Sept. 19, 2007).

[7] *Id.*

more efficiently by improving reception and decreasing interference. MAS technology can be incorporated in both TDD and FDD systems. Having provided MAS software to both TDD and FDD equipment manufacturers, ArrayComm has a deep understanding of each system and how adaptive antennas can improve their efficiency.

TDD embedded with MAS technology is more spectrally efficient than FDD embedded with MAS or "plain" TDD. TDD systems utilizing the most powerful MAS techniques (i.e., those that have the greatest impact on spectral efficiency) continuously adapt to the radio environment. For example, when a user initiates a call, the base station that receives the user's signal can ascertain the location of that user. The base station can then focus the radio signal back to that user rather than broadcast the signal in all directions. Because the return path from the base station to the user is virtually identical to the path from the user to the base station, the focusing is more precise and the efficiency is improved. In FDD, the two paths are on separate frequencies and, as a result, are somewhat different. This difference reduces the effectiveness of the focusing of the signal.

Because of this, ArrayComm has encouraged utilization of TDD technology, particularly to transmit high-speed wireless data. Others in the industry have expressed past support for TDD-type technologies.[8] Combined with the deployment of MAS technology, TDD can transmit voice traffic, as well as data, in a more spectrally efficient manner than is possible with traditional systems, whether FDD or "plain" TDD.[9] ArrayComm believes that the market should

[8] On November 8, 2005, the TDD Coalition submitted reply comments to the Commission in ET Docket No. 00-025, *In the Matter of 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 Advanced Wireless Services, including Third Generation Wireless Services*. The reply comments expressed support for TDD and noted that spectrum allocations for AWS should accommodate TDD. Members of the TDD coalition included ArrayComm, Aperto Networks, BeamReach Networks, Inc., CALY Networks, Clearwire Technologies, Harris Corporation, Interdigital Communications Corp., IP Network, Raze Technologies, Inc., and Wavion, Ltd.

[9] The deployment of MAS for FDD systems will improve their efficiency in delivering wireless voice and data services and will also have a positive impact on the consumption of spectrum. However the gains in spectral efficiency are less with FDD than with TDD.

determine how the AWS-3 spectrum be used. Thus, we believe it is important that the Commission not adopt a technological approach that would prohibit TDD.

B. Both the structured uplink/downlink and downlink use approaches are less spectrally efficient than the uplink/downlink use approach

In addition to seeking comment on an uplink/downlink use approach in the AWS-3 band, the Commission also seeks comment on two alternative approaches – structured uplink/downlink use and downlink use. These alternatives are presented as ways to address concerns about potential interference in the adjacent AWS-1 and AWS-2 bands. The structured uplink-down link use approach would allow for both mobile and base transmissions, but only in the central portion of the band. The outer five MHz bands would be reserved exclusively for base transmissions. The downlink use approach would only allow for base transmissions. Both approaches are less spectrally efficient than the uplink/downlink use approach. Interference issues are addressed in Section IV.

The structured uplink/downlink use approach is less spectrally efficient than the uplink/downlink use approach because it limits the amount of spectrum that can be used for mobile-station transmissions. Only allowing such transmissions in the middle 10 MHz of the band could result in underutilization of the spectrum. In addition, the restricting of uplink communications to the middle 10 MHz of the band might make the spectrum less attractive to new entrants who may not have additional spectrum holdings in which to operate mobile-plus-base station transmissions.

The downlink use approach is the least efficient approach presented by the Commission. This approach would also limit the flexibility of operators to adjust certain system parameters for maximum efficiency.[10]

[10] With TDD you can easily change the ration of uplink (UL) to downlink (DL) traffic. For example a typical 60% DL to 40% UL ration can be changed as traffic changes. With FDD, this ratio is fixed by the spectrum allocations.

C. Allowing TDD in the AWS-3 band would provide more flexibility to deal with asymmetrical data transmissions

Wireless broadband systems will feature data transmissions that are asymmetrical in nature. These data services will emanate from both base and mobile stations. For example, a warehouse or factory using a commercial application to download inventory reports would primarily use downlink transmissions. Public safety applications, on the other hand, may primarily use uplink transmissions to send data such as videos from burning buildings or from police cars seeking identification confirmation. While commercial and public safety applications will have usages that are base and mobile oriented, most of these communications will be asymmetrical and the degree of asymmetry is rarely known at the time spectrum is allocated. This simply means that a preponderance of the data transmissions will come from the base rather than the mobile, or vice versa.

