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

In the Matter of	)	
	)	
Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands	)	WT Docket No. 02-146
	)	

MEMORANDUM OPINION AND ORDER

Adopted: February 24, 2005 **Released: March 3, 2005**

By the Commission:

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I. INTRODUCTION AND EXECUTIVE SUMMARY

1. In this *Memorandum Opinion and Order,* we address the Petition for Reconsideration[1] filed by the Wireless Communications Association International, Inc. (WCA)[2] on February 23, 2004. WCA seeks reconsideration of the Commission's October 16, 2003, *Report and Order,*[3] which adopted service rules to promote the private sector development and use of the spectrum in the 71-76 GHz, 81-86 GHz, and 92-95 GHz bands.[4] The Petition and the instant *Memorandum Opinion and Order* focus exclusively on the licensed use of the 71-76 GHz and 81-86 GHz bands.

2. For the reasons provided herein, we grant in part and deny in part the Petition as follows:

- We require interference analyses prior to registering all (new or modified) links in the 71-76 GHz and 81-86 GHz bands.
- We eliminate the band segmentation and loading requirements and adopt an efficiency requirement of 0.125 bits per second (bps)/Hertz (Hz).
- We modify the interference protection criteria by deleting the minimum 36 dB carrier signal to interference signal (C/I) ratio, and by adopting for receivers employing analog modulation a 1.0 dB degradation limit for the baseband signal-to-noise (S/N) ratio required to produce an acceptable signal in the receiver. Also, we reaffirm that the 1.0 dB receiver threshold-to-interference (T/I) ratio degradation limit for digital systems that we adopted in the *Report and Order* still applies.[5] We also decline Petitioner's request to adopt 36 dB as the maximum required C/I.
- We adopt a power spectral density limit of 150 milliwatts (mW)/100 Megahertz (MHz).
- We modify the technical parameters to accommodate smaller, less expensive antennas with a minimum antenna gain of 43 dBi and a 1.2 degree half-power beamwidth.

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[1] Petition for Reconsideration in the 70/80 GHz Bands, WT Docket No. 02-146, filed Feb. 23, 2004 (Petition).

[2] WCA is a trade association whose membership includes a wide variety of Commission licensees, system operators, equipment manufacturers, and consultants interested in the domestic deployment of spectrum for wireless broadband service. *See* WCA Comments, filed Nov. 1, 2002, at 1.

[3] Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, WT Docket No. 02-146, *Report and Order*, 18 FCC Rcd 23318 (2003) ("*Report and Order*").

[4] *See, e.g.,* 47 C.F.R. §§ 101.1501-101.1527.

[5] *See Report and Order*, 18 FCC Rcd at 23353 ¶ 91; *see also* 47 C.F.R. § 101.147(z)(2). The threshold-to-interference (T/I) ratio is defined as the ratio of desired to undesired signal power that degrades the digital receiver static and dynamic (outage) thresholds. *See* Telecommunications Industry Association/Electronic Industries Association Telecommunications Systems Bulletin 10-F (TIA/EIA TSB10-F), Interference Criteria for Microwave Systems, Annex B, at B-1.

- We decline Petitioner's requests: to shorten the construction period from 12 months to 180 days; to provide conditional authorization during the pendency of an application for a nationwide, non-exclusive license; and to require Automatic Transmitter Power Control (ATPC)[6] for links with Effective Isotropic Radiated Power (EIRP)[7] greater than 23 dBW.

II. BACKGROUND

3. On October 16, 2003, the Commission adopted a *Report and Order* establishing service rules to promote non-Federal development and use of the "millimeter wave"[8] spectrum in the 71-76 GHz, 81-86 GHz, and 92-95 GHz bands,[9] which are allocated to non-Federal Government and Federal Government users on a co-primary basis.[10] Based on the determination that the highly directional, "pencil-beam" signal characteristics permit systems in these bands to be engineered so that many operations can co-exist in the same vicinity without causing interference to one another, the Commission adopted a flexible and innovative regulatory framework for the bands.[11] Specifically, the *Report and Order* permits the issuance of an unlimited number of non-exclusive, nationwide licenses to non-Federal Government entities for all 12.9 GHz of spectrum. Under this licensing scheme, a license serves as a prerequisite for registering individual point-to-point links; licensees may operate a link only after the link is both registered with a third-party database and coordinated with the National Telecommunications and Information Administration (NTIA).[12] This flexible and streamlined regulatory framework

[6] ATPC automatically increases or decreases the output power of a transmitter based on the received signal level. For example, if the signal at the receiver drops below a certain level due to rain, the transmitter will temporarily increase power to restore the signal at the receiver to the required level. Once the rain stops, the transmitter power will decrease to the normal power necessary to maintain the required signal level at the receiver.

[7] EIRP represents the level of the transmitted signal. It is the product of the power sent to the antenna and the antenna gain where the antenna gain is measured with respect to an isotropic antenna. Gain is a measure of the performance of an antenna in a given direction relative to the performance of a theoretical (isotropic) antenna and is expressed in decibels with respect to an isotropic antenna (dBi).

[8] The term "millimeter wave" is derived from the wavelengths of radio frequency signals between 30 GHz and 300 GHz, which range between 1 and 10 millimeters.

[9] Herein, the term "bands" generally refers to the combined 71-76, 81-86, and 92-95 GHz bands. If a band is discussed separately, or a discussion pertains to two of the three segments, then the specific segment(s) will be referenced (*e.g.,* 71-76 GHz band, 71-76 GHz and 81-86 GHz bands) or we will refer to the particular bands collectively (*e.g.*, 71-76 GHz and 81-86 GHz bands will be referred to as the "70/80 GHz" bands and all of the bands will be referred to as the "70-80-90 GHz" bands).

[10] The bands are allocated to both Federal Government and non-Federal Government users on a co-primary basis, except the 94.0-94.1 GHz portion, which is allocated for Federal Government use on a primary basis. See generally *Report and Order*, 18 FCC Rcd at 23322-31 ¶¶ 6-26. In the context of spectrum management, "Federal Government" refers to use by the Federal Government and "non-Federal Government" refers to use by private and commercial entities and state and local governments. *See Report and Order*, 18 FCC Rcd at 23319 n.3.

[11] *Report and Order*, 18 FCC Rcd at 23337-9 ¶¶ 44-47.

[12] Initially, coordination of non-Federal government links with Federal government operations was accomplished under the existing coordination process; that is, requested non-Federal government links were recorded in the Commission's Universal Licensing System (ULS) database and coordinated with NTIA through the Interdepartment Radio Advisory Committee (IRAC) Frequency Assignment Subcommittee. *Report and Order*, 18 FCC Rcd at 23343 ¶ 60. Starting on February 8, 2005, this interim link registration process was replaced by a permanent process where third-party database managers are responsible for recording each proposed non-Federal link in the third-party (continued....)

was designed to encourage innovative uses of the "millimeter wave" spectrum, facilitate future development in technology and equipment, promote competition in the communications services, equipment, and related markets, and advance potential sharing between non-Federal Government and Federal Government systems.

