

**Before the  
Federal Communications Commission  
Washington, D.C. 20554**

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| In the Matter of  | ) |                      |
|   | ) |                      |
| Wireless Operations in the 3650-3700 MHz Band                                     | ) | ET Docket No. 04-151 |
|   | ) |                      |
| Rules for Wireless Broadband Services in the<br>3650-3700 MHz Band                | ) | WT Docket No. 05-96  |
|   | ) |                      |
| Additional Spectrum for Unlicensed Devices<br>Below 900 MHz and in the 3 GHz Band | ) | ET Docket No. 02-380 |
|   | ) |                      |

**MEMORANDUM OPINION AND ORDER**

**Adopted: May 22, 2007**

**Released: June 7, 2007**

**By the Commission:** Commissioner Adelstein issuing a statement.

1. By this action, we address petitions for reconsideration filed in response to the Commission's *Report and Order* in the above proceedings relating to the 3650-3700 MHz band (3650 MHz band).<sup>1</sup> In this item, we affirm our previous decisions to create a spectrum environment that will encourage multiple entrants and stimulate the expansion of broadband service to rural and under served areas. To facilitate rapid deployment in the band, we maintain the previously adopted, non-exclusive licensing scheme. Additionally, we decline to reconsider the requirement that equipment operating in the 3650 MHz band incorporate a contention-based protocol, a technology that permits multiple licensees to share spectrum by ensuring that all licensees receive reasonable opportunities to operate in the band.<sup>2</sup> In response to the record, we do, however, clarify the meaning of contention-based protocol and modify our rules to limit the operation of equipment using "restricted" contention-based protocols to the lower 25 megahertz portion of the 3650 MHz band.<sup>3</sup> We find that this clarification and modification will facilitate operation of the widest variety of broadband technologies with minimal risk of interference in both the near and long terms. They should further reduce the potential for co-channel interference, provide additional protections to the multiple users in the band under the current licensing regime, and create incentives for the rapid development of broadly compatible contention technologies. Lastly, we deny requests for reconsideration of various technical rules relating to fixed and mobile transmission power limits, out-of-band emissions, and the coordination of terrestrial operators with satellite licensees.

<sup>1</sup> See *Wireless Operations in the 3650-3700 MHz Band*, ET Docket No. 04-151, Report & Order, 20 FCC Rcd 6502 (2005) ("*3650 MHz Order*"). The parties petitioning for reconsideration were: BRN Phoenix; the Enterprise Wireless Alliance (EWA); Intel Corporation, Redline Communications and Alvarion (jointly); Motorola; Redline Communications; the Satellite Industry Association (SIA); the Wireless Communications Association (WCA); and the Wi-Max Forum.

<sup>2</sup> See *infra* n.13.

<sup>3</sup> As discussed further below, "restricted" protocols are those capable of avoiding interference only to other devices using the same protocol.

## I. BACKGROUND

2. Historically, the 3650 MHz band was exclusive Federal Government spectrum allocated on a primary basis for radiolocation services and, later, was also allocated to the non-government radiolocation service on a secondary basis.<sup>4</sup> In 1984, the Commission added a primary allocation in the 3650 MHz band for non-government Fixed Satellite Service (FSS) space-to-Earth operations, restricted by footnote to international inter-continental systems. In 1995, NTIA identified the band for transfer to mixed Federal Government and non-Federal Government use status, which provided the Commission the opportunity to consider additional, more extensive non-Federal Government uses of the band. It did so in a 1998 *Notice of Proposed Rulemaking and Order*, in which the Commission proposed to allocate the 3650 MHz band to the non-government fixed service on a primary basis and tentatively concluded not to allocate the band to land mobile service.<sup>5</sup> The Commission also ceased accepting applications for new or modified FSS earth stations in the band at that time.

3. In October 2000, the Commission released a *First Report and Order and Second Notice of Proposed Rulemaking* that allocated the 3650 MHz band to fixed and mobile (base station only) terrestrial services on a co-primary basis and that grandfathered existing FSS earth stations on a primary basis, while allowing new FSS earth stations on a secondary basis.<sup>6</sup> In addition, the Commission deleted the government radiolocation allocation, but grandfathered three existing government radiolocation sites.<sup>7</sup> As part of that action, the Commission also sought comment on licensing and service rules for fixed and mobile services, but ultimately did not directly pursue those proposals.<sup>8</sup>

4. In April 2004, the Commission released the *Unlicensed 3650 MHz Notice* and proposed to allow the operation of unlicensed devices in the 3650 MHz band.<sup>9</sup> In the *Unlicensed 3650 MHz Notice*, the Commission tentatively concluded that permitting unlicensed operation in the 3650 MHz band would foster the introduction of new and advanced services to the American public, especially in rural areas, and would result in a more efficient use of spectrum. The Commission proposed to allow unlicensed devices to operate in this band with higher power limits (up to 24 Watts EIRP) than typically allowed for Part 15 devices, and proposed requiring the use of smart/cognitive safeguards intended to avoid causing interference to licensed satellite services. The Commission also sought comment on alternative options

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<sup>4</sup> See Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band, ET Docket Nos. 04-151, 02-380 and 98-237, *Notice of Proposed Rulemaking*, 19 FCC Rcd 7545 (2004) (*Unlicensed 3650 MHz Notice*) (describing history of 3650 MHz band).

<sup>5</sup> Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, *Notice of Proposed Rule Making and Order*, 14 FCC Rcd 1295 (1998) (*3650 MHz Allocation Notice and FSS Allocation Freeze Order*).

<sup>6</sup> Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band; The 4.9 GHz Band Transferred from Federal Government Use, *First Report and Order and Second Notice of Proposed Rule Making*, ET Docket No. 98-237, WT Docket No. 00-32, 15 FCC Rcd 20,488 (2000) (*3650 MHz Allocation Order and 3650 MHz Service Rules Notice*, respectively).

<sup>7</sup> *3650 MHz Allocation Order*, 15 FCC Rcd at 20,503, ¶ 34-39. The Commission also deleted the unused government aeronautical radio-navigation service (ground-based) allocation in the band. *Id.*

<sup>8</sup> To some extent, certain proposals in the *3650 MHz Service Rules Notice* was superseded by events. For example, although the Commission sought comment on the feasibility of pairing the 3650 MHz band with the 4940-4990 MHz (4.9 GHz) band for mobile services, the 4.9 GHz band subsequently became unavailable for commercial services when the Commission designated the band for exclusive public safety use.

<sup>9</sup> *Unlicensed 3650 MHz Notice*, 19 FCC Rcd 7545.

for providing licensed or a combination of unlicensed and licensed terrestrial services in this band, including whether it should split the band to allow separate spectrum for unlicensed devices and terrestrial licensed use in different segments. In the *Unlicensed 3650 MHz Notice*, the Commission was mindful of the need to protect grandfathered FSS radiolocation operations in the band.

5. When it issued the *3650 MHz Order* in March 2005, the Commission decided to provide for structured entry into the band by adopting a non-exclusive licensing scheme, in lieu of an unlicensed scheme that had originally been proposed. In reaching this decision, it considered several factors, including the band's encumbrance with grandfathered satellite and radiolocation operations, which prevented terrestrial use in major population centers along the east and west coasts, and the lack of pairing opportunities with other spectrum for duplex operations. This, as well as evidence that the band was well suited to high-power broadband operations, persuaded the Commission that much of the interest in developing the band was focused on smaller markets and less densely populated areas.<sup>10</sup> For these reasons, the Commission structured the band's rules to provide WISPs and other providers an economical means of quickly initiating broadband services, particularly in under-served and rural areas.<sup>11</sup>

6. Based on the record as well as on certain characteristics of the band, the Commission concluded that the 3650 MHz band would be best put to use on a non-exclusive shared use basis.<sup>12</sup> Accordingly, the Commission adopted a nationwide, non-exclusive licensing scheme for terrestrial operations in the band. It also adopted a number of provisions designed to allow cooperative, shared use of the band, including a streamlined licensing mechanism and a requirement that equipment operating in the band incorporate a contention-based protocol to minimize interference.<sup>13</sup> The Commission concluded that this licensing approach struck an appropriate balance, providing a regime with low entry costs and minimal regulatory delay, while still ensuring more orderly operation than would exist under a traditional unlicensed approach in which users must accept interference from others in the band and users' locations are unknown.<sup>14</sup>

7. The Commission also designed the 3650 MHz band rules to provide flexibility for a variety of new terrestrial uses in order to encourage multiple entrants.<sup>15</sup> It required that all 3650 MHz licensees must cooperate and "make every effort" to avoid harmful interference and specifically declined to give

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<sup>10</sup> See *3650 MHz Order*, 20 FCC Rcd at 6513, ¶ 30.

<sup>11</sup> The Commission also noted that this approach promoted the objective of Section 706 of the Communications Act of 1996 by furthering the deployment of advanced telecommunications services to all Americans. See *3650 MHz Order*, 20 FCC Rcd at 6503, ¶ 2.

<sup>12</sup> *3650 MHz Order*, 20 FCC Rcd at 6511, ¶ 25.

<sup>13</sup> The Commission defined the contention-based protocol as follows:

A protocol that allows multiple users to share the same spectrum by defining the events that must occur when two or more transmitters attempt to simultaneously access the same channel and establishing rules by which a transmitter provides reasonable opportunities for other transmitters to operate. Such a protocol may consist of procedures for initiating new transmissions, procedures for determining the state of the channel (available or unavailable), and procedures for managing retransmissions in the event of a busy channel.

*3650 MHz Order*, 20 FCC Rcd at 6523, ¶ 58.

<sup>14</sup> *3650 MHz Order*, 20 FCC Rcd at 6511-12, ¶ 27. For example, licensed Fixed Service (FS) operations (which have primary status) will be entitled to interference protection vis-à-vis new FSS earth stations (which will have secondary status), whereas unlicensed FS operations would not.

<sup>15</sup> *3650 MHz Order*, 20 FCC Rcd at 6508, ¶ 15.

interference priority to licensees who were the first to deploy in an area.<sup>16</sup> To facilitate the negotiations that would accompany the cooperative use of the band by multiple entrants, the Commission required that all 3650 MHz band licensees register their fixed and base stations in a common database.<sup>17</sup>

8. As a further means of promoting effective shared use of the spectrum, the Commission concluded that contention-based protocols were well suited to avoiding interference among the multiple users that seek to use the band simultaneously.<sup>18</sup> While the Commission required equipment operating in the band to incorporate a contention-based protocol, it did not specify a particular protocol. Instead, it left to industry and standards bodies the task of developing appropriate protocols for use in the band.<sup>19</sup> The Commission, through the equipment certification process, retained the authority to determine whether equipment that operators sought to deploy in the band met the requirements it had established for contention-based protocols.<sup>20</sup>

9. The Commission also adopted a number of provisions to protect grandfathered satellite operators, which retained their primary status, against interference from the newly authorized operations in the band. Specifically, the Commission created exclusion zones with a radius of 150 kilometers around approximately 100 grandfathered FSS earth stations and prohibited terrestrial operations in the band within these exclusion zones, absent agreement with the affected satellite operators.<sup>21</sup> To provide further protection to the grandfathered earth stations, the Commission set maximum permissible power levels for both mobile and fixed or base stations operating in the band and required that mobile units be configured to transmit only when they could receive an enabling signal from a licensed base station.<sup>22</sup>

10. As indicated above, eight petitions were filed seeking reconsideration of various aspects of the *3650 MHz Order*. The Commission received more than 160 oppositions, replies, or comments to these petitions.

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<sup>16</sup> *3650 MHz Order*, 20 FCC Rcd at 6512-13, ¶¶ 29-31. The Commission defined the duty of cooperation that it created for the band's licensees as follows:

All applicants and licensees shall cooperate in the selection and use of frequencies in the 3650-3700 MHz band in order to minimize the potential for interference and make the most effective use of the authorized facilities. A database identifying the locations of registered stations will be available at <<http://wireless.fcc.gov/uls>>. Licensees should examine this database before seeking station authorization, and make every effort to ensure that their fixed and base stations operate at a location, and with technical parameters, that will minimize the potential to cause and receive interference. Licensees of stations suffering or causing harmful interference are expected to cooperate and resolve this problem by mutually satisfactory arrangements.