It is here that TDD systems have distinct advantages over FDD systems. In FDD systems, the symmetry (or rarely, if ever, the asymmetry) is specifically determined by the initial spectrum allocation and cannot be changed without a reallocation of spectrum. Thus flexibility is lacking. However, TDD systems can be designed to have the desired uplink/downlink balance without regulatory involvement. Changes can even be made after systems have been deployed. As demand for different data services proliferate, flexibility will assume greater and greater significance in increasing spectral efficiency.

IV. POTENTIAL INTERFERENCE TO ADJACENT BAND HOLDERS CAN BE MITIGATED IF UPLINK AND DOWNLINK COMMUNICATIONS OCCUR IN THE BAND

In the Notice, the Commission states its plan for achieving its goal of maximizing use of the spectrum to provide AWS is to "permit as many types of technologies in the band as possible that are consistent with our fixed and mobile allocation, and with the need to protect against

interference."[11] Because of concerns that allowing mobile transmissions in the AWS-3 band could cause potential interference to adjacent channels, the Commission offered two alternative approaches to deal with such concerns – structured uplink/down use and downlink use.

The structured uplink/downlink use approach outlined in the Notice would address interference concerns by restricting uplink transmissions to the center portion of the 20 MHz band. This solution simplifies the interference issue at the expense of sacrificing uplink throughput and overall spectral efficiency. The downlink use approach outlined in the notice would completely ban uplink transmissions in the band to eliminate mobile-to-mobile interference issues. Under this approach, only FDD and other one-way systems, such as broadcast IPTV, could use the AWS-3 spectrum.

ArrayComm believes that interference to adjacent bands can be mitigated with uplink communications allowed in the entire band. In evaluating whether uplink transmissions can be allowed anywhere in the AWS-3 band, the Commission must analyze two potential interference conditions: The first is out-of-band emissions from adjacent AWS-1 and AWS-2 base stations that could result in interference for AWS-3 base stations when they are receiving uplink transmissions. The second is that out-of band emissions by an AWS-3 mobile device will cause interference to existing AWS-1 or AWS-2 mobile devices when they are receiving downlink transmissions.

There is a legitimate concern that adjacent channel base stations could cause interference to the receipt of mobile communications by 2155-75 MHz base stations because TDD stations will receive – and transmit – both mobile and base communications on the same frequency. ArrayComm believes this problem can satisfactorily be managed. Because the transmit spectral masks of the adjacent band base stations are known or can be known, filtering technology can be

[11] *Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band*, WT Docket No. 07-195, *Notice of Proposed Rulemaking*, FCC 07-164 (rel. Sept. 19, 2007).

used in AWS-3 base stations to reduce the out-of-band interference to an appropriate level as the particular deployment dictates.

There is also a concern that an AWS-3 mobile transmission could cause interference to an adjacent channel mobile station when the latter is receiving transmissions from its own base station, thus affecting its performance. Numerous studies have shown that because of the lower transmit power of mobiles, the defined spectral mask requirements, and the increased path loss for mobile-to-mobile transmission paths, the outage percentage caused by this type of interference is extremely low.

ArrayComm encourages the Commission to examine other countries, such as Australia and South Africa, that have deployed wireless broadband networks using TDD technologies incorporating MAS. Both countries are using currently the TDD-based HC-SDMA technology and were able to reduce the size of the guard bands to nearby FDD systems and successfully coexist.[12] Clearly, technical solutions exist that will allow both uplink and downlink transmissions to occur in the AWS-3 band that do not cause interference to adjacent spectrum holders.

V. CONCLUSION

ArrayComm supports the adoption of service rules for the AWS-3 band that would promote the most efficient and effective use of the spectrum. We believe allowing both uplink and downlink transmissions in the band is the most spectrally efficient. In addition, allowing both uplink and downlink transmissions would allow for the widest use of technologies, including TDD, and would ensure that both incumbents and new entrants could bid for the spectrum. While we believe the market should decide what technologies should be deployed in the AWS-3 band, we believe TDD combined with MAS technology in unpaired spectrum would

[12] In South Africa, HC-SDMA runs in the GSM-1800 guard band (1785-1805 MHz) in the frequency range of 1787 - 1797 MHz. In effect, this reduces the 20MHz guard band to 2MHz.

provide the most spectrally efficient use of this spectrum. Also, wireless service providers in this band using MAS technology, would be able to effectively mitigate any potential interference to adjacent spectrum holders.

Respectfully submitted,

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