4. The Commission divided the 71-76 GHz and 81-86 GHz bands into four unpaired 1.25 GHz segments each (eight total), without mandating specific channels within the "soft" segments.[13] The Commission also determined that these segments may be aggregated without limit, as needed, although first-in-time interference protection rights would be diminished if the licensee did not load the spectrum at the rate of one bit per second per Hertz (1 bps/Hz).[14]

5. On February 23, 2004, the Wireless Communications Association International, Inc. (WCA) filed a Petition seeking reconsideration ("the Petition") of the *Report and Order*. We received no oppositions or replies in response to the Petition but WCA, as well as individual members of WCA, clarified or refined the Petition in *ex parte* meetings with Commission staff.[15] As discussed in further detail below, we considered all of the comments and *ex parte* presentations in the record in reaching our decisions.

(...continued from previous page)
database link system and coordinating with NTIA's automated "green light/yellow light" mechanism to determine the potential for harmful interference with Federal operations. *See* Wireless Telecommunications Bureau Announces Permanent Process for Registering Links in the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands, *Public Notice*, DA 05-311 (rel. February 3, 2005). A "green light" response indicates that the link is coordinated with the Federal Government; a "yellow light" response indicates a potential for interference to Federal Government or certain other operations. *See generally* 47 C.F.R. § 2.106 (US388, US389). In the case of a "yellow light," the licensee must file an application for the requested link with the Commission, which in turn will submit the application to the IRAC for individual coordination. *See Report and Order*, 18 FCC Rcd at 23341-43 ¶¶ 52, 54, 58; *see also* Wireless Telecommunications Bureau Announces Licensing and Interim Link Registration Process, Including Start Date for Filing Applications for Non-exclusive Nationwide Licenses in the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands, *Public Notice*, 19 FCC Rcd 9439 (2004); Wireless Telecommunications Bureau Opens Filing Window for Proposals to Develop and Manage Independent Database of Site Registrations by Licensees in the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, *Public Notice*, 19 FCC Rcd 4597 (2004). This automated process is designed to streamline the administrative process for non-Federal users in the bands. We noted that the classified nature of some Federal Government operations precludes the use of a public database containing both Federal Government and non-Federal Government links. *See Report and Order*, 18 FCC Rcd at 23340 ¶ 48. Database managers will not be responsible for assigning frequencies but will be responsible for establishing and maintaining the database. However, they are not precluded from offering additional services, such as frequency coordination, which will assist a licensee in designing a link.

[13] *Report and Order*, 18 FCC Rcd at 23319 ¶ 2, 23331-3 ¶¶ 27-32.

[14] *Report and Order*, 18 FCC Rcd at 23333, 23349-50 ¶¶ 32, 81.

[15] *See* WT Docket No. 02-146 (notices of *ex parte* presentations). *See, e.g.*, Letter to Marlene H. Dortch, Secretary, from Randall W. Sifers, Counsel to GigaBeam Corporation, *Notice of Ex Parte* meeting between representatives of the WCA Above 60 GHz Committee and the Wireless Telecommunications Bureau in WT Docket No. 02-146, dated July 22, 2004; Letter to Marlene H. Dortch, Secretary, from Mary L. Brown, Cisco Systems, Inc., *Notice of Ex Parte* presentation of Cisco Systems, Inc. and other members of the WCA Above 60 GHz Committee in WT Docket No. 02-146, dated August 24, 2004; Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, WCA Above 60 GHz Committee in WT Docket No. 02-146, dated October 8, 2004; Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, WCA Above 60 GHz Committee in WT Docket No. 02-146, *Notice of Ex Parte* meeting between representatives of the WCA Above 60 GHz Committee and the Office of Engineering Technology and the Wireless Telecommunications Bureau, dated January 27, 2005; Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, WCA Above 60 GHz Committee in WT Docket No. 02-146, dated January 31, 2005.

III. DISCUSSION

6. In its Petition, WCA claims that the *Report and Order* overlooked a number of detailed technical issues relating to the 70/80 GHz bands. WCA suggests that the Commission take a course of remedial action as follows: (1) require each new user of the 70/80 GHz bands to verify in advance that it will not cause harmful interference to any existing link; (2) reconsider its segmentation and channel loading requirements, preferably eliminating them but at the very least reducing the minimum throughput at which a designated assignment remains eligible for first-in-time interference protection; (3) adopt the interference protection criteria proffered by WCA, (4) shorten the construction period from 12 months to 180 days; (5) reconsider a trio of issues related to antenna and power requirements, including the Commission's rejection, in the *Report and Order*, of the industry's proposed power/gain tradeoff and requirement for certain radios to use ATPC, and its decision not to adopt a power spectral density limit; and (6) grant conditional operating authority to first-time 70/80 GHz applicants who have successfully coordinated and registered their proposed link but are awaiting their non-exclusive nationwide license.[16] Following a discussion of the scope of this reconsideration and the effective date of our determinations, we address each of the issues raised by WCA in turn below.

A. Scope of Reconsideration

7. In the *Report and Order,* the Commission adopted rules and policies for non-Federal Government use of certain of the bands on an unlicensed (Part 15) and licensed (Part 101) basis. The Petition, and thus the instant *Memorandum Opinion and Order*, addresses only the rules and policies for non-Federal Government, licensed use of the 71-76 and 81-86 GHz bands.

B. Mandatory interference analyses requirement for non-federal users

1. Background

8. In the *Report and Order*, the Commission stated that due to the unique characteristics of the transmissions in these "millimeter wave" bands, no "prior coordination" among non-Federal Government licensees is required in advance of operation.[17] In reaching this decision, the Commission focused only on traditional microwave prior coordination as set forth in Part 101 of the Commission's rules and did not consider prior interference analyses.[18] Specifically, the Commission stated that the antenna systems proposed for these bands would "concentrate energy in a very narrow path and have considerable attenuation at much shorter distances than occurs in the lower microwave bands" and that those characteristics would allow systems to be engineered to operate in close proximity to other systems so that many operations can co-exist in the same

[16] Petition at 1-2.

[17] *Report and Order*, 18 FCC Rcd at 23338-9 ¶ 45; 47 C.F.R. § 101.103.

[18] *See Report and Order*, 18 FCC Rcd at 23338-9 ¶ 43 (*citing* Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, *Notice of Proposed Rule Making,* WT Docket No. 02-146, RM-10288, 17 FCC Rcd 12182, 12206-07 ¶ 65 (2002)(*NPRM*) (discussing Loea's proposal to adopt a nationwide licensing scheme with site-by-site coordination in the 70-80-90 GHz bands); *NPRM*, 17 FCC Rcd at 12208 ¶ 69 (while discussing Loea's proposal for coordination, the Commission stated that it expects a coordinator to function in accordance with the rules of traditional microwave prior coordination codified in section 101.103 of the Commission's rules).

vicinity without causing interference to each other.[19] Because the "pencil beam" characteristics of the bands diminish the risk of interference, the Commission reasoned that the first-in-time standard will protect the first-in-time registered or incumbent links, thus alleviating the need for traditional microwave prior coordination, which involves extensive interference analysis and "notice and response" to all licensees and applicants in the area that could be affected by the proposed operation.[20] As a result, the *Report and Order* required that parties work out any interference that might occur after operations commence and interference is actually detected. Parties that are unable to reach an agreeable resolution are free to submit a complaint to the Commission after 30 days.