47 C.F.R. § 90.1319(c).

<sup>17</sup> *3650 MHz Order*, 20 FCC Rcd at 6513-14, ¶ 31.

<sup>18</sup> Examples of contention-based protocols described in the order include channel monitoring used by private land mobile radios under Part 90 and Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) used by Wi-Fi devices. See *3650 MHz Order*, 20 FCC Rcd at 6522-23, ¶ 57.

<sup>19</sup> *3650 MHz Order*, 20 FCC Rcd at 6523, ¶ 58.

<sup>20</sup> *3650 MHz Order*, 20 FCC Rcd at 6523, ¶ 58.

<sup>21</sup> *3650 MHz Order*, 20 FCC Rcd at 6525-26, ¶¶ 63-64.

<sup>22</sup> *3650 MHz Order*, 20 FCC Rcd at 6520-21, ¶¶ 50-52.

## II. DISCUSSION

11. Several of the reconsideration petitions challenge both the non-exclusive licensing regime and the requirement that equipment operating in the band incorporate a contention-based protocol to manage interference in the shared spectrum. As reflected in the *3650 MHz Order*, these two issues are closely intertwined. The utility of the non-exclusive licensing model the Commission adopted is enhanced by the interference protection aspect of the contention requirement, and the contention requirement would not have been necessary in an exclusively licensed environment. As discussed more fully below, we remain convinced that these provisions will operate together effectively to ensure the goal of efficient spectrum use by multiple licensees in the 3650 MHz band. Accordingly, we are retaining the non-exclusive licensing scheme for the band. We likewise are retaining the contention-based protocol requirement for new fixed, base and mobile equipment, but are clarifying that our intent was to adopt a requirement that allows for the certification of a variety of devices employing different types of protocols. In addition, we are limiting operations of certain contention-based protocols – *i.e.*, “restricted” protocols, which are those capable of avoiding interference only to other co-frequency devices using the same protocol – to the lower 25 megahertz portion of the 3650 MHz band. We find that this modification will further reduce the potential for co-channel interference, provide additional protections to the multiple users in the band under the current licensing regime, and create incentives for the rapid development of broadly interoperable contention technologies.

12. Additionally, we are denying requests for reconsideration of the previously adopted power limits for fixed and mobile transmissions in the band, concluding that the limits adopted serve to protect against interference both among the band’s licensees and with satellite earth stations. Finally, we are denying requests to modify the out-of-band emission limits in the rules and declining to revise our rules regarding coordination with satellite licensees operating in the grandfathered FSS exclusion zones.

### A. Licensing and Use of the Band

13. As noted above, the Commission adopted a nationwide non-exclusive licensing scheme for the 3650 MHz band in order to create a spectrum environment conducive to the prompt entry by multiple broadband providers in under-served markets - and at low entry costs and with minimal regulatory delay.<sup>23</sup> In reaching its conclusion to adopt this streamlined licensing approach, the Commission rejected both unlicensed and exclusive licensing (both geographic area and site-based) approaches for either the whole 3650-3700 MHz band or part of the band. In particular, the Commission rejected assertions in the record that the interference protection essential to exclusive licensing would be necessary to provide spectrum users with sufficient incentive to invest in the band. The Commission concluded that the non-exclusive licensing model, in conjunction with operational and technical safeguards (such as the contention-based protocol and registration requirement), obligated licensees to cooperate to avoid harmful interference. The Commission concluded that the licensing rules it adopted would “ensure open access to this spectrum for nominal application fees and allow effective and efficient use of this spectrum in response to market forces.”<sup>24</sup> This, the Commission reasoned, would encourage “rapid deployment of broadband technologies” and advance the “goal of bringing broadband services to all Americans, including consumers living in less densely populated rural and suburban areas.”<sup>25</sup>

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<sup>23</sup> *3650 MHz Order*, 20 FCC Rcd at 6508, ¶ 16.

<sup>24</sup> *3650 MHz Order*, 20 FCC Rcd at 6511, ¶ 27.

<sup>25</sup> *3650 MHz Order*, 20 FCC Rcd at 6511, ¶ 27.



14. Several petitioners ask that we replace non-exclusive licensing with an exclusive licensing scheme in all or part of the 3650 MHz band, either throughout the U.S. or in urban areas.<sup>26</sup> Some petitioners argue that exclusive licensing should be implemented on a geographic area basis, with one licensee selected by auction for each available license. While some parties, such as Motorola, seek exclusive licensing throughout the country,<sup>27</sup> others distinguish between urban and non-urban areas and offer a mix of licensing approaches.<sup>28</sup> The Wireless Communications Association, which advocates the use of exclusive licensing to address concerns about the quality of service that will be provided in the band, asks that the Commission exclusively license 25 megahertz on an MSA/RSA basis and keep the remaining 25 megahertz non-exclusively licensed in order to provide easy access by “those willing to accept the risks associated with non-exclusive licensing.”<sup>29</sup> These petitioners generally do not offer new arguments against the feasibility of the non-exclusive licensing scheme, instead reiterating arguments made in response to the *Unlicensed 3650 MHz Notice* and addressed by the Commission in the *3650 MHz Order*.<sup>30</sup>

15. To the extent that the petitioners raise issues arguing in favor of exclusive licensing that the Commission previously considered and decided, we deny those petitions. Based on our review of the record and the information provided in the petitions for reconsideration and responses, we continue to believe that a non-exclusive licensing scheme represents the best fit for the 3650 MHz band.<sup>31</sup>

16. In various proceedings, the Commission has tried to strike a balance between its licensed and unlicensed approaches to assigning spectrum rights, determining which approach to use based on all of the relevant circumstances.<sup>32</sup> The unique characteristics of this band, including the limitations on use in many major population areas near FSS earth stations that characterize the 3650 MHz band, continue to suggest that the non-exclusive licensing regime adopted in the *3650 MHz Order* best serves the public interest.<sup>33</sup> As noted in that order, these FSS earth stations preclude ubiquitous use of this spectrum

<sup>26</sup> See Motorola Petition at 2; Intel Petition at 18-19; WCA Petition at 12.

<sup>27</sup> See Motorola Petition at 2 (arguing that we should divide the band into two 25-MHz blocks and license them exclusively throughout the country); TDS Telecommunications comments at 7 (auction by individual MSA/RSA will permit smaller entities to meaningfully participate).

<sup>28</sup> See Intel Petition at 18-19 (seeking exclusive licensing in urban areas – specifically the top 50 Metropolitan Statistical Areas – and supporting a continuation of the non-exclusive scheme that the Commission previously adopted in the remaining geographic areas); Verizon comments at 5 (advocating exclusive licenses for the entire band in high-density areas, with only 25 megahertz being exclusively licensed elsewhere).

<sup>29</sup> WCA Petition at 12.

<sup>30</sup> See, e.g., Intel Petition at 21-22 (“Companies are more willing to risk capital investments where they can better control spectrum access and thus create optimum [quality of service] for their subscribers.”); WCA Opposition at 12-14 (discussing merits of exclusive access to spectrum). *3650 MHz Order*, 20 FCC Rcd at 6511-13, ¶¶ 25-30.

<sup>31</sup> See generally WISPA comments at 1 (non-exclusive licensing in band “will foster an environment of continued service and competition” where it has not previously existed); Wi-Max Forum comments at 4 (non-exclusive licensing will bring “broadband availability, services and options for residential, business, and civic entities” to rural areas).

<sup>32</sup> See, e.g., In the Matter of Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices below 900 MHz and in the 3 GHz Band, *First Report and Order and Further Notice of Proposed Rule Making*, ET Docket Nos. 04-186, 02-380, 21 FCC Rcd 12266, 12277 ¶ 27 (2006).

<sup>33</sup> *3650 MHz Order*, 20 FCC Rcd at 6511, ¶ 30. See also Cisco Opposition at 3-4 (“Exclusion zones to protect satellite earth stations or federal government installations will make it impossible to use this band for general distribution of broadband capacity to subscribers in” many major metropolitan areas). Comparison of the map of FSS exclusion zones, Appendix F to the *3650 MHz Order*, and a list of the top 50 MSAs (available at <http://www.fcc.gov/oet/info/maps/areas/names/cmanames.txt>) indicates that terrestrial operations in the band would

throughout the United States, particularly in major population centers along much of the east and west coasts.<sup>34</sup> Development of the band is thus particularly well suited to smaller markets and less densely populated areas where non-exclusive operation is more easily accommodated. In addition, the need to protect incumbent users from harmful interference requires that terrestrial users in the 3650 MHz band operate at lower power levels than are typical of many exclusively licensed services. Finally, the record continues to indicate that a number of service providers, such as WISPs are willing to invest in using the spectrum for the development of wireless broadband services in underserved and rural communities on a non-exclusively licensed basis.<sup>35</sup> Accordingly, we continue to believe that non-exclusive licensing best balances the competing interests in this band.<sup>36</sup>

17. Because we are not altering the existing non-exclusive licensing approach for the band, we need not consider at length the different ways petitioners suggested that we apportion the band. We conclude that the use of geographic or spectrum-related divisions to the band would unnecessarily frustrate potential licensees' abilities to make full use of the 3650 MHz band.<sup>37</sup> Because we believe that adequate interference mitigation techniques can be employed in this band, we do not accept the argument that the likely difference in congestion between urban and rural markets justifies adopting two different licensing schemes.<sup>38</sup>

18. We note that the record generated on reconsideration also reflects a broader concern that the particular approach and rules we adopted in conjunction with our non-exclusive licensing plan will frustrate potential users and limit the practical use of the band. Intel, Redline and Alvarion contend that the current rules will cause licensees to register, but not build, operations in an attempt to prevent other licensees from entering the market – in effect “squatting” in the band.<sup>39</sup> They also contend that ambiguities in the rules – such as the absence of a specified time period in which a licensee must deploy service after registration, the absence of criteria defining when a station becomes “unused” and must be deleted from the registration database, and the absence of standards for cooperation between licensees – along with the potential for delay in evaluating and approving contention-based technologies will slow the launch of new services in rural areas.<sup>40</sup>

19. Several petitioners also assert that our current rules cannot ensure sufficient interference protection to provide an adequate quality of service to support desired applications, such as voice over

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be prohibited in at least the following cities, absent an agreement with affected satellite providers: New York; Los Angeles; Philadelphia; San Francisco; Washington, DC; Dallas-Fort Worth; Miami; Pittsburgh; Baltimore; San Diego; Denver; Seattle; Tampa-St. Petersburg; San Jose; Portland, Oregon; Hartford, Connecticut; Sacramento; Bridgeport, Connecticut; Albany; Nashville; Greensboro, North Carolina; New Haven; and Honolulu.

<sup>34</sup> *3650 MHz Order*, 20 FCC Rcd at 6511, ¶ 25.

<sup>35</sup> *See, e.g.*, WISPA comments at 1; Voorhees ex parte presentation dated August 30, 2005 at 1.

<sup>36</sup> *See 3650 MHz Order*, 20 FCC Rcd at 6511, ¶ 30 (stating that “[t]he record indicates that this band is well suited for high power broadband operations using contention-based technologies that facilitate sharing and that, provided entry barriers are low, parties are prepared to use these technologies to operate in the band on a non-exclusive basis”); *id.* at 6511-12 ¶ 27.

<sup>37</sup> *See* Cisco opposition at 5 (stating that splitting spectrum among metropolitan and non-metropolitan areas is “rarely a good idea” for large fixed stations and legacy services, and that such an approach would be even less beneficial for a new service such as those anticipated for the 3650 MHz band); Part 15.org opposition at 10 (claiming that splitting the 50 MHz available in the band could result in “technically unusable” spectrum).

<sup>38</sup> *Cf.* Intel Petition at 18-24.

<sup>39</sup> Intel Petition at 8-9.

<sup>40</sup> Intel Petition at 10-11.