2. Petition

9. The Petitioner asserts that each registrant of a new link should be required to verify in advance, during the registration process, that its proposed link will not cause or receive harmful interference to or from any existing link previously registered in either the government or non-government databases.[21] Notably, WCA suggests that with current technology permitting real-time, electronic interference analysis, the cost of prevention is negligible, while the consequences of harmful interference discovered after the fact can be "catastrophic" in terms of the severe impact a prolonged network outage has on the demand for 70/80 GHz radios.[22] WCA states that for any application that requires gigabits-per-second speeds, "a network outage of thirty minutes is catastrophic, let alone thirty days."[23] WCA objects to the interference protection procedures as outlined in the *Report and Order* because they are initiated only after a third-party database manager is notified of harmful interference. WCA is concerned that a "*post hoc*" approach would not adequately protect investment in equipment and would be both expensive and less likely to result in expeditious resolution.[24] WCA argues that the Commission's approach requires the user to first ascertain that the system outage is due to RF interference (and not equipment malfunction) and then to notify the database manager so as to help identify the source of the interference. Even after the source is identified, if parties cannot resolve the issue informally, they must then file a complaint with the Commission 30 days after the matter is first reported to a database manager. With no guarantee on how long it will take for the Commission to rule,[25] WCA asserts that customers are not willing to risk an outage of 30 days or longer "at some unspecified time in the indefinite future."[26] Furthermore, WCA contends that a "*post hoc*" regime for commercial links makes little sense given the inescapable need to coordinate with Federal Government users in these bands. In sum, WCA argues that the "*post hoc*" approach adopted in the *Report and Order* imposes a one-time burden of coordinating

[19] *Report and Order*, 18 FCC Rcd at 23338 ¶ 45.

[20] *Report and Order*, 18 FCC Rcd at 23343 ¶ 58. *See* 47 C.F.R. § 101.103 (description of coordination requirements).

[21] Petition at 1, 3-7.

[22] *Id.* at 4.

[23] *Id* at 5.

[24] *Id* at 4-7.

[25] *Id* at 4-5.

[26] *Id* at 6.

with government users plus placing on licensees the continued burden of monitoring new registrations indefinitely.[27]

10. In subsequent *Ex Parte* meetings, WCA further refined its position by stating that in a registration-only regime there may be a long delay between link registration and interference detection, making it harder to identify and correct the problem after the fact.[28] WCA also asserts that interference analysis should be mandated because interference is often asymmetrical, with later registrants causing interference to first registrants without experiencing any interference in return, and thus later registrants would have no incentive to protect incumbent registrants.[29]

3. Discussion

11. We grant the Petitioner's request that we require interference analyses for non-Federal Government licensees. We still believe that interference is unlikely due to the "pencil-beam" nature of the transmissions in this service. However, a change from our original decision is justified after weighing the "unique pencil beam" characteristics of the 70/80 GHz band transmissions against new evidence in the record that the current regulatory scheme will delay, and perhaps hinder, industry efforts to use the 70/80 GHz band as anticipated (*e.g.*, for wireless broadband).[30] We agree with WCA that the uncertainty and delay caused by an after-the-fact approach toward interference protection, and the severe impact of a network outage during the pendency of the interference resolution process, requires us to consider alternatives to the current registration process.[31] We conclude that it would be easy, and far less costly in the long run, for non-government users to finish all interference analyses prior to equipment installation, particularly because non-government users already have to produce an interference profile to satisfy government coordination requirements.[32] Although the risk of interference between users in these "pencil beam" bands should be low, we are persuaded by WCA's assertion that it is not low enough to risk the costs associated with an outage of 30 days or longer while a complaint is pending before the Commission. An examination of costs and benefits reveals that the costs of performing interference analyses would be small, particularly when compared to the benefits of preventing harmful interference to existing operations. In particular, we consider WCA's point that current technology permits real-time electronic interference analysis, thus rendering the cost

[27] *Id.*

[28] Letter to Marlene H. Dortch, Secretary, from Randall W. Sifers, Counsel to GigaBeam Corporation, *Notice of Ex Parte* meeting between the Wireless Communications Association International, Inc. Above 60 GHz Committee and the Wireless Telecommunications Bureau in WT Docket No. 02-146, dated July 22, 2004, at 4.

[29] *Id.*

[30] WCA asserts that the consequence of harmful interference discovered only after the fact can be "bad enough to disqualify this technology as a viable option for much of the target market." Letter to Marlene H. Dortch, Secretary, from Randall W. Sifers, Counsel to GigaBeam Corporation, *Notice of Ex Parte* meeting between the Wireless Communications Association International, Inc. Above 60 GHz Committee and the Wireless Telecommunications Bureau in WT Docket No. 02-146, dated July 22, 2004, at 4.

[31] Petition at 4-5; Letter to Marlene H. Dortch, Secretary, from Randall W. Sifers, Counsel to GigaBeam Corporation, *Notice of Ex Parte* meeting between the Wireless Communications Association International, Inc. Above 60 GHz Committee and the Wireless Telecommunications Bureau in WT Docket No. 02-146, dated July 22, 2004, at 3-6.

[32] Petition at 6.

of prevention minimal when compared to the cost of a network outage.[33] We also note that the record contains no opposition to WCA's claims.

12. It is important to facilitate entry and development of this industry by lowering the risk of interference and thereby ensuring continued investment. Accordingly, we find that the additional assurance of no harmful interference provided by interference analyses in these bands would better serve the public interest. Therefore, we are revising the rules to require licensees, as part of the link registration process, to submit to the database manager an analysis under the interference protection criteria for the 70-80 GHz bands[34] that demonstrates that the proposed link will neither cause nor receive harmful interference relative to previously registered non-government links. This requirement will apply to link registrations (new or modified) that are first submitted to a database manager on or after the effective date of this new requirement.[35]

13. In the unlikely event there is interference after operations commence, despite the prior interference analysis(es), the interference protection procedures set forth in the *Report and Order* govern: the first-in-time registered link is entitled to interference protection and the database manager will so inform the later-registered link operator that the link must be discontinued or modified to resolve the problem.[36] If the complaining first-in-time licensee is not satisfied that the interference has been resolved, then 30 days after the matter is first reported to a database manager, a complaint may be filed with the Commission.[37]

14. The database managers will accept all interference analyses submitted during the link registration process and retain them electronically for subsequent review by the public. It is important for the "first-in-time" determination, and for adjudicating complaints filed with the Commission, that the interference analysis captures the exact snapshot in time (i.e., conditions at the time-of-link-registration) that will be dispositive in a dispute. Without the benefit of an interference analysis on file, it would be much more difficult for registrants to recreate

[33] Petition at 4. The link data currently submitted by licensees at link registration will facilitate and expedite the process of obtaining interference analyses by providing the necessary site, antenna, and equipment data. *See Report and Order*, 18 FCC Rcd at 23378, Appendix C (Required Link Data).