IP.<sup>41</sup> They argue that potential operators will be unwilling to invest in the band,<sup>42</sup> resulting in slow service deployment and, ultimately, inefficient use of the band.<sup>43</sup> Intel, Redline and Alvarion suggest a different path to the same result. They contend that non-exclusive licensing will lead to an insupportable number of entrants that will overwhelm the available spectrum, resulting in a quality of service too low to provide reliable broadband communications.<sup>44</sup>

20. Some of the parties that oppose exclusive licensing in the 3650 MHz band propose other changes we could make to the registration or cooperation rules that they contend would provide for more efficient use of the band. While most parties reject the petitioners' suggestions that we select by auction a single licensee for each of several geographic-based area-wide licenses and prefer having multiple entrants access the band, some advocate modifications that would effectively infuse the non-exclusive licensing scheme with some of the rights and protections of a traditional, exclusively licensed regime. For example, Covad proposes that licensees who have registered their intention to build facilities in a particular area should receive certain protections against interference from later entrants.<sup>45</sup> While Covad's plan would not entirely exclude later entrants, it would require that they coordinate their operations with those of previous entrants. By contrast, Airstream suggests setting an application deadline for the band. Licenses for each market would be issued only to those operators who met the deadline, and operators in each market would decide among themselves on an appropriate interference avoidance mechanism.<sup>46</sup> WCA claims that the requirement that both incumbent and new licensees cooperate to resolve interference by mutually satisfactory arrangements does not give licensees sufficient assurance that their systems will receive adequate interference protection.<sup>47</sup> XO Communications, which argues that non-exclusive licensing in the *3650 MHz Order* will reduce regulatory barriers, increase the number of market entrants and lead to the more efficient use of spectrum, also asks us to adopt a Part 90-style frequency coordination regime for the band that would permit coordinators to evaluate licensees'

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<sup>41</sup> WCA Petition at 2. *See also* Wi-Max Forum Petition at 8-9; Motorola Petition at 5 (claiming that these issues would make it very difficult to deploy any services that require a specific quality of service).

<sup>42</sup> *See* EWA Petition at 5 ("it is unlikely that EWA members or other prospective users will invest in the Band without a reasonable level of confidence that their systems will not experience destructive interference"). *See also* Motorola Petition at 5; TDS Telecommunications comments at 3.

<sup>43</sup> *See, e.g.*, Motorola Petition at 6 (stating that the Commission's approach "will not allow rapid deployment at 3650 MHz nor offer the most efficient use of the spectrum, particularly in dense urban areas").

<sup>44</sup> Intel Petition at iii, 12-14. Intel likens this situation to a "tragedy of the commons," in which the significant interference collectively caused by all the users renders the band virtually useless. *See id.* at iii. *See also* TDS Telecommunications comments at 5 (with no limitation on the number of licensees, the spectral noise floor will gradually but significantly rise to levels that will render productive uses of the band impossible).

<sup>45</sup> *See* Covad ex parte presentation dated August 22, 2006 at 4-9. In order to prevent squatting, Covad also suggests that licensees be required to complete construction and begin service within 90 days of registering operations in a particular market. *Id.* at 5-6. *See also* Enterprise Wireless Alliance Petition at 8 (suggesting that industry be charged with developing consensus management plan for band, including possibly a prior coordination regime); API comments at 6; XO Communications Opposition at 10 ("XO specifically opposes any regulations that would impose on incumbent users the obligation to modify their operations to accommodate new entrants.").

<sup>46</sup> *See* AirStream comments at 5-6. If licensees could not agree among themselves on an interference protection scheme, the Commission would mediate the process. *Id.* *Accord* American Petroleum Institute comments at 6 (suggesting development by industry consensus of coordination procedures, channelization plan and or technical standards for the band).

<sup>47</sup> WCA Petition at 11-12.



needs for requested spectrum at specific sites.<sup>48</sup> It also asks us to adopt performance standards for the band to ensure that licensees actually provide service in the markets where they have registered operations.<sup>49</sup>

21. In general, all of the arguments for making modifications to our licensing rules rest on the assumption that non-exclusive licensing will frustrate potential users of the band and its efficient use.<sup>50</sup> We disagree with these projections. While we acknowledge that the use of a non-exclusive licensing approach must be accompanied with the means to ensure that multiple users can operate successfully in the band, we conclude that the Commission adopted appropriate and practical mechanisms to ensure such an outcome.<sup>51</sup>

22. We discuss, at greater length below, the contention-based protocol and the record that indicates that contention technology will effectively prevent interference.<sup>52</sup> The band's other rules, in particular the cooperation requirement, give us additional confidence in the feasibility of the non-exclusive licensing scheme. Providers will not be permitted simply to turn up their transmitters and overwhelm others in the area; instead, they will be required to reach a reasonable accommodation with the other operators nearby. In this regard, we do not foresee that the mutual cooperation obligation will be as burdensome as some commenters envision.<sup>53</sup> To the contrary, we expect that contention technology will facilitate multiple users' sharing of the band. To the extent that contention technology does not alone facilitate spectrum sharing, the registration database will substantially assist providers in locating the source of interference that they may be experiencing and facilitate cooperative operating agreement among the parties.

23. We decline to alter the band's cooperation requirement to approximate more clearly the rights available in an exclusive licensing model. We are not persuaded that the various steps that parties suggest in this regard would further the public interest and the Commission's goals in this proceeding better than the current non-exclusive licensing scheme or that the benefits of these proposed changes outweigh the costs. For example, creating the type of first-in-time rights that parties suggest would give initial market entrants ability to structure their operations in a manner that could impede subsequent providers' ability to offer viable services and diminish any incentive that such initial market entrants might have in negotiating interference avoidance measures to accommodate new entrants. Requiring the use of third-party frequency coordinators would also add an unnecessary extra layer of process that operators would have to satisfy before deploying their equipment and initiating service. Given the use of contention protocols in the band, we do not see the need to require a separate entity to serve as a gate-keeper for the spectrum. Similarly, the performance standards and the attendant reporting obligation that

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<sup>48</sup> Under our Part 90 rules, most applications for new and modified private land mobile radio licenses must be filed through a frequency coordinator. Frequency coordinators are private organizations that have been certified by the Commission to recommend the most appropriate frequencies for applicants in designated radio services. See 47 C.F.R. §§ 90.7, 90.175.

<sup>49</sup> XO Communications Opposition at 3 and 11-14.

<sup>50</sup> As discussed above, the results described in the parties' petitions include over-crowding and unacceptably low quality of service – or that the prospect of such an interference environment will discourage investment in the band altogether.

<sup>51</sup> See also MAP at 5-6 (arguing that the rules resolve potential network administration issues and will make high quality of service possible in the band).

<sup>52</sup> See *infra* ¶¶ 27-39.

<sup>53</sup> See, e.g., WCA Petition at 11-12; Covad *ex parte* presentation dated August 11, 2006 at 5-7; AirStream comments at 5-6.

XO suggests are duplication of the discipline that the market will already provide. If an operator is not providing adequate service, other operators will be free to deploy their facilities in the market and begin their own operations.

24. We disagree that non-exclusive licensing will make the band unusable. With respect to Intel's concern about squatting, we agree with Cisco that the licensing procedures adopted for the band provide no first-in-time right to exclude others from entering a market, as would be necessary to make such behavior profitable.<sup>54</sup> To the contrary, the cooperation and contention-based protocol rules both require that licensees take various steps to accommodate (or at least avoid interfering with) the operations of other licensees in their area. Similarly, these requirements should eliminate licensee behavior that could overcrowd the band to the detriment of all users. They will prevent licensees from consuming the full band and crowding out the transmissions of other operators. Licensees that must coordinate their operations with other licensees and deploy equipment that avoids harmful interference will not be able to overwhelm their neighbors.

25. In contrast to an exclusive licensing model in which a licensee may exclude others from a particular license area, the non-exclusive licensing model adopted in the *3650 MHz Order* requires a potential entrant to consider that the presence of other licensees will require cooperative use and may, at times, restrict the amount of spectrum and/or time that spectrum is available to any particular licensee.<sup>55</sup> That trade-off, however, does not automatically render the spectrum unusable.<sup>56</sup> We note that, while some parties claim that the risks associated with the accommodation of multiple entrants will deter investment in the band,<sup>57</sup> the record also includes filings by others, including WISPA, and service provider Attron Networks, that claim an interest in developing services under the non-exclusive licensing approach.<sup>58</sup>

26. For the foregoing reasons, we decline to reconsider the previously adopted non-exclusive licensing scheme and affirm that aspect of the *3650 MHz Order*.

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<sup>54</sup> Cisco Opposition to Petitions for Reconsideration at 7.

<sup>55</sup> Compare Verizon comments at 4 (attributing commercial wireless licensees' successful deployment of service to their exclusive rights to the use of their spectrum and contending that "[t]hese 'exclusive use' licenses facilitate the deployment of high quality wireless services, without the risk of harmful interference, and create the incentives for companies to invest substantial sums of money in the construction of wireless networks") with Cisco opposition at 8-9 (claiming that because the likely use of the 3650 MHz band will be for opportunistic narrow-beam backhaul applications specifically designed around pre-existing users, the existing rules are appropriate for the band).

<sup>56</sup> See, e.g., Cisco opposition at 10 ("Any band, whether licensed or unlicensed, can eventually become so full that additional entry is unattractive, but the Commission would be borrowing troubles from the future if it were to forego the benefits of nationwide non-exclusive licensing today based on the uncertain prospect of congestion in some future decade."); MAP at 4 (concluding that the rules strike a proper balance of interference risks versus the benefits of new service deployments). See also WCA Petition at 12 (asking for exclusive licensing but endorsing retention of non-exclusive licensing for a portion of the spectrum for easy access by "those willing to accept the risks associated with non-exclusive licensing").

<sup>57</sup> See, e.g., Verizon comments at 4.

<sup>58</sup> WISPA comments at 1; Attron Networks comments. See also Voorhees ex parte presentation dated August 30, 2005. In further support of a non-exclusive licensing approach, Part 15.org notes that other, unlicensed, bands have an established history of supporting sufficient quality of service to work over large distances and support broadband technologies. Part15.org comments at 9. MAP also notes that dozens of commercial vendors offer equipment for existing unlicensed spectrum and that municipalities and other service providers have made extensive use of more congested unlicensed bands. MAP comments at 5-7.

## B. Contention-Based Protocol

27. Given our decision to maintain a non-exclusive licensing scheme, we now address the necessity of preventing co-frequency interference, which could arise from multiple entrants' shared use of the band. We are not persuaded, as certain petitioners contend, that contention-based protocols, as the Commission has defined them, will widely fail to avoid co-frequency interference among licensees sharing the band. As we discuss below, there is much record evidence to the contrary. We thus remain convinced that the use of contention-based technologies will be an effective mechanism to facilitate multiple users in the band, and we retain this requirement. Although we are not modifying our decision to require the use of contention-based protocols, we are clarifying that the requirement allows for the certification of a variety of devices using various different types of protocols. We also modify our rules to limit the operation of devices using "restricted" protocols, as explained below, to the lower 25 megahertz of the band so as to provide for additional protections against interference in this band and to create further incentives for the rapid development of broadly interoperable contention technologies. We believe that our clarification and our treatment of "restricted" protocols will help speed deployment of equipment and the use of this band, especially in rural areas.

28. In the *3650 MHz Order*, the Commission explained that contention-based protocols, which it required for fixed, base and mobile equipment operating in the band, would "allow multiple users to share the same spectrum by defining the events that must occur when two or more devices attempt to simultaneously access the same channel and establishing rules by which each device is provided a reasonable opportunity to operate."<sup>59</sup> The Commission's goal in adopting the contention requirement was to speed deployment in the 3650 MHz band by allowing multiple entrants to provide service. It saw the protocol as a means to "ensure efficient and cooperative shared use of the spectrum."<sup>60</sup> The Commission chose not to require a specific contention-based protocol, leaving it to industry and standards bodies to determine appropriate protocols. The Commission cautioned, though, that equipment would not be certified for use in the band if it appeared "to be designed to preclude others from using this spectrum."<sup>61</sup> The Commission stated that it would monitor use of the spectrum, and would modify the rules if there appeared to be significant problems in this regard.<sup>62</sup>

29. Several parties raise concerns about the contention requirement.<sup>63</sup> In particular, Motorola and the coalition of petitioners led by Intel argue that the listen-before-talk (LBT) model of contention technology will not be effective either: (1) for long-range, higher-power transmissions, as would be necessary to serve rural areas, or (2) for avoiding interference among numerous, unrelated users, as would be necessary in densely populated, urban areas.<sup>64</sup> They assert that contention technology, such as listen-before-talk, is best suited to use with unlicensed Wi-Fi devices operating at relatively low power, over short distances and under the control of a single entity.<sup>65</sup> Over longer distances and at higher power, the

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<sup>59</sup> *3650 MHz Order*, 20 FCC Rcd at 6508, ¶ 16. See also note 13 *supra* (Commission definition of contention-based protocol).

<sup>60</sup> *3650 MHz Order*, 20 FCC Rcd at 6508, ¶ 16.

<sup>61</sup> *3650 MHz Order*, 20 FCC Rcd at 6523, ¶ 58.

<sup>62</sup> *3650 MHz Order*, 20 FCC Rcd at 6523, ¶ 58.

<sup>63</sup> See Motorola Petition at 4-5; Intel Petition at 11-12; Wi-Max Forum Petition at 10.

<sup>64</sup> See Motorola Petition at 4-5 (discussing problems with contention technologies over greater distances); Intel, Redline & Alvarion Petition at 12-13 (arguing that contention technologies perform poorly over longer distances and when numerous, unrelated users are involved).

<sup>65</sup> Intel Petition at 11-12. By way of background, a Wi-Fi station seeking to transmit must first sense the radio channel it intends to use to determine if another station is transmitting on it. If the channel is free, the transmission

petitioners argue, the increased number of potential users renders voluntary operator-to-operator cooperation infeasible and the efficacy of contention technologies breaks down, generally reducing the throughput possible in the band.<sup>66</sup> The Wi-Max Forum and Motorola argue that the contention requirement will delay deployment in the band while equipment manufacturers develop the necessary contention technology.<sup>67</sup> Some petitioners assert that, even if the Commission continues to rely on non-exclusive licensing in rural areas, the contention protocol requirement should be eliminated because the likely number of providers will be small enough so that they can cooperate in avoiding interference to each other.<sup>68</sup>

30. On the other hand, Cisco and certain other parties support the contention requirement, arguing that it is feasible and imposes only a minimal regulatory burden that is adequately justified by the increase in spectrum efficiency to which it would lead.<sup>69</sup> WISPA concurs that a contention protocol lowers entry barriers and is a cost-effective means of providing interference protection.<sup>70</sup> Parties such as Cisco and Tropos disagree with the petitioners' assertions that a contention protocol is not effective for long range operations. Thus, Cisco argues that equipment using a contention protocol can be used effectively for backhaul in rural areas, and Tropos Networks claims that large geographic areas can be served by mesh networks employing contention protocols.<sup>71</sup>

31. Additionally, some petitioners assert that the *3650 MHz Order* leaves substantial doubt about precisely what will be necessary to satisfy the contention requirement and request that the Commission provide clarification. Redline and WCA assert that the criteria should be technologically neutral, and that the Commission should not require all devices to employ a single protocol; they argue such a decision would delay deployment of service in the band and stifle new product development.<sup>72</sup> The petitioners also ask the Commission to clarify that Wi-Max technology, which is being developed for use in this band world-wide, satisfies the contention protocol requirement, even though it does not employ a listen-

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may proceed. If the channel is busy, the Wi-Fi protocol (which is based on IEEE standard 802.11 and is formally known as Carrier Sense Multiple Access with Collision Avoidance) imposes a random wait time before again sensing the channel; it repeats this process until it senses a free channel and allows the station to transmit. *See generally* BOB O'HARA & AL PETRICK, IEEE 802.11™ HANDBOOK 22-23 (2005). Since Wi-Fi actually determines whether the spectrum is in use before transmitting, it can effectively avoid interfering with the transmissions of all potential competing operators, regardless of the type of contention technology that they incorporate.

<sup>66</sup> Intel Petition at 14. *See also* Motorola Petition at 4 (“Where the transmitting device intends to transmit over a long distance, not only is there greater probability that multiple users also will be attempting to access the spectrum at the same time, but there also is reduced throughput because more users must remain silent for longer periods of time to avoid interference.”).

<sup>67</sup> Wi-Max Forum Petition at 10 (if there is a U.S. specific contention protocol, users cannot rely on off-the-shelf technology); Motorola Petition at 5-6(referring to solving problems of the hidden node problem and longer distances) .

<sup>68</sup> *See, e.g.*, Intel Petition at 18-19; WCA Opposition at 8.

<sup>69</sup> Cisco comments at 10-11. XO Communications argues that the Commission should maintain its requirement for contention technologies over the long term, but, to facilitate prompt deployment, also allow operation of equipment without contention capability, subject to a frequency coordination requirement. XO Communications comments at 8-9.

<sup>70</sup> WISPA comments at 1.

<sup>71</sup> Cisco Opposition at 11; Tropos Networks Opposition at 7-8.

<sup>72</sup> Redline Petition at 2-3; WCA Opposition at 12-16. *See also* Motorola Petition at 6.

before-talk protocol.<sup>73</sup> Many commenters agree that the contention protocol requirement should allow for more than one type of protocol to be recognized for use in the band, and ask the Commission to clarify whether Wi-Max technology would satisfy the Commission's requirement.<sup>74</sup>

32. After reviewing the arguments raised by the petitioners and the commenters, we conclude that the public interest is best served by retaining the requirement that fixed, base and mobile equipment operating in the band incorporate a contention-based protocol. Given our decision to retain non-exclusive licensing in the 3650 MHz band, we continue to believe that equipment incorporating a contention-based protocol will provide a cost-effective means to enable multiple users to operate on the same frequencies in the band without interfering with one another. By retaining the contention-based protocol requirement, operators and their customers will not have to rely on frequency coordination prior to the initiation of service; this will reduce costs and delay. We note that most commenters do not dispute the utility of contention protocols for interference avoidance but, rather, address whether such technology has shortcomings that limit its application in the band to short distances or to less congested areas. We are not persuaded that the shortcomings that petitioners such as Motorola and Intel ascribe to contention protocols will necessarily limit use of the band to short range applications. Competing evidence indicates that contention technology is suitable for many different applications that the *3650 MHz Order* envisioned, including long range operations.<sup>75</sup> Long range transmissions typically would be point-to-point using narrow beams. Point-to-point transmissions at the power limits adopted for the band will have a lower potential for interference and allow providers to use this band for backhaul operations, especially in less congested rural areas.<sup>76</sup> The Commission's goal of providing for multiple entrants in the band can best be accomplished if users have the flexibility to choose the technology most appropriate to meet their needs. Accordingly, we are denying those petitions for reconsideration that seek elimination of the contention protocol requirement.

33. Further, we clarify that the 3650 MHz rules provide for certification of a variety of devices that may use different types of protocols or interference avoidance mechanisms that satisfy the contention definition that applies to the 3650 MHz band. The definition of what constitutes a valid contention protocol for the 3650 MHz band is broad enough to encompass different types of contention protocols and interference avoidance mechanisms, thereby promoting innovation and product development. As stated in the Order, equipment for use in the 3650 MHz band must incorporate a mechanism that allows "multiple users to share the same spectrum ... and establish[es] rules by which each device is provided a

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<sup>73</sup> Wi-Max technology, which is based on IEEE standard 802.16, avoids interference by synchronizing the timing of potentially competing transmissions so that the various transmitters are assigned to discrete time slots. Although the transmitters operate on the same frequency, their transmissions do not overlap in time and therefore do not interfere with each other. The technology could be used in a variety of frequency bands allocated for fixed service, including the 3400-3700 MHz band which is allocated internationally for fixed service, and the 2500-2690 MHz band in the U.S.

<sup>74</sup> See XO Communications comments at 6-8 (supporting clarification that both listen-before-talk and Wi-Max protocols satisfy the requirement); Part 15.Org comments at 7; WISPA comments at 2 (definition may eliminate Wi-Max). Cf. Cisco comments at 10-11 (definition is technologically neutral).

<sup>75</sup> See Tropos Networks Opposition at 7 ("contention based unlicensed devices are capable of providing quality broadband over substantial distances"); WISPA comments at 1 (contention technology "provide[s] few barriers to entry" while offering "protection to existing investments"); Cisco Opposition at 10-11. Tropos Networks asserted that contention technology allows "large scale Wi-Fi deployment with high throughput" across "large geographic areas" and offers "fixed and mobile broadband connectivity with a user experience indistinguishable from wired networks." Tropos Opposition at 1-2.

<sup>76</sup> See paragraphs 41-46 below for discussion of power limits for the 3650 MHz band.



reasonable opportunity to operate.”<sup>77</sup> Although the Commission stated that it would not certify equipment that appeared “to be designed to preclude others from using this spectrum,”<sup>78</sup> it was not the Commission’s intent that only one type of contention protocol be used by all equipment deployed in the band. The record, however, reveals two broad categories of contention-based protocols, discussed below, both of which appear to meet our definitional requirements for operation in this band. Nonetheless, they may not be compatible with each other, and the use of both types could result in co-frequency interference and thus frustrate the Commission’s goal of allowing for multiple entrants in the band

34. Under the Commission’s rules, contention-based protocols can be broadly categorized as either “unrestricted” or “restricted.” Those contention protocols that we refer to as unrestricted protocols are broadly compatible and function to prevent interference even with other, dissimilar contention technologies on the market. A listen-before-talk technology such as is used by Wi-Fi devices is a prime example of an unrestricted contention-based protocol. If a system using Wi-Fi technology hears a competing signal before it transmits, it takes steps to avoid interfering, regardless of the format of, or interference technology associated with, the other signal. It thus allows each device a “reasonable opportunity to operate.” On the other hand, restricted contention protocols can prevent interference only with other devices incorporating the same protocol. Wi-Max, with its scheduling protocol, currently stands as the main example of a restricted contention technology. In its present format, Wi-Max technology effectively prevents interference among multiple transmitters on a single Wi-Max system. Different Wi-Max systems can be coordinated to avoid interfering with each other, thus providing each Wi-Max device a “reasonable opportunity to operate.” However, because it relies on a scheduling protocol and does not empirically determine whether other types of transmitters are operating on a channel, a Wi-Max system cannot now avoid causing interference to with other technologies, such as Wi-Fi, which rely on different interference-avoidance strategies. Equipment incorporating Wi-Max technology thus runs the risk of interfering with, or drowning out, transmissions using other contention technologies.

35. Allowing the use of different protocols in the band will serve our goal of speeding deployment of service, since operators will be able to deploy many different technologies, including those already being developed for use in the 3650 MHz band world-wide. Nonetheless, we must resolve the potential for conflict between certain types of protocols, which could result in interference and/or a denial of access to the band for certain users. To resolve this conflict, we will certify equipment using a restricted contention protocol – *i.e.*, one which can avoid co-frequency interference only with other devices incorporating the same type of protocol – but will limit the operation of such equipment to the lower 25 megahertz of the 3650 MHz band. Devices incorporating a restricted contention-based protocol will only be certified for operation in, and may only transmit over, the lower 25 megahertz of the 3650 MHz band. This will effectively permit equipment using unrestricted protocols to operate in the band since it will be able to operate in the upper 25 megahertz of the band without being subjected to potential interference from licensees with equipment using restricted contention protocol. On the other hand, equipment using an unrestricted contention protocol – *i.e.*, one which can avoid co-frequency interference with devices using all types of protocols – will be allowed to operate throughout the 50 megahertz in the 3650 MHz band since it will be able to detect other transmissions throughout the band and thus avoid co-frequency interference anywhere in the band. We conclude that this approach will ensure efficient use of the spectrum and permit the prompt deployment in this country of equipment that is already being used in this spectrum in other countries around the globe.<sup>79</sup> Permitting a number of different contention based

<sup>77</sup> 3650 MHz Order, 20 FCC Rcd at 6508, ¶ 16.