[34] *See* 47 C.F.R. § 101.105(a)(5), App. B, *infra*. "For receivers employing digital modulation: based upon manufacturer data and following TSB 10-F or other generally acceptable good engineering practice, for each potential case of interference a threshold-to-interference ratio (T/I) shall be determined that would cause 1.0 dB of degradation to the static threshold of the protected receiver. For the range of carrier power levels (C) between the clear-air (unfaded) value and the fully-faded static threshold value, in no case shall interference cause C/I to be less than the T/I so determined unless it can be shown that the availability of the affected receiver would still be acceptable despite the interference." *Id.* at § 101.105(a)(5)(i).

[35] The requirement to submit an interference analysis to a database manager is subject to the Paperwork Reduction Act of 1995 and will be submitted to the Office of Management and Budget (OMB) for review. *See* ¶ 45, *infra*. The effective date of this new or modified information collection and/or third-party disclosure requirement will be no earlier than (1) thirty days after publication in the Federal Register and (2) the date that OMB approves it.

[36] *Report and Order*, 18 FCC Rcd at 23343 ¶ 58.

[37] Although not raised in the Petition, we take this opportunity to clarify that the 30-day period starts to run as soon as the database manager is notified in keeping with the overall premise that legitimate interference concerns must be addressed quickly. In addition, as noted in the *Report and Order*, where, in the rare cases it appears that Federal Government and commercial operations are sources of interference to the other, the Commission will work with NTIA to resolve the issues. *Id.*

conditions accurately after the fact. In addition to being responsible for establishing and maintaining the database, the database managers are not precluded from offering additional services, such as frequency coordination, which will assist a licensee in designing a link, or their own interference analyses.[38]

C. Segmentation and Channel Loading requirement

1. Background

15. The introduction of competition plays a major role in how the market reacts to new and expanded telecommunications services. Ensuring a competitive environment was at the forefront of the Commission's original decision to segment the spectrum into units smaller than 5 GHz.[39] Stating that such a plan will encourage efficiency, the Commission provided four unpaired 1.25 GHz segments in each band, for a total of eight segments intended to facilitate adequate guard bands and the maximum number of users at a given location.[40] The Commission did not subject the spectrum to any aggregation limit, so each licensee can operate on up to all 12.9 GHz of co-primary spectrum and use as many segments as it needs on a 1.25 GHz increment.[41] The Commission stated that the flexible or "soft" segmentation, coupled with a loading requirement, are appropriate safeguards that provide new entrants with reasonable access to spectrum by ensuring that spectrum is used rather than hoarded.[42]

16. The Commission also determined that commercial 70/80 GHz licensees will have to meet the 1 bps/Hz loading requirement of section 101.141 of the Commission's rules.[43] Thus, when a licensee has not met that requirement, the registration database would be modified to limit coordination rights to the spectrum that meets the section 101.141 requirement and the licensee loses protection rights on spectrum that has not.[44]

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[38] *See Report and Order*, 18 FCC Rcd at 23340 ¶ 50 ("a database manager is also permitted to offer optional services such as coordination analysis of proposed links with prior-registered links"); Wireless Telecommunications Bureau Opens Filing Window for Proposals to Develop and Manage Independent Database of Site Registrations by Licensees in the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, *Public Notice*, 19 FCC Rcd 4597, 4598 (2004) (database managers are not precluded from offering additional services, such as frequency coordination, which will assist a licensee in designing a link). We note that the licensee is under no obligation to use the third-party database manager's services. Licensees are free to conduct their own interference analyses or to procure the interference analyses from a third party source or the database managers, provided the analyses meet generally accepted good engineering practice and the interference protection standards of section 101.105.

[39] *Report and Order*, 18 FCC Rcd at 23332 ¶ 31.

[40] *Report and Order*, 18 FCC Rcd at 23332-3 ¶¶ 31-32.

[41] *Report and Order*, 18 FCC Rcd at 23339 ¶ 47.

[42] *Report and Order*, 18 FCC Rcd at 23333 ¶ 32. Segments are "soft" because there is no limit on aggregating segments, no pairing requirement (pairing is permitted but not required), and no channelization requirement within the segments. "Soft" segmentation provides a factor of scalability to the amount of spectrum that is authorized to a given user.

[43] *Report and Order*, 18 FCC Rcd at 23350 ¶ 81.

[44] *Id.*

2. Petition

17. The Petitioner asks the Commission to reconsider its "soft" segmentation of the 70/80 GHz bands and to reduce or eliminate the channel loading requirement.[45] WCA asserts that there is no public interest benefit to be gained by regulating the width of the channels, the number of channels used, or the data rate transmitted. WCA also states that the record supports the 70/80 GHz bands not being channelized and that licensees should be permitted to use bandwidths of up to 5 GHz in each direction, in order to maximize flexibility in link design and to facilitate a smooth "upgrade path" as a user's data needs expand.[46] According to the Petition, the segmentation scheme may force manufacturers to produce radios in conformance with the 1.25 GHz increments and, because some modulation schemes do not fit neatly into 1.25 GHz increments, this complicates equipment design and raises the cost of equipment.[47]

18. WCA asserts that no loading requirement is currently necessary and that the Commission should allow the marketplace to dictate the appropriate balance between spectral efficiency, equipment cost, and bandwidth.[48] WCA also states that depending on how the loading requirements are applied, the joint operation of the segmentation and loading rules might discourage or prevent flexible and low-cost frequency plans within a given "spatial pipe."[49] WCA argues that the Commission can impose a channel loading requirement later if applicants find themselves precluded from deployment due to inefficient spectrum utilization.[50] WCA notes that because the spectrum must be occupied one narrow pipe (or pencil beam) at a time, it would be impossible to warehouse the spectrum and otherwise gain market power.[51] Petitioner states that the build-out requirement makes this impossible because the expensive radios in these frequencies make it less likely for competitors to be able to finance a plan to gain market dominance.[52] Further, a 1 bps/Hz loading requirement would prohibit the use of existing, inexpensive binary signaling modulation schemes (*e.g.*, on-off keying (OOK) and binary phase shift keying (BPSK)), when it is in the public interest to facilitate the use of the simplest possible modulation schemes in these bands,[53] and may force manufacturers to use other higher-order modulation schemes that may be more costly and experimental, and hence more time-consuming to develop, thereby delaying introduction of the millimeter wave equipment.[54] Alternatively, WCA argues that if the Commission decides to retain a loading requirement, it should reduce the

[45] Petition at 7-13.

[46] *Id.* at 7.

[47] *Id.* at 8.

[48] *Id.* at 12-13.

[49] *Id.* at 8. "Spatial pipe" is a term used by WCA to describe "a radio link between two points within which users would be permitted to use some or all of the spectrum for a single pair or multiple pairs of radios, using any modulation scheme the licensee desired." *Id.* at 7.

[50] *Id.* at 11.

[51] *Id.*

[52] *Id.*

[53] *Id.* at 8.