<sup>78</sup> 3650 MHz Order, 20 FCC Rcd at 6523, ¶ 58.

<sup>79</sup> See, *e.g.*, Motorola Petition at 2. For example, spectrum in the 3.5 GHz range is already in use for fixed, and in some cases mobile, operations in Germany, Ireland, Spain, Austria, France, Chile and Argentina.

technologies to operate in the band will also provide additional flexibility to licensees to choose the best suitable technology for the type of services they plan to provide.

36. We will implement this approach through our equipment certification process, under which we will examine for compliance with our rules all equipment proposed for use in the 3650 MHz band. We will condition the certification for equipment using a restricted protocol to limit its operation and tuning range to the bottom 25 megahertz of the band.<sup>80</sup> The base and fixed stations registration database will include the FCC identification number, reflecting the equipment certification condition restricting the licensee's operating frequency range if the licensee employs equipment using a restricted contention-based protocol.<sup>81</sup> We recognize that manufacturers, through software upgrades or other means, may alter the emission characteristics of previously deployed devices so that they move from the restricted to the unrestricted category. To the extent that this occurs, the manufacturer will be responsible for complying with the Commission's rules regarding the need for new equipment certification before the device will be permitted to tune over the full 50 megahertz of the 3650 MHz band.<sup>82</sup> Further, affected licensees must update their base and fixed station registrations to reflect this change.

37. By contrast, we will not condition the certification for equipment incorporating an unrestricted contention-based protocol, thus allowing such equipment to operate throughout the full 50 MHz of the band. By permitting licensees deploying unrestricted contention technology to operate throughout the band, we expect to create an added incentive for industry groups and manufacturers to speed their development and deployment of such technology. In the long term, this, should improve the quality of service in the 3650 MHz band, furthering the public interest. At the same time, however, permitting restricted contention technologies to operate in the lower 25 MHz of the band will ensure that a wider range of currently available equipment may be immediately deployed in the band.<sup>83</sup>

38. The record indicates that the industry is already making progress in developing additional unrestricted protocols. For example, Airspan Networks, Inc., has proposed a "detect and protect" carrier sensing mechanism that it claims will be compatible with both Wi-Fi and Wi-Max technology (which incorporates IEEE standard 802.16) and will offer the spectrum-sharing benefits of contention technology. Airspan asserts that its interference-avoidance technology has been successfully deployed in dense, urban areas of Japan.<sup>84</sup> Furthermore, under the auspices of the IEEE, industry groups are modifying standards for both 802.11 and 802.16 technology to facilitate the operation and coexistence in

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<sup>80</sup> We modify Commission rule 90.1319 to incorporate this limitation on the tuning range of equipment incorporating restricted contention protocols.

<sup>81</sup> The *3650 MHz Order* delegated to the Commission's Wireless Telecommunications Bureau the authority to adopt "requirements regarding the reporting of registration and licensing information, pertaining to the 3650 MHz Wireless Broadband Services, in the Universal Licensing System database." *3650 MHz Order*, 20 FCC Rcd at 6536, ¶ 103. The appearance of this information in the public registration database will allow other operators to determine the types of equipment operating in a particular market.

<sup>82</sup> Section 2.1043 of the Commission's rules describes the certification requirements for modified equipment. Section 2.1043(a) sets out the conditions under which a new grant of certification is required, and Section 2.1043(b) sets out three categories of permissive changes that may be made without the application for and grant of a new certification. See 47 C.F.R. § 2.1043.

<sup>83</sup> Cf. Wi-Max Forum Petition at 10; Motorola Petition at 5-6.

<sup>84</sup> See Airspan ex parte presentation dated July 6, 2006 at 5 n.9 (Airspan's "carrier-sense technique is currently being used in Wi-Max-based equipment supplied by Airspan to an operator in Japan for Tokyo-wide network deployment"); *id.* at 5 ("[C]riticisms of 'listen and protect' systems raised by certain parties are inapposite to the carrier sensing technique Airspan proposes . . .").

the 3650 MHz band of devices built to those standards.<sup>85</sup> Cisco has asserted that an updated 802.11 standard for the 3650 MHz band “is possible as early as December 2007.”<sup>86</sup> We are optimistic that, in the relatively near term, these and other technical initiatives will yield effective contention-based protocols like those that the Commission envisioned as necessary to support the non-exclusively licensed operation in the 3650 MHz band. Accordingly, we deny the eight petitions for reconsideration to the extent that they seek elimination of the requirement that equipment in the 3650 MHz band incorporate a contention-based protocol.

39. We note briefly the request by BRN Phoenix that the Commission certify its Advanced Antenna System as the (apparently sole) contention-based protocol for use in the 3650 MHz band.<sup>87</sup> Several parties strongly oppose BRN’s request, correctly arguing that the Commission did not intend to choose a single technology as the dominant contention protocol for use in the band.<sup>88</sup> As the above discussion makes clear, we expect that a variety of different contention technologies will qualify for deployment in the band. BRN, like other parties may seek certification for its Advanced Antenna System from the Laboratory Division of the Commission’s Office of Engineering and Technology. We similarly reject BRN’s attempt to achieve by waiver what it seeks to accomplish by petition for reconsideration. It requests waiver of 47 C.F.R. § 90.203(o)(1), which requires that parties seeking certification for equipment to operate in the 3650 MHz band “describe the methodology used to meet” the contention-based protocol requirement.<sup>89</sup> BRN fails to explain how application of the rule to its AAS technology would frustrate the underlying purpose of the rule, nor does it identify unique circumstances that would make application of the rule inequitable, unduly burdensome or contrary to the public interest in this case.<sup>90</sup>

### C. Emissions Limits

40. In setting the power limits for transmissions in the 3650 MHz band, the Commission balanced numerous competing factors to “serve the public interest and foster the expeditious introduction of new terrestrial services in the 3650 MHz band.”<sup>91</sup> These factors included (1) the importance of interference protection for grandfathered FSS earth stations and federal government radiolocation stations and (2) the need to ensure efficient use of the band by avoiding mutual interference among licensed

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<sup>85</sup> See Nextwave ex parte presentation dated January 24, 2007 at 4 (“Both Wi-Fi and Wi-Max are being modified to meet the FCC’s requirements for the 3.65GHz band.”); *id.* at 4-10 (providing details of modifications to 802.11h standards that will allow Wi-Max systems to co-exist with each other and with systems using different technologies, such as Wi-Fi, including Dynamic Channel Selection, Adaptive Extended Quiet Periods and Listen Before Talk).

<sup>86</sup> Cisco ex parte presentation dated August 21, 2006 at 3. Describing the capabilities of the standard under development, Cisco states:

The future . . . protocol will define procedures for initiating transmissions, determining the state of the channel (available or unavailable), and managing retransmissions in the event of a busy channel. Dynamic Frequency Selection will allow transmitters to assess if channels are in use by others, and to change frequency and bandwidth. Transmission Power Control based on [equivalent isotropically radiated power] will allow transmitters to change power.

*Id.*

<sup>87</sup> See BRN Petition at 1-2.

<sup>88</sup> See, e.g., WCA Opposition at 12-16; Motorola Opposition at 3-6.

<sup>89</sup> See BRN Phoenix Petition at 11.

<sup>90</sup> Cf. 47 C.F.R. § 1.925(b)(3).

<sup>91</sup> 3650 MHz Order, 20 FCC Rcd at 6519, ¶ 47.

operators. To this end, the Commission adopted a peak power density of 25 Watts per 25 MHz of bandwidth and no greater than 1 watt per 1 MHz of bandwidth for fixed operations and imposed a limit of 1 Watt per 25 MHz of bandwidth for mobile operations.<sup>92</sup> Various petitioners seek reconsideration of these aspects of the order.

### 1. Fixed and Mobile Power Limits

41. Redline asks that we reconsider the power limits for fixed operations and permit point-to-point devices to employ transmitting antennas with directional gain greater than 6 dBi without a corresponding reduction in transmitter peak power output.<sup>93</sup> Redline contends that such a change in the rules will extend the reach of the point-to-point links that WISPs will rely on in bringing broadband service to rural areas. Similarly, several petitioners request that we increase the allowable power for mobile transmissions in the band to 5 Watts per 25 MHz. They argue that the higher power limit is necessary to “allow reliable mobile communications over several kilometers” and to facilitate deployment of wireless broadband services in rural areas.<sup>94</sup> Cisco, the Satellite Industry Association and Sprint oppose an increase in the power limits, arguing that the Commission struck the correct balance between signal strength and protecting FSS earth stations.<sup>95</sup>

42. We decline to increase the power limits for either fixed or mobile operations in the 3650 MHz band. In adopting power limits for this band, the Commission balanced the potential for inter-service and intra-service interference with the need to provide for satisfactory service by 3650 MHz devices: it sought to ensure efficient and expeditious use of the band by adopting power limits that would allow multiple 3650 MHz licensees to operate within reasonable proximity of each other without unacceptable interference. At the same time, the Commission was concerned that the combination of power limits and the size of the earth station exclusion zones that it adopted would adequately protect from harmful interference the grandfathered FSS operations and Federal Government radiolocation stations.<sup>96</sup> As the Commission noted, the higher the power limit – more particularly the higher the power density expressed in watts per megahertz – the greater the separation distance that is necessary to protect the grandfathered satellite earth stations.<sup>97</sup>

43. The parties seeking reconsideration of the power limits do not claim that the Commission erred in reaching the balance it struck among these various considerations. They do not, for example, argue that the rules’ power limits will prevent deployment in the band or make a viable service impracticable. Rather, they merely ask that we give greater weight to considerations of transmission

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<sup>92</sup> *3650 MHz Order*, 20 FCC Rcd at 6520-21, ¶¶ 50, 52. *See also* 47 C.F.R. § 90.1321 (codifying power limits).

<sup>93</sup> Redline Petition at 3-4 (citing 47 C.F.R § 15.247(b)(4)(ii), which permits a similar exemption to power limits in unlicensed services). *See also* Wi-Max Forum Reply at 2.

<sup>94</sup> Wi-Max Reply at 2. *See also* Intel, Redline & Alvarion Petition at 20 (increase in mobile power “will provide more meaningful coverage in rural areas, while allowing for expeditious, low cost access to the 3650 MHz band for rural WISPs”); XO Communications comments at 14-15 (supporting power increase for fixed or mobile stations to 5 watts/25 MHz; opposing any increase in permissible power for point-to-point operations).

<sup>95</sup> *See* Cisco comments at 12-13; SIA comments at ii-iii, 12; Sprint comments at 3. Cisco also notes that higher power limits could lead to larger nodes, with more subscribers per node and could eventually lead to congestion in the band. *Id.* at 12.

<sup>96</sup> *3650 MHz Order*, 20 FCC Rcd at 6519, ¶ 47.

<sup>97</sup> *See 3650 MHz Order*, FCC Rcd at 6520, ¶ 50.

strength (and range) than to interference avoidance.<sup>98</sup> The petitioners have not persuaded us that the Commission erred in striking a balance that will serve the public interest, and we consequently deny these requests for reconsideration.<sup>99</sup> We therefore conclude that the Commission set the 3650 MHz power limits at an appropriate level. The levels adopted are adequate to support commercially viable services and will allow licensees to operate effectively in the band without unacceptably interfering with each other's operations (provided they deploy equipment incorporating an appropriate contention technology). At the same time, the power limits, combined with the size of the protection zones for grandfathered FSS earth stations, will prevent terrestrial operations in the band from interfering with in-band satellite operations.<sup>100</sup>

## 2. Advanced Antenna Systems

44. BRN Phoenix asks that we reconsider section 90.1321 of the rules as it applies to limit the power output of BRN's advanced antenna system ("AAS") to 25 watts per 25 MHz for operations in the 3650 MHz band. BRN explains that its AAS technology uses sectorized antennas to narrow the beam width of transmissions and thereby reduce the probability of interference with FSS earth stations.<sup>101</sup> It argues that reconsideration of the rule's power limit would serve the public interest by encouraging technologies that protect earth stations from interference.<sup>102</sup> SIA opposes BRN's request, arguing that it would create harmful interference to grandfathered earth stations.<sup>103</sup>

45. We decline BRN's request to reconsider our limit on power output in the 3650 MHz band. In the *3650 MHz Order*, the Commission already balanced the public interest factors that BRN raises in its petition. Specifically, the Commission explicitly considered the issues surrounding "deployment of advanced antenna systems, including sectorized and adaptive array systems."<sup>104</sup> It balanced the need for "flexibility for licensees to employ a wide variety of advanced antennas to meet their needs" with the goal of protecting FSS earth stations.<sup>105</sup> In so doing, it concluded that, "to allow flexibility in deployment" of these systems, it would allow such antennas to operate with a slightly higher power output.<sup>106</sup> BRN

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<sup>98</sup> Cf. SIA comments at 12 (opposing any increase in power limits and noting that an increase in the size of the FSS protection zones would be necessary if the Commission should adopt higher power limits for the band).

<sup>99</sup> *Mobile Relay Associates v. FCC*, 457 F.3d 1, 8 (D.C. Cir. 2006) (court will "uphold the Commission if it makes a 'technical judgment' that is supported 'with even a modicum of reasoned analysis,' 'absent highly persuasive evidence to the contrary'") (citing *Hispanic Info. & Telecomm. Network v. FCC*, 865 F.2d 1289, 1297-98 (D.C.Cir.1989)); *EarthLink, Inc. v. FCC*, 462 F.3d 1, 9 (D.C. Cir. 2006) (according FCC "an extra measure of deference" where "decision involves a high level of technical expertise in an area of rapid technological and competitive change") (internal quotation omitted).

<sup>100</sup> Cf. SIA Opposition at 11-12 (arguing that increase in fixed and mobile power levels would "increase the power level of any interference directed at an earth station" and would "enable the operation of mobile units farther away from their base stations, and thus closer to earth stations, resulting in significantly reduced attenuation (path loss) of potential interference").

<sup>101</sup> BRN Phoenix Petition at 10.

<sup>102</sup> BRN Phoenix Petition at 10.

<sup>103</sup> SIA Opposition at 11.

<sup>104</sup> *3650 MHz Order*, 20 FCC Rcd at 6522, ¶ 54.

<sup>105</sup> *Id.*

<sup>106</sup> *Id.* Specifically, the Commission permitted systems using sectorized antennas "to operate with an aggregate transmit output power transmitted simultaneously on all beams of up to 8 dB above the limit for an individual beam." *Id.*



Phoenix identifies no deficiency in the Commission's decision that would warrant reconsideration. Accordingly, we deny its petition in this regard.

46. Again duplicating the thrust of its reconsideration petition, BRN also asks that we waive the power output rule as it applies to BRN's AAS technology,<sup>107</sup> but it has failed to meet the requirements for waiver of a Commission rule. It has established neither (1) that underlying purpose of the rule would be ill-served or frustrated by application in this case, nor (2) that unusual facts make application of the rule unduly burdensome or contrary to the public interest.<sup>108</sup> Accordingly, we deny the requested waiver.

#### **D. FSS Satellite Issues**

47. As discussed above, the Commission took several steps to minimize the extent to which terrestrial operations in the 3650 MHz band would affect the operations of satellite operators in both the conventional C-band (3700-4200 MHz) and the extended C-band (3625-3700 MHz). First, the Commission established protection zones with a radius of 150 km around the earth stations of grandfathered Fixed Satellite Service operators in the 3650 MHz band.<sup>109</sup> The Commission ruled that licensees in the 3650 MHz band could establish Fixed Service operations within the protection zones only with the consent of the affected FSS operator.<sup>110</sup> As we note above, for 3650 MHz licensees, the Commission established fixed station operating power limits of 25 Watts and mobile station operating power limits of 1 Watt.<sup>111</sup> Additionally, the Commission sought to avoid out-of-band interference by requiring operators to limit emissions into adjacent bands by a minimum attenuation of  $43 + 10 \log(P)$  below the transmit power.<sup>112</sup>

##### **1. Out-of-Band Interference.**

48. The Satellite Industry Association (SIA) seeks reconsideration of the *3650 MHz Order*, arguing that the newly authorized terrestrial operations in the 3650 MHz band will create interference in the adjacent 3700-4200 band that, contrary to the public interest, could disrupt C-band satellite operations.<sup>113</sup> SIA asserts that satellite receivers are particularly sensitive to such out-of-band emissions as operators move to the more aggressive modulation schemes necessary for spectrum-intensive, high-definition services. It argues that the potential for harmful interference is exacerbated where, as here, the licensing requirements are "minimal in nature," and it asserts that the Commission's discretion to address harmful interference once such interference occurs provides insufficient protection, particularly where interference sources may be unregistered, mobile consumer devices.<sup>114</sup>

49. In the *3650 MHz Order*, the Commission established a limit of  $43+10 \log(p)$  dB below transmit power as the minimum out-of-band attenuation for operations in the 3650 MHz band. SIA argues for the significantly more restrictive out-of-band emission limit of  $71.25+10 \log(p)$  dB below transmit power. SIA's petition includes two tables on which it relies to demonstrate that the *3650 MHz*

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<sup>107</sup> See BRN Phoenix Petition at 10.

<sup>108</sup> See 47 C.F.R. § 1.925(b)(3).

<sup>109</sup> *3650 MHz Order*, 20 FCC Rcd at 6526, ¶¶ 64, 65.

<sup>110</sup> *3650 MHz Order*, 20 FCC Rcd at 6527, ¶ 66.

<sup>111</sup> *3650 MHz Order*, 20 FCC Rcd at 6520-21, ¶¶ 50, 52.

<sup>112</sup> *3650 MHz Order*, 20 FCC Rcd at 6530, ¶ 75. See also 47 C.F.R. § 90.1323 (codifying emissions limit).

<sup>113</sup> SIA petition at 5-9.

<sup>114</sup> SIA Petition at 10-13. See also Fox/HBO Comments at 2-3.

*Order's* signal attenuation requirement is insufficient to prevent disruption to C-band earth-station operations.<sup>115</sup> These tables analyze the interrelationship between the arrival angle<sup>116</sup> of the interfering 3650 MHz signal and the distance of the 3650 MHz transmitter from the satellite earth station. They purport to show that satellite operators will achieve a sufficient carrier-to-interference (C/I)<sup>117</sup> ratio only in rare instances under the attenuation limit in the rules.<sup>118</sup> As we discuss below, we find certain flawed assumptions in SIA's analysis that combine to significantly overstate the potential problems associated with the adopted out-of-band emission limit.

50. First, SIA relies on free-space assumptions for its analysis of signal propagation. That is, it assumes that the signal emitted by a 3650 MHz licensee travels, without impediment, reflection or other attenuation, to the antenna of the C-band earth station. This fails to account for various factors that, in practice, would substantially weaken a terrestrial 3650 MHz signal before it could reach an earth station – factors such as clutter loss and reflection off of the earth's surface. When the analysis is adjusted to reflect the real-world propagation conditions in which a 3650 MHz licensee will operate, the signal loss is significantly greater. This adjustment to the attenuation calculation replaces SIA's free-space path loss exponent of 2 with a more realistic factor, such as a number between 2 and 3.<sup>119</sup> Indeed, modifying the analysis in this one respect yields a carrier-interference margin that falls within what SIA describes as an acceptable range<sup>120</sup> in almost all of the scenarios it considers.<sup>121</sup>

51. Second, SIA claims, without citation of authority or supporting analysis, that its members' satellite systems require a carrier-interference (C/I) ratio of at least 22 dB for effective operation.<sup>122</sup> We believe this value to be conservative as it incorporates a large protection factor which would essentially limit the level of an interfering signal to approximately 10 dB below the noise floor of a C-band satellite receiver. More specifically, the C/I value consists of two factors, the carrier-noise (C/N) value which is

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<sup>115</sup> SIA Petition, attachments A & B.

<sup>116</sup> The arrival angle that SIA refers to is the angle, measured at the earth station receiver, between the 3650 MHz signal and the directional axis of the earth station receiver. *See* SIA Petition at 9.

<sup>117</sup> The carrier-interference ratio indicates the strength of the desired satellite signal above the ambient radio-frequency interference measured at an earth station's receiver.

<sup>118</sup> Specifically, SIA's table shows an adequate C/I ratio for an arrival angle of 30 degrees if the 3650 MHz transmitter is at least 1000 meters away, and for an arrival angle of 45 degrees only if the 3650 MHz transmitter is at least 600 meters away. According to SIA's calculations, a sufficient C/I ratio will never be achieved if the transmitter is 1000 meters away and the arrival angle of the 3650 MHz signal is 15 degrees or less.

<sup>119</sup> *See* THEODORE S. RAPPAPORT, WIRELESS COMMUNICATIONS PRINCIPLES & PRACTICE 138-39, & Tab. 4.2 (2d ed. 2002) (proper path loss exponent for exterior environments is between 2.7 and 5); PROPAGATION OF RADIO WAVES 191-192 (Les Barclay, ed., 2d ed. 2003).

<sup>120</sup> The acceptable range for C/I margin under the different conditions of separation distance and satellite arrival angle is shown in Attachment B to SIA's petition for reconsideration. It's C/I margin calculations there still indicate the potential interference in certain cases involving satellite arrival angles between 5 and 15 degrees, and distances from 50 to 200 m.

<sup>121</sup> Adopting a path loss exponent of 3 yields what SIA views as an adequate C/I ratio for distances (between the 3650 MHz transmitter and the satellite earth station) greater than 200 meters, assuming an arrival angle of 5 degrees; for distances greater than 100 meters, assuming an arrival angle of 15 degrees; and for distances greater than 50 meters, assuming an arrival angle of 30 degrees or greater. Adopting a slightly higher path loss exponent further reduces the number of instances in which the C/I ratio would fall below SIA's preferred figure of 22 dB.

<sup>122</sup> *See* SIA Petition at 8; SIA Reply at 3.

the operating margin above the noise floor,<sup>123</sup> and the interference-noise (I/N) value which is an additional protection level to account for any potential interference that may be received. A typical C/N for C-Band earth stations is 12 dB,<sup>124</sup> which, based on a C/I of 22 dB results in a calculated I/N of -10 dB.<sup>125</sup> We note that an I/N of -10 dB has an effect of raising the noise floor by only 0.4 dB which only reduces the operating margin for a C-Band satellite receiver by a negligible amount. Thus, use of a more reasonable I/N value further reduces instances where SIA's models predict interference due to out-of-band signals.

52. Third, we note that the worst case C/I interference margins in SIA's analysis relies in part on scenarios assuming an arrival angle for the satellite antenna of only 5 degrees. That is, it assumes that the 3650 MHz signal will be amplified by the satellite antenna's gain which is very large at or below 5 degrees (*i.e.* it assumes that the satellite antenna is almost pointed directly at the 3650 MHz transmitter). Satellite earth stations will rarely, and only for unique locations in the U.S., operate at this low of an angle to the earth.<sup>126</sup> The greater arrival angles that will typically occur will further reduce the potential for interference from wireless OOB emissions by 3650 MHz stations.

53. Nevertheless, we are sensitive to the concerns that SIA has raised about the potential for 3650 MHz operators to interfere with satellite signals. We recognize that, in rare instances, a 3650 MHz transmitter may be placed (or proposed for construction) near the main beam and within a line of sight of a satellite earth station. In those cases, which we expect to be exceedingly rare, the Commission may require greater suppression of the 3650 MHz operator's out-of-band emissions, pursuant to the rules adopted in the *3650 MHz Order*.<sup>127</sup>

54. We therefore decline to reconsider this aspect of the *3650 MHz Order*. We conclude that SIA's analysis contains overly conservative assumptions about path loss attenuation, the necessary C/I protection ratio and the arrival angle of a 3650 MHz signal at a satellite earth station. Each of these assumptions contributes to the overly pessimistic picture that SIA paints in its Attachment A analysis. When these assumptions are adjusted to reflect more realistic operational scenarios the attenuation requirement in the *3650 MHz Order* adequately protects operations in adjacent bands as validated by SIA by its acceptance of the C/I margin levels presented in its Attachment B. We note, however, that the Commission may require greater suppression of the out-of-band emissions of a 3650 MHz operator in those rare instances when a 3650 MHz transmitter falls near the main beam and in a line of sight of a satellite earth station. Our proposed out-of-band emission limits will also speed deployment, facilitating the design and construction of economic devices for use in the band in a way that SIA's substantially

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<sup>123</sup> The C/N value consists of a minimum carrier level above the noise floor that a receiver needs to operate plus some additional margin to account for fading and other effects.