[54] *Id.* at 12.

current 1 bps/Hz requirement to a 0.125 bps/Hz standard, measured over the bandwidth specified in the emission designator of the equipment employed.[55]

3. Discussion

19. We grant WCA's proposal to eliminate segmentation and grant in part WCA's request to modify the 1 bps/Hz loading requirement in the 70/80 GHz bands. Our initial concerns about spectrum warehousing or monopolistic behavior by first registrants will be addressed by the 12-month construction requirement[56] and the existing requirement to provide equipment and site-related data at link registration, including the type of emission designator and corresponding bandwidth.[57] Together, these requirements limit a licensee to registering only for what it intends to build within 12 months, thus limiting opportunities for spectrum "hoarding." Moreover, we do not find segmentation to be necessary to avoid warehousing or monopolistic behavior because the "pencil beam" characteristic of transmissions in these bands ensures that even if a licensee registers for all 5 GHz in either the 71-76 GHz or 81-86 GHz bands, such transmissions will still be limited to narrow "pencil beams" and thus will not generally preclude other link registrants from locating nearby.[58] Such high link densities will be further facilitated by our decision to require prior interference analyses[59] together with the "pencil beam" and "spatial pipe" concepts envisioned for these bands.[60] We are convinced that elimination of the segmentation scheme will provide manufacturers the freedom to produce radios utilizing a variety of modulation schemes, rather than only those that fit within a 1.25 GHz increment, thus lowering the cost of equipment for new entrants and spurring technological development and rollout. Furthermore, we find that allowing users the maximum flexibility in link design and the freedom to upgrade as their needs evolve will facilitate new entry in this nascent service.

20. Similarly, we find that it would be more prudent to adopt WCA's proposed 0.125 bps/Hz efficiency requirement to promote technical flexibility. In the *Report and Order*, we adopted a loading standard to promote efficient use of the spectrum and we established 1 bps/Hz as the efficiency requirement for these bands given that it is the least burdensome bit rate specified under Part 101.[61] However, while 1 bps/Hz is a reasonable and readily achievable efficiency requirement for microwave operations, we conclude that retaining the requirement for these bands would unnecessarily risk inhibiting the nascent industry's flexibility to offer

[55] *Id.* at 12-13.

[56] *See* 47 C.F.R. §§ 101.63(b).

[57] *See Report and Order*, 18 FCC Rcd at 23378 (Appendix C: Required Link Data). *See also* FCC Form 601 Schedule M.

[58] *See* Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, WCA Above 60 GHz Committee in WT Docket No. 02-146, dated January 31, 2005 (the only scenario in which the industry's proposal to allow both 50 dBi and 43 dBi antennas would lead to fewer link deployments than under the existing rules would be in the case of a very-high density, hub-and-spoke configuration that one might find on the roof of a skyscraper in an urban core); *see also discussion infra* at paras. 32-33.

[59] *See discussion supra* at para. 11.

[60] *See discussion infra* at para. 32.

[61] *See Report and Order*, 18 FCC Rcd at 23350 ¶ 81 ("licensees will have to meet the loading requirements of [47 C.F.R. § 101.141] which is a minimum of one bit [per second] per Hertz").

products or services that meet their customers' needs. In this connection, we consider WCA's point that the requirement precludes the use of certain inexpensive modulation schemes (that are not precluded by a 0.125 bps/Hz efficiency requirement) together with the bands' unique pencil-beam characteristic and nonexclusive licensing regime (which ensure that any given link is very unlikely to preclude another licensee from operating a link in the same area). Put differently, although 1 bps/Hz is a reasonable efficiency rate, retaining it for these bands could unnecessarily preclude product offerings or increase equipment costs for customers such as plants, universities, or farms, that could otherwise use pencil-beam links (perhaps within their property), to transfer minimal amounts of data using devices that need not achieve 1 bps/Hz to meet the user's need, *e.g.*, remote control or telemetry. Moreover, as WCA observes, the Commission retains discretion to consider in the future whether a higher efficiency standard is necessary, *e.g.*, after the industry better develops equipment and usage.[62] We also realize that we cannot impose a practical analog standard at this time until we determine that licensees are actually utilizing analog equipment and have enough data and history to determine how much traffic is warranted over certain bandwidths. We acknowledge that problems may arise under a 0.125 bps/Hz limit when the bands become more congested, but we find the risk of traffic congestion to be lower due to the "pencil beam" transmission characteristics of this service.[63] Furthermore, as this industry matures, it is inevitable that more efficient systems will force those using the lower 0.125 bps/Hz limit to upgrade to equipment with higher bit rates in order to stay competitive. We also find that lower-cost equipment will provide opportunities to develop the service, particularly in underserved rural areas where build-out costs are often the largest barrier to entry into those markets.

D. Interference Protection Criteria

1. Background

21. In the *Report and Order*, the Commission stated that the record supports the use of Part 101 in these bands to curtail possible harmful interference.[64] Accordingly, the Commission adopted 36 dB as the minimum desired-to-undesired (D/U) ratio for protection of existing digital and analog facilities and a 1 dB degradation limit to the static threshold of the protected receiver for existing digital systems.[65]

[62] Because the primary basis for adopting a lower channel loading requirement is to spur deployment by lowering equipment costs, there is no advantage to selecting a channel loading requirement between 0.125 bps/Hz and 1 bps/Hz. Any channel loading requirement greater than 0.125 bps/Hz will affect equipment development by limiting a manufacturer's choice of modulation schemes.

[63] As stated above, our decisions to employ interference analyses (*supra* at para 11) and to retain the existing power/gain tradeoff standard associated with the narrow "pencil beam" transmissions envisioned in these bands (*infra* at para. 33) will facilitate higher link densities.

[64] *Report and Order*, 18 FCC Rcd at 23353 ¶ 91.

[65] *Report and Order*, 18 FCC Rcd at 23353 ¶ 91; 47 C.F.R. § 101.147(z)(2). For purposes of our discussion, we will use the desired-to-undesired (D/U) ratio interchangeably with the carrier-to-interference (C/I) ratio.

2. Petition

22. Because WCA expects the vast majority of early and mature deployments in the 70/80 GHz bands to employ digital modulation, particularly in densely populated areas, WCA believes maintaining a carrier-to-interference signal (C/I) ratio of 36 dB as the *minimum* would substantially overprotect many links, possibly giving those first in operation unneeded and unwarranted preemption rights over later entrants.[66] Consequently, WCA asks the Commission to remove the 36 dB minimum limit from Section 101.147(z) and to adopt WCA's proposal to amend Section 101.105 so as to set the C/I ratio to protect each link as needed but in no event more than 36 dB.[67] In addition, WCA proposes adoption of interference protection criteria based on no more than 1.0 dB of degradation to the static threshold of a protected receiver using digital modulation, and no more than 1.0 dB of degradation to the signal-to-noise (S/N) requirement of the receiver that will result in acceptable signal quality for continuous operation of a protected receiver using analog modulation.[68]

3. Discussion

23. We grant the Petition in part by deleting the 36 dB C/I ratio altogether because we find that a 1 dB receiver degradation standard provides adequate protection for both digital and analog systems[69] and addresses WCA's concern that the current rule "over protects" existing links.[70] We find that deleting the 36 dB C/I interference protection requirement, when combined with a requirement to employ best engineering practices to design systems, will best serve the public interest. By relying on the ability to determine a "reasonable" C/I requirement based on the characteristics of the equipment deployed on a specific link in a specific location, we provide greater flexibility to new entrants, will not overprotect certain incumbent stations, and will not be subject to abuse by entrants unreasonably claiming a need to be protected to a high C/I ratio. Eliminating the 36 dB C/I ratio provides new entrants the flexibility to select and develop equipment best suited for their business models and relieves them of the burden of providing more interference protection than necessary. WCA proposes doing away with the 36 dB C/I minimum, and requests setting a 36 dB C/I as a maximum instead, with the presumption that the majority of entrants will deploy digital equipment, but offers no technical basis for choosing 36 dB as the maximum threshold. Setting a maximum C/I ratio unnecessarily constrains the design of deployments and may not allow for adequate protection to all systems, in particular analog

[66] Petition at 20-21.

[67] Petition at 21 and Appendix A (at 2-A).

[68] *See* WCA's Petition, Appendix A (at 2-A).

[69] Although we anticipate, as does WCA, that the majority of entrants will be utilizing digital equipment, we will, consistent with our shift away from a command-and-control regime toward a flexible scheme, not preclude the option for new entrants to employ analog equipment in this still-undeveloped industry.

[70] Our decision also focuses on reception which is consistent with the policy goals set forth in the Commission's *Spectrum Policy Task Force Report*. *See* Spectrum Policy Task Force, ET Docket No. 02-135, *Report* (rel. Nov. 2002), at pp. 27-34 (Spectrum Policy Task Force Report). The report also emphasizes adopting more flexible and market-oriented regulatory models to increase opportunities for technologically innovative and economically efficient spectrum use and recommends that regulatory models clearly define the interference protection rights and responsibilities of licensees. Spectrum Policy Task Force Report at 3, 16-19.

systems.[71] Moreover, it is not possible to select specific C/I ratios that would adequately protect both digital and analog systems without possibly overprotecting some systems and under protecting others. Rather than setting a C/I limit based on a presumption of a digital-only environment, and given the early stage of equipment development in this nascent service, it would be more prudent to eliminate the existing standard to maximize flexibility and afford licensees the freedom to develop and deploy equipment, analog or digital, to fit their specific needs.[72]

24. We find that adopting, in part, the changes sought by WCA will provide a specified level of protection for both analog and digital systems without unnecessarily constraining system design. We also find that our aforementioned decision to require interference analyses will enable licensees to determine their needed C/I and the C/I requirements of incumbent link registrants from equipment specifications contained in the third party link registration database. This will give licensees the opportunity to determine a "reasonable" C/I requirement based on the characteristics of the equipment utilized on a specific link.

25. Accordingly, we delete the minimum 36 dB C/I interference protection requirement and adopt a 1.0 dB degradation limit of the baseband signal-to-noise ratio required to produce an acceptable signal in the receiver for analog modulation. Also, we reaffirm our requirement adopted in the *Report and Order* that previously registered links be protected to a T/I level of 1.0 dB of degradation to the static threshold of the protected receiver for digital modulation.[73] Because the 1.0 dB limit for degradation of the T/I ratio was adopted in the *Report and Order,* we need not address WCA's request to impose this requirement.

E. Construction Period

1. Background

26. Persuaded by the aggressive construction requirements set forth in the record, in the *Report and Order* the Commission shortened the traditional 18-month construction requirement of Section 101.63 of the Commission's rules to 12 months.[74] The Commission clarified that each construction period will commence on the date that the third-party database manager registers each link and that it will not require users to file a notification requirement as mandated by section 1.946(d) of the Commission's rules. Instead, licensees will provide notice to a database manager to withdraw unconstructed links from the third-party link registration database.[75]

[71] We also note that the Commission's service rules have traditionally not established a maximum C/I, but rather specify a minimum C/I ratio to protect incumbents. *See, e.g.*, 47 C.F.R. § 101.105

[72] Setting an arbitrary limit could preclude classes of equipment which may need higher C/I ratios than would be required in the Commission's rules.

[73] *Report and Order*, 18 FCC Rcd at 23353 ¶ 91; 47 C.F.R. § 101.147(z)(2).

[74] *Report and Order*, 18 FCC Rcd at 23349 ¶ 80.

[75] *Id.*

2. Petition

27. The Petition proposes to shorten the build out period from 12 months to 180 days.[76] In submitting modifications to Section 101.63(b) of the Commission's rules, WCA proposes that construction of each link occur within 180 days, commencing on the date of the registration for that particular link.[77] WCA provides no justification for its proposal to change the construction period.

3. Discussion

28. We do not want to prematurely foreclose new entrants who may not have readily available capital to build out within a short timeframe. Mandating a 180-day build-out period on a nascent service with little or no equipment available may result in a flood of waiver requests and impose unnecessary costs or burdens on new entrants. It is our understanding that equipment production is underway, so we are hesitant to compress build-out where the timing of equipment rollout is not certain. We also do not want to set regulatory standards so high that it is more likely to impede build-out than encourage development of the service. The Commission reserved the discretion to revisit the issue if experience indicates that additional measures are necessary[78] and we continue to find that to be the prudent approach in this developing service. Thus, we deny Petitioner's request to shorten the build-out period.

F. Antenna and power requirements

1. Minimum antenna gain and maximum power

a. Background

29. In the *Report and Order*, the Commission adopted a minimum 50 dBi and 0.6 degree half-power beamwidth which was supported by most commenters.[79] The Commission agreed with the WCA proposal for technical parameters specifying a minimum 50 dBi gain in order to maximize the efficiency and use of the spectrum but decided not to adopt parameters for antennas with a gain of less than 50 dBi. The Commission stated that it could foresee legacy antennas with undesirable radiation patterns that could pose serious obstacles to the growth of microwave links in these bands in highly populated urban areas in the future.[80]

b. Petition

30. WCA asks the Commission to adopt the "power/gain tradeoff" proposal developed by the industry, *i.e.*, 43 dBi minimum antenna gain and a 1.2 degree half-power beamwidth, rather than the adopted 50 dBi minimum antenna gain and 0.6 degree half-power beamwidth.[81] WCA

[76] Petition at 11 and Appendix A (at 1-A to 2-A).

[77] Petition at Appendix A (at 2-A).

[78] *Report and Order*, 18 FCC Rcd at 23349 ¶ 80.

[79] *Report and Order*, 18 FCC Rcd at 23355 ¶ 96.

[80] *Report and Order*, 18 FCC Rcd at 23355 ¶ 96.