<sup>124</sup> See TIMOTHY PRATT, ET AL., *SATELLITE COMMUNICATIONS* 114, Tabs. 4.4a, 4.4b (2d ed., 2003). See also F.H SANDERS, U.S. DEP'T OF COMMERCE, *ANALYSIS OF ELECTROMAGNETIC COMPATIBILITY BETWEEN RADAR STATIONS AND 4 GHz FIXED SATELLITE EARTH STATIONS*, NTIA Rpt No. 94-313 at 34, Tab. 4 (for Digital Television Receive Only Systems, the minimum operating margin is 7.5 dB and the protection ratio, provided by the ITU-R, is 12 dB). See also *id.* at 34 ("Manufacturers of 4-GHz earth station have indicated that digital systems are more susceptible to interference than analog stations.").

<sup>125</sup> In other words:  $(C/I) = (C/N) - (I/N)$ .

<sup>126</sup> See PanAmSat Look Angle Calculator (visited Apr. 4, 2007) [http://www.panamsat.com/global\\_network/calc\\_look\\_angle.asp](http://www.panamsat.com/global_network/calc_look_angle.asp) (calculator for C-band operating elevation angles in the U.S.).

<sup>127</sup> See 47 C.F.R. § 90.1323(b).

more restrictive proposal would not.<sup>128</sup>

55. Given the adequacy of the protection our signal-attenuation rules offer C-band operators, we need not address SIA's arguments relating to the mobile units permitted in the band, since the emission limits from mobile units are so much lower than for base stations and since mobile units can only operate within the range of the base station's enabling signal.<sup>129</sup> Accordingly, we reject SIA's argument and affirm the signal attenuation rule the Commission previously adopted.

## 2. Power Limits and LNB Saturation

56. SIA argues that the Commission failed to address evidence in the record regarding the potential for emissions from the 3650 MHz transmitters to saturate the low noise block converters (LNBS) on FSS earth stations operating in the adjacent C-band at 3700-4200 MHz.<sup>130</sup> SIA requests that the Commission reconsider the permissible power level for fixed and base stations, at least in the upper half of the 3650 MHz band (that closest to the C-band) and set it at a level below the 25-watt figure that the order adopted.

57. We decline to reconsider the permissible power limits in the 3650 MHz band as SIA requests. A review of the analysis that SIA provides for its argument on LNB saturation reveals that it is based on two very conservative assumptions.<sup>131</sup> The predicted saturation is most pronounced when the arrival angle of the satellite antenna is 5 degrees. At greater arrival angles – as will exist for the great majority of earth stations – the interference projected by SIA's analysis is reduced. We also note that SIA has again assumed free space assumptions for its propagation analysis. Employing a path loss exponent greater than 2 as we did for the OOB emissions estimate significantly reduces the potential interference.

58. Given the smaller separation distances necessary to alleviate LNB saturation predicted by a more realistic propagation model, a modest coordination effort should allow satellite earth stations to operate effectively, despite the presence of nearby operations in the 3650 MHz band. We expect 3650 MHz licensees and satellite operators to undertake such coordination where necessary.<sup>132</sup> The registration requirement for fixed and base station operations in the band will facilitate this coordination. As the order describes, in the registration process, licensees in the 3650 MHz band will be required to provide identification and location information for their fixed and base stations, as well as the technical information necessary for interference analysis.<sup>133</sup>

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<sup>128</sup> See Verizon comments at 6.

<sup>129</sup> See SIA Petition at 10-12.

<sup>130</sup> SIA Petition at 13-14. See also Fox/HBO Comments at 3. As SIA explains:

LNBS are “basically amplification devices used in FSS earth stations, and are designed to operate within a specific power range much like any other amplifier. If these devices are forced to operate near the level of saturation, the result could be distortion of the received signal in the form of phase noise, which is quite detrimental to high order modulation schemes such as those used for HDTV distribution. Saturation also triggers amplifier suppression effects in which the emissions from WISP devices could actually overcome weaker satellite transmissions.

SIA Petition at 13.

<sup>131</sup> See SIA Petition, attachment C.

<sup>132</sup> We note that 3650 MHz licensees can search the IBFS (<http://svartifoss2.fcc.gov/myibfs/welcome.do>) to determine if there are any known earth stations with which they should be concerned.

<sup>133</sup> See *3650 MHz Order*, 20 FCC Rcd 6513, ¶ 32 & n. 57.

59. Despite the implication of SIA's argument in this proceeding, the authorization for terrestrial operations in the 3650 MHz band is hardly a new development. In 2000, the Commission allocated the band for terrestrial fixed service and base station operations of mobile service on a co-primary basis.<sup>134</sup> Accordingly, satellite operators have been on notice for some time of the potential for many of the adjacent-band operations about which SIA now complains. It appears that, for economic reasons, satellite operators may have chosen not to install the appropriate filters in response to the Commission's 2000 action. If that is the case, we decline at this point to relieve them of the consequences of their business decisions.

60. We thus reject SIA's contention that the Commission's authorization of operations in the 3650 MHz band improperly places the burden of avoiding interference on incumbents.<sup>135</sup> It is not Commission policy to protect incumbent licensees against all emissions from adjacent bands; this is particularly true when the emissions are a foreseeable result of prior allocation orders. Installation of appropriate filters on satellite earth stations can adequately address the LNB saturation issue that SIA now raises.<sup>136</sup>

### 3. Satellite Coordination Requirements

61. Several parties urge reconsideration of the portion of the *3650 MHz Order* governing coordination of 3650 MHz fixed station operations within the exclusion zones established around grandfathered FSS earth stations.<sup>137</sup> WCA suggests that the requirement that fixed station operators negotiate individualized agreements with earth station licensees, without a pre-determined interference protection framework, imposes significant transaction costs on 3650 MHz licensees. It contends that this structure creates a significant disincentive for operations within the exclusion zones, "even where the interference risk is minimal or non-existent."<sup>138</sup> To reduce these burdens, the petitioners ask that we impose the guidelines of the Commission's Part 101 rules (which govern the private use of certain microwave radio spectrum) as a framework for the coordination, to expedite fixed station entry without

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<sup>134</sup> Amendment of the Commission's Rules With Regard to the 3650-3700 MHz Government Transfer Band, ET Docket No. 98-237, MR-9411, WT Docket No. 00-32, *First Report & Order and Second Notice of Proposed Rulemaking*, 15 FCC Rcd 20488, 20495-96, ¶¶ 13, 16 (2000).

<sup>135</sup> See SIA Reply at 6-7.

<sup>136</sup> SIA suggests that, in permitting mobile operations in the 3650 MHz band, the Commission changed course without providing a reasoned explanation. See SIA Reply at 8. In making this argument, SIA refers to language from an earlier action in this proceeding in which the Commission declined to permit mobile operations in the band, allocating it instead only for fixed and base station operations. See *Amendment of the Commission's Rules with Regard to the 3650-3700 MHz Government Transfer Band*, ET Dkt No. 98-237, RM-9411, WT Dkt No. 00-32, First Report and Order and Second Notice of Proposed Rule Making, 15 FCC Rcd, 20488, 20496, ¶ 16 (2000) (2000 Order & NPRM) ("Given the challenging spectrum sharing environment involving the relatively weaker satellite receive signals, we remain concerned about mobile station (*i.e.* roving handset) operations in the 3650-3700 MHz band."). It is hardly true, however, that the Commission simply changed course without considering the effects of permitting mobile operations in the band. Rather, it required that mobile transmitters receive a base station's enabling signal and imposed a peak power limit, both in an attempt to "provide a reasonable balance between interference protection goals and fostering the most flexible use of mobile stations" in the band. *3650 MHz Order*, 20 FCC Rcd at 6520-21, ¶¶ 51, 52.

<sup>137</sup> See, e.g., WCA Petition at 23; Wi-Max Forum Petition at 11-12. Airstream comments at 7; Verizon comments at 6.

<sup>138</sup> WCA Petition at 23.



creating interference risk to the grandfathered FSS earth stations.<sup>139</sup>

62. SIA opposes application of the Part 101 coordination rules to the 3650 MHz band, arguing that the architecture of the networks covered by Part 101 differs significantly from those that will be operating in the 3650 MHz band. Instead, it suggests permitting interested parties to develop their own coordination procedures but relying, in the meantime, on the operator-to-operator coordination procedures envisioned in the *3650 MHz Order*.<sup>140</sup>

63. We decline to adopt our Part 101 rules as the sole means of coordination for those 3650 MHz licensees seeking to operate fixed services within the exclusion zones that the Commission established around grandfathered FSS earth stations. Our Part 101 rules, *inter alia*, “prescribe the manner in which portions of the radio spectrum may be made available for private . . . microwave operations that require transmitting facilities on land.”<sup>141</sup> In doing so, however, they set out specific coordination procedures and interference protection criteria for covered fixed microwave transmitters.<sup>142</sup> Rather than impose these specific procedures and criteria, we prefer to allow the parties involved to choose for themselves the rules governing their particular negotiations. They are certainly free to adopt the Part 101 rules; or they may prefer to structure their coordination process differently. For example, Appendix D of the *3650 MHz Order* laid out a different methodology for coordinating the placement of a fixed station within an FSS exclusion zone.<sup>143</sup>

### III. ORDERING CLAUSES

64. Accordingly, IT IS ORDERED that, pursuant to the authority contained in Sections 4(i), 302, 303(e), 303(f), and 307 of the Communications Act of 1934, as amended, 47 USC §§ 154(i), 302, 303(c), 303(f), and 307, this Order on Reconsideration IS HEREBY ADOPTED.

65. IT IS FURTHER ORDERED that, pursuant to Sections 4(i), 302, 303(e) 303(f), 303(g), 303(r) and 405 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), 303(f), 303(g) and 405, that the petitions for reconsideration, filed by Motorola and Redline and seeking

<sup>139</sup> WCA Petition at 22-24; Wi-Max Forum Petition at 11-12. *See also* Airstream comments at 7 (without Part 101 procedures, earth station operators have “no incentive to negotiate in good faith” and can “stonewall provision of service” in exclusion zones); Verizon comments at 6; NextWeb comments at 9.

<sup>140</sup> SIA comments at 13-14.

<sup>141</sup> 47 C.F.R. § 101.1(b).

<sup>142</sup> *See* 47 C.F.R. §§ 101.103, 101.105.

<sup>143</sup> *See 3650 MHz Order*, Appendix D, 20 FCC Rcd at 6554-61. We note that, as originally published, the formulas in Appendix D had two minor errors, which we correct here. First, in Equation 6, we replace Gd with  $\theta x$ , where  $\theta x$  is the off axis angle. With that change, Equation 6 becomes:  $Mfx = 18.17 * Exp^{(-0.055*\theta x)}$ . Second, in Equation 7, we reverse the sign of the factor on the right side of the equation, so it reads as follows:

$$Dx(km) = \frac{150}{10^{\left[ \frac{(0.724 - Gd + Mfr)}{20} \right]}}$$

Note that  $\theta x$  (once computed) can have a value greater than 48 degrees. In those cases (i.e.,  $\theta x > 48$  degrees), set  $\theta x$  to 48 degrees in Equation 6 and solve.

clarification regarding the contention-based protocol requirement ARE GRANTED to the extent discussed above.

66. IT IS FURTHER ORDERED that Part 90 of the Commission's rules IS AMENDED as specified in Appendix A, and such rule amendments shall be effective 30 days after publication of the text thereof in the Federal Register.