[81] Petition at 15-18.

argues that the adopted 50 dBi minimum gain requirement necessitates the use of antennas that are a minimum of 0.61 meter (2 feet) in diameter, thereby adding to the cost of infrastructure, and thus potentially precluding greater deployment.[82] Specifically, WCA states that these antennas are less marketable, more costly, and more sensitive to tower siting issues than smaller antennas.[83] Petitioner asserts that the use of larger antennas limits available tower structures because of loading limitations and that the sway and twist of many towers are too great to be compatible with antennas with 0.6 degree or less beamwidth.[84] According to WCA, less restrictive beamwidth rules coupled with a corresponding power reduction would maximize the use of existing antenna structures and promote the deployment in the 70/80 GHz bands without increasing the potential for interference. WCA argues adopting that the industry's proposal would provide more flexibility and lower the overall interference environment, provided that for antennas with gains of less than 50 dBi, the maximum EIRP is decreased by 2 dB for every 1 dB decrease in the antenna gain.[85] Petitioner claims that a more flexible specification with a corresponding reduction in power would make it possible to use lower-cost, lower-power products, thus lowering barriers to entry without increasing the potential for interference.[86] In this connection, WCA claims that computer simulations show the power/gain tradeoff is even more important where Automatic Transmitter Power Control (ATPC) is not used although WCA emphasizes that it is important to disentangle the power/gain tradeoff from the separate question of whether to require ATPC.[87]

31. In late January 2005, WCA further explained that, apart from the earlier engineering claims, the consensus estimate of its membership is that adopting the proposal would expand the market for 70/80 GHz radios from perhaps 20 to 25 percent of business locations to perhaps 75 to 80 percent of business locations. WCA notes that there are approximately 750,000 business locations of 20 or more employees (which typically indicates a need for high bandwidth) within one mile of a fiber point-of-presence (POP) but that most of these buildings do not have fiber connections.[88] In this connection, WCA explains that the existing Commission's requirement for

[82] Petition at 15.

[83] *Id*.

[84] *Id.*

[85] Petition at 16.

[86] Petition at 16. In doing so, WCA acknowledges that the use of smaller antennas will result in wider transmitted beamwidths, but asserts that the interference analysis proposed by WCA will ensure that the use of smaller antennas will not unduly reduce frequency re-use opportunities.

[87] *See* Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, Wireless Communications Association International, Inc. Above 60 GHz Committee in WT Docket No. 02-146, *Notice of Ex Parte* presentation, dated October 8, 2004 (WCA asserts that these new simulations do not assume the use of ATPC whereas its earlier simulations show the expected percentage of failed links if the Commission were to replace its current antenna and power requirements with *both* the power/gain tradeoff and mandatory use of ATPC proposed by WCA).

[88] *See* Letter to Marlene H. Dortch, Secretary, from Mary L. Brown, Esq., Cisco Systems, Inc., *Ex parte* presentation of Cisco Systems, Inc. and other members of the Wireless Communications Association's Above 60 GHz Committee in WT Docket No. 02-146, dated August 24, 2004, at 6 citing RHK (750K business buildings in the U.S. have more than twenty employees; only five percent of these buildings have fiber connections and 75 percent of these buildings are within one mile of a fiber hotel). In response to the staff's request for a reference for these statistics, WCA advises that it "found many other attributions [to similar statistics in trade articles] but they differ in some ways and many do not seem to agree with the source to which they are attributed." E-mail from Mark

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50 dBi gain antennas would allow industry to serve only business locations with large concentrations of users, whereas 43 dBi gain antennas would allow the industry to serve locations with lower density business locations, such as campuses or office park settings.[89] WCA also acknowledges that its power/gain tradeoff proposal may result in a potential reduction in deployment density on relatively few large buildings, but avers that this reduction pales in comparison to the much larger benefit of making the service attractive in lower-density business locations.[90] WCA asserts that the spectral cost of the industry's proposed rule is therefore low because the theoretical reduction in the maximum density of hub-and-spoke links on a single rooftop will be limited to a very small subset of potential deployments.[91] For example, WCA states that Gigabeam, a WCA member focusing on using 50 dBi gain antennas to serve the higher-density end of the market, performed a technical analysis that shows that it is possible to place 200 simultaneous two-way gigabit-class links on a large skyscraper rooftop using 43 dBi gain antennas. In this regard, WCA explains that while requiring at least a 50 dBi gain antenna might allow double that density to 400 links, there are simply not many rooftops where that level of deployment would occur.[92] Moreover, WCA points out that adopting the industry proposal "would not *prevent* the use of 50 dBi gain antennas; it would only provide the additional flexibility for lower-gain, lower-power applications on *other* rooftops."[93] WCA also emphasizes that allowing flexibility to deploy lower-gain antennas at lower powers would allow the industry to address significantly more business locations because smaller antennas are cheaper to manufacture and cheaper and easier to mount because they require less expensive and thinner materials (plastic or metal), and a smaller surface area.[94] WCA provides price ratios between the smaller and larger antennas that showed that the larger antennas could, depending on the vendor, cost from 3 to 8 times as much as the smaller antennas included in its proposal.[95] WCA adds that

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Grannis, Esq., to Peter Daronco, FCC, dated Feb. 23, 2005 (Attachment 1 is a list of hyperlinks to seven articles), WT Docket No. 02-146. Additionally, WCA advises that "further research with RHK has turned up a statement from them [that] they believe the actual percentage of buildings lit by fiber in 2002 was around 11% (which may or may not include some buildings more than 1 mile from fiber)." *Id.* (Attachment 2 is *RHK News Outlook* -- Special Report on Access Network). We note in this regard that while the imprecision of these statistics may be unavoidable, it does not distract from WCA's underlying point that there are many business locations within one mile of a fiber point-of-presence that are not lit by fiber.

[89] Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, WCA Above 60 GHz Committee in WT Docket No. 02-146, *Notice of Ex Parte* meeting between representatives of the WCA Above 60 GHz Committee and the Office of Engineering Technology and the Wireless Telecommunications Bureau, dated January 27, 2005.

[90] Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, WCA Above 60 GHz Committee in WT Docket No. 02-146, dated January 31, 2005.

[91] *Id.*at 2.

[92] *Id.*

[93] *Id.*

[94] WCA states that all antennas, large or small, must be manufactured with low surface tolerances in order to meet the Commission's sidelobe requirements but that it is "far more expensive and difficult to produce such low surface tolerances for larger antennas than for small ones for the simple reason that there is a larger surface area." *Id.* at 2.