67. IT IS FURTHER ORDERED that, pursuant to Sections 4(i), 302, 303(e) 303(f), 303(g), 303(r) and 405 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 302, 303(e), 303(f), 303(g) and 405, that the remainder of the petitions for reconsideration filed by Motorola and Redline, as well as the reconsideration petitions of BRN Phoenix, the Enterprise Wireless Alliance, the Satellite Industry Association, the Wireless Communications Association, the Wi-Max Forum, and the joint petition of Intel, Redline and Alvarion ARE DENIED.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch  
Secretary

## APPENDIX A

## Final Rule Changes

For reasons discussed in the preamble, the Federal Communications Commission amends 47 CFR part 90 to read as follows:

**PART 90 – PRIVATE LAND MOBILE RADIO SERVICES**

1. The authority citation for part 90 continues to read as follows:

**Authority:** Sections 4(i), 11, 303(g), 303(r), and 332(c)(7) of the Communications Act of 1934, as amended, 47 U.S.C. 154(i), 161, 303(g), 303(r), 332(c)(7).

2. Section 90.7 is amended by revising the definition of contention-based protocol to read as follows.

**§ 90.7 Definitions.**

\* \* \* \* \*

*Contention-based protocol.* A protocol that allows multiple users to share the same spectrum by defining the events that must occur when two or more transmitters attempt to simultaneously access the same channel and establishing rules by which a transmitter provides reasonable opportunities for other transmitters to operate. Such a protocol may consist of procedures for initiating new transmissions, procedures for determining the state of the channel (available or unavailable), and procedures for managing retransmissions in the event of a busy channel. Contention-based protocols shall fall into one of two categories:

- (1) An unrestricted contention-based protocol is one which can avoid co-frequency interference with devices using all other types of contention-based protocols.
- (2) A restricted contention-based protocol is one that does not qualify as unrestricted.

\* \* \* \* \*

3. Section 90.203 is amended by revising paragraph (o) to read as follows:

**§ 90.203 Certification required.**

(o) Equipment certification for transmitters in the 3650-3700 MHz band.

- (1) Applications for all transmitters must describe the methodology used to meet the requirement that each transmitter employ a contention based protocol and indicate whether it is capable of avoiding co-frequency interference with devices using all other types of contention-based protocols (see §§ 90.7, 90.1305 and 90.1321 of this part);
- (2) Applications for mobile transmitters must identify the base stations with which they are designed to communicate and describe how the requirement to positively receive and decode an enabling signal is incorporated (see § 90.1333 of this part); and
- (3) Applications for systems using advanced antenna technology must provide the algorithm used to reduce the equivalent isotropically radiated power (EIRP) to the maximum allowed in the event of overlapping beams (see § 90.1321 of this part).

- (4) Applications for fixed transmitters must include a description of the installation instructions and guidelines for RF safety exposure requirements that will be included with the transmitter. (See § 90.1335).

4. Section 90.1319 is amended by revising paragraphs (a), (b), (c), and adding paragraph (d) to read as follows:

**§ 90.1319 Policies governing the use of the 3650-3700 MHz band.**

(a) Channels in this band are available on a shared basis only and will not be assigned for the exclusive use of any licensee

(b) Any base, fixed, or mobile station operating in the band must employ a contention-based protocol.

(c) Equipment incorporating an unrestricted contention-based protocol (i.e. one capable of avoiding co-frequency interference with devices using all other types of contention-based protocols) may operate throughout the 50 megahertz of this frequency band. Equipment incorporating a restricted contention-based protocol (i.e. one that does not qualify as unrestricted) may operate in, and shall only tune over, the lower 25 megahertz of this frequency band.

(d) All applicants and licensees shall cooperate in the selection and use of frequencies in the 3650-3700 MHz band in order to minimize the potential for interference and make the most effective use of the authorized facilities. A database identifying the locations of registered stations will be available at <<http://wireless.fcc.gov/uls>>. Licensees should examine this database before seeking station authorization, and make every effort to ensure that their fixed and base stations operate at a location, and with technical parameters, that will minimize the potential to cause and receive interference. Licensees of stations suffering or causing harmful interference are expected to cooperate and resolve this problem by mutually satisfactory arrangements.

## APPENDIX B

**Parties Filing Petitions for Reconsideration  
of the Report and Order**

1. BRN Phoenix, Inc.
2. Enterprise Wireless Alliance (EWA)
3. Intel Corporation, Redline Communications, Inc. and Alvarion Inc. (joint petition)
4. Motorola, Inc.
5. Redline Communications, Inc.
6. Satellite Industry Association (SIA)
7. Wireless Communications Association International, Inc (WCA)
8. Wi-Max Forum.

**Timely Filed Oppositions, Comments and Replies**

- |  |  |
|--|--|
| 1. Alband, Linda                         | 2. AirStream Data, LLC                   |
| 3. American Petroleum Institute (API)    | 4. Anderson, Ithaka                      |
| 5. Ansik, Mihal                          | 6. April, Jay                            |
| 7. Armstrong, Marilee                    | 8. Aronoff, Paul                         |
| 9. Austin Free-Net                       | 10. Baier, Randal                        |
| 11. BG Wireless, Inc.                    | 12. Bilderback, Jim                      |
| 13. Boone, Douglas R.                    | 14. Borus, Audrey A.                     |
| 15. BPS Networks                         | 16. BRN Phoenix, Inc.                    |
| 17. Bspeedy Wireless Inc.                | 18. Burns, William                       |
| 19. Bushard, Mike Jr.                    | 20. Butler, Peter                        |
| 21. Cape, Melissa                        | 22. Carter, Steve                        |
| 23. Carullo, Scott A.                    | 24. Chicago Media Action                 |
| 25. Chounet, Linda and Paul              | 26. Cisco Systems, Inc.                  |
| 27. Coastal Sierra, Inc.                 | 28. Coberly, Allan                       |
| 29. Coelho, Marco C.                     | 30. Coffey, Greg                         |
| 31. Connolly, Michael                    | 32. Conrad, Ryan                         |
| 33. Cronin, Kevin                        | 34. Crossman, Kimo                       |
| 35. Davis, Morgan                        | 36. Direct Wireless Web                  |
| 37. Dougherty, Martin                    | 38. Drew, Christopher A.                 |
| 39. Dunphy, Joseph F.                    | 40. Ellsworth, Mike                      |
| 41. Enterprise Wireless Alliance         | 42. Erskine, Michael                     |
| 43. Fisler, Nancy                        | 44. Foster, Tim                          |
| 45. Fox Networks & Home Box Office, Inc. | 46. Friedman, Nicole                     |
| 47. Friedman, Paula                      | 48. Frosty Hollow Ecological Restoration |
| 49. Garland, Jeff                        | 50. Gerry, Lyn                           |
| 51. Giguere, P.                          | 52. Glass, Brett                         |
| 53. Glynn, David                         | 54. Gustafsson, Eje                      |
| 55. Halsted, Chad N.                     | 56. Harkness, Roger                      |
| 57. Harnish, Richard                     | 58. Hart, Deborah Forest                 |
| 59. Havens, Brent A.                     | 60. Hayes, David                         |
| 61. Henry, Roger                         | 62. Herber, Steven J.                    |
| 63. Institute for Local Self-Reliance    | 64. Irmiger, Don                         |



65. Johnson, Deborah
67. Jones, Tom
69. Kaye, Clair
71. Kerns, Timothy
73. Kleiman, Steven L.
75. Koenigsdorf, Brian
77. Krusemeyer, Gloria
79. Lacy, Edward
81. Larsen, Matt
83. Laura, Joe
85. Lienhart, Debbie
87. Magnuson, Brian
89. Maranda, Michael
91. Martin, Mark
93. McGuire, James
95. McMillion Curtis
97. Meinrath, Sascha D.
99. Michiana Wireless
101. Moran, Peter
103. Murphy, Karen
105. Neuliep, Michael
107. Nicholas, Garth
109. Penland, Kerry
111. Ponschock, Lon
113. Potthoff, Rick
115. RapidDSL & Wireless, Inc
117. Reiter, Tobias H.
119. Ridge Runner Internet Services Inc.
121. Ronan, Stephen B.
123. Russell, Brian
125. Saddlemire, Craig
127. Schaefer, John
129. Sherwood, Jay
131. SmarterBroadband
133. Sussman, RJ
135. TDS Telecommunications Corp.
137. Thomas, Kent
139. Towers, Matt
141. UpHi.net, LLC
143. Veloxinet, Inc.
145. Wade, Karen
147. Wallace, Ron
149. Weaver, Rosie
151. Wenger, John
153. Win.Net Internet
155. Wireless Internet Service Providers Ass'n (WISPA)
157. Wolfe, Timothy E
159. XO Communications, Inc.
66. Johnson, Robert
68. Kaminga, John Paul
70. Kazemi, Haudy
72. Kirsher, William
74. Knox, Rich
76. Koskenmaki, Mark
78. Kunze, Rick
80. Lamb, Michael
82. Last Mile Wireless
84. Levy, Don
86. Lister, Hillary J.
88. Manro, Don
90. Marie, Theresa
92. Massey, David Dyar
94. McKinion, James M.
96. Media Access Project
98. Meyer, Kenneth W.
100. Miller, Noah
102. Motorola Inc.
104. Murphy, Kevin
106. NextWeb, Inc.
108. PART-15.ORG
110. Pittman, Charles
112. Pool, Herman
114. Quarles, Wendy
116. Reed, Scott B.
118. Riddle, Dan
120. Roadstar Internet
122. Rothgery, Robert F.
124. Rzeszutek, Konrad
126. Satellite Indus. Ass'n
128. Schwieters, Nancy
130. Shevokas, Amanda
132. Sprint Corporation
134. Szczepanczyk, Mitchell
136. Technology For All
138. Timmerman, Rudolf H.
140. Tropos Networks
142. Valeri, Andy
144. Verizon
146. Wallace, Randy
148. Warriar, Unni
150. Webster, Brian
152. WiMax Forum
154. Wireless Communications Ass'n Int'l, Inc.
156. WirelessVT Solutions Inc
158. Worley, Robin

**STATEMENT OF  
COMMISSIONER JONATHAN S. ADELSTEIN**

*Re: Wireless Operations in the 3650-3700 MHz Band (ET Docket No. 04-151); Rules for Wireless Broadband Services in the 3650-3700 MHz Band (WT Docket No. 05-96); Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band (ET Docket No. 02-380); Memorandum Opinion and Order*

A little over two years ago, I was very pleased to support the Commission's innovative decision to make the spectrum in the 3650-3700 MHz (3650 MHz) band available on a licensed, but non-exclusive, basis. In many respects, this was a bold statement. We wanted to take advantage of the success of the WiFi movement and take it to another level. We wanted to find the right balance between a licensing model for traditional, area-wide mobile systems and a model for unlicensed, consumer-based services. Our licensing regime for the 3650 MHz band will serve as a wireless highway between small towns and the big city – it will facilitate the delivery of broadband to all corners of the country by serving a different user group, one that often is driven by more localized, community based needs.

Since our initial decision, I have talked often about the public interest benefits of the new licensing rules for the 3650 MHz band. I have spoken with many supporters of our decision, and with those who believe the band would be better used on an exclusive basis. But I remain convinced the hybrid licensing approach that we first adopted for the 3650 MHz band is the correct one, and I enthusiastically support our reconsideration order today.

During my time at the Commission, I have pushed for flexible licensing approaches that make it easier for community-based providers to get access to wireless broadband opportunities, and the rules we affirm for the 3650 MHz band should help make wireless broadband services available to a large number of new users. Today, we uphold our earlier decision to put in place a regime that doesn't rely on first in time and provides equal access to all. I have heard from representatives of the Community Wireless Network movement about our 3650 MHz licensing rules, and they are thrilled with the hybrid approach and the positive impact it will have on their efforts to deploy broadband networks in underserved communities around the country.

So, once again, I wholeheartedly support our 3650 MHz licensing decision. Of course, only time will tell if this unique approach will result in increased use of this spectrum band. But I think that given the success of unlicensed wireless networks, we are on the right track, and our creative spectrum management approach is well justified.