[95] WCA Above 60 GHz Committee states that its members have seen "antenna vendors quoting price ratios of approximately 1:3 to 1:8 between vendor prices for the smaller antennas that can be used for the slightly wider beamwidth permitted under the industry's rule, and the larger antennas currently required." According to WCA, one of its members that requested bids from seven different vendors noted that most of the seven vendors refused to even
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the current "one-size-fits all approach" means that the antenna cost at the lower end of the market will become a significant portion of the retail price of the link, causing prices to be higher than they need to be, and demand to be suppressed. WCA asserts that while some market segments, such as those in higher-density areas, are relatively price insensitive, they do not represent the entire market. Rather, WCA states that the "other half (or more)" of the market resides in lower-density locations, businesses in campus or office park settings, with buildings of just two or three stories, that will initially deploy 1 Gigabit (Gb)/s Ethernet links and are price sensitive, *i.e.*, will not invest if the price is too high.[96] Therefore, WCA states that its consensus estimate is that adoption of its proposal would dramatically expand the market for 70/80 GHz radios from perhaps 20 to 25 percent of business locations to perhaps 75 to 80 percent of business locations.[97]

c. Discussion

32. We grant WCA's request to modify our technical requirements to allow for a minimum antenna gain of 43 dBi and 1.2 degree half-power beamwidth on policy grounds. We find that allowing smaller, wider beamwidth antennas is in the public interest because it will promote increased usage of the 71-76 GHz and 81-86 GHz bands in areas where those frequencies might otherwise be underutilized. Although the smaller antennas will produce a wider beam, we find that they will produce beam patterns that will retain the "unique pencil beam" characteristics envisioned in these bands. We also find that providing licensees the flexibility to select a wider range of equipment that best suits their particular business plans, whether the target market is high-density, high-rise locations in urban core areas or lower-density, office park settings with buildings of just two or three stories, will facilitate development and growth in this service. We also consider the cost information and market data that WCA provided to be illustrative of the significant economic impact that allowing smaller, less expensive antennas will have on the deployment of services in the 71-76 GHz and 81-86 GHz bands from 20-25 percent to 75 to 80 percent of business locations.

33. For the record, in reaching this decision, we are not persuaded by WCA's claim that allowing the 43 dBi antenna to operate under the "power/gain tradeoff" would result in less interference than the 50 dBi antenna. WCA's analysis wrongly assumes that all links will operate at the maximum allowed power.[98] We find it unlikely that all 70/80 GHz links will operate with the full power allowed under the rules,[99] given that point-to-point links are deployed to transmit data, *etc.*, between two or more locations defined by the users' needs and sound engineering, rather than the maximum distance achievable using the maximum allowable power

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bid on the 24-inch antenna that would meet the Commission's current specification, while several offered to produce the 13-inch version with relaxed sidelobes for $60 to $100 per antenna (plus non-recurring costs of $200,000 to $300,000). *Id.* at 3

[96] *Id.* at 3.

[97] *Id.*

[98] A review of our licensing records for point-to-point stations below 24 GHz reflects that less than one percent of these frequencies are authorized for the maximum EIRP allowed under Part 101.

[99] WCA's October 8, 2004 *Ex Parte* at 2-3.

levels.[100] Although WCA's October 8, 2004 *Ex Parte* asserts that Cisco Systems' simulation results demonstrate that random deployment[101] would not suffer increased link failures as a result of the proposed power/gain tradeoff, Cisco noted earlier that, for equal path lengths (not for equal transmitter power) "the percentage of link failures decreases as the half power beamwidth (HPBW) decreases" and that "[w]ith equal maximum path length, devices with narrower beam, higher gain antennas require less transmit power, resulting in lower interference levels in the system."[102] In other words, at any appropriate EIRP needed to make a link work reliably, a 0.6 degree beamwidth will always have less potential to block other licensees from operating links between the same most desirable points (*e.g.*, the rooftops of the two tallest buildings in an urban area) than a 1.2 degree beamwidth operating with the same EIRP. In sum, there is less side lobe interference potential with the 50 dBi gain antennas, as well as less overall interference potential because the transmitter power needed is reduced with the higher gain, narrower beam, antennas.

34. Nonetheless, as discussed above, we are persuaded as a policy matter that relaxing the technical parameters to allow for lower-gain, wider beamwidth antennas best serves the public interest by promoting increased development of the nascent 70/80 GHz industry and thereby increase access to the 70/80 GHz bands that might otherwise remain underutilized.[103] The benefits of smaller antennas in terms of aesthetics and structure loading are undeniable,[104] as a general matter, and the record before us reflects a potential for significant cost savings associated with deployment of the smaller antennas, with the larger antennas costing from three to eight times as much as the smaller antennas.[105] We also consider the concern that a "one-size-fits all approach" to antenna equipment may fail to address the needs of over half of the potential market.[106] In sum, we find that revising the rules to allow antenna gain less than 50 dBi (but

[100] *See* 47 C.F.R. § 101.113 (Transmitter power limitations). "On any authorized frequency, the average power delivered to an antenna in this service must be the minimum amount of power necessary to carry out the communications desired." *Id.* at § 101.113(a).

[101] *See, e.g.,* WCA's October 8, 2004 *Ex Parte* at 2, Figure 1.

[102] Letter to Marlene H. Dortch, Secretary, from Mary L. Brown, Cisco Systems, Inc., *Notice of Ex Parte* presentation of Cisco Systems, Inc. and other members of the Wireless Communications Association's Above 60 GHz Committee in WT Docket No. 02-146, at 15, dated August 24, 2004; Letter to Marlene H. Dortch, Secretary, from Mark A. Grannis, Wireless Communications Association International, Inc. Above 60 GHz Committee in WT Docket No. 02-146, *Notice of Ex Parte* presentation, at 2-3, dated October 8, 2004.

[103] We adopt Petitioner's proposed modifications to section 101.115 of the Commission's rules including new technical parameters for radiation suppression for cross polarization discrimination and for co-polar discrimination between 1.2 and 5 degrees. *See* Appendix B *infra*.

[104] *See* Amendment of Part 101 of the Commission's Rules to Streamline Processing of Microwave Applications in the Wireless Telecommunications Services, Telecommunications Industry Association Petition for Rulemaking, WT Docket No. 00-19, RM-9418, *Report and Order*, 17 FCC Rcd 15040, 15075 ¶ 77 (2002) (discussing the merits of allowing smaller antennas in the 10 GHz and 23 GHz bands).

[105] Antenna vendors are quoting price ratios of approximately 1:3 to 1:8 between vendor prices for the smaller antennas under the industry's rule, and the larger antennas currently required. For one WCA member soliciting bids, most of the vendors contacted refused to even bid on the 24-inch antenna that would meet the Commission's current specification. WCA Jan. 27, 2005 *Ex Parte*. at 3.

[106] Some market segments, such as those for "virtual fiber" in higher-density, urban core areas, are relatively price insensitive. They don't represent the entire market, however. The "other half (or more)" of the market for customers that will initially deploy 1 Gb/s Ethernet links in lower-density user locations or businesses in campus or

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greater than or equal to 43 dBi) with a proportional reduction in maximum authorized EIRP in a ratio of 2 dB of power per 1 dB of gain will best serve the public interest by expanding the potential for services from the 20 to 25 percent of business locations in high-density urban areas to 75 to 80 percent of business locations, particularly in lower-density locations.[107] We further find that these benefits outweigh the relatively minor overall increase in interference potential resulting from these rule changes. In this connection, we consider that the new interference analysis requirement adopted herein will also provide great benefit by reducing the potential for harmful interference.[108] Because our decision will necessitate modifications to one or more databases used to register links, we advise licensees that it will not be possible to submit registrations for links with antennas that meet the revised rule, *i.e.*, antenna gain less than 50 dBi (but greater than or equal to 43 dBi) until all necessary software modifications are completed. Licensees interested in filing such links should first consult with a database manager as to the status of the system updates.

2. Automatic Transmitter Power Control (ATPC)

a. Background

35. In the *Report and Order*, the Commission decided against requiring ATPC on the basis that the industry is in the early stages of development of equipment for these bands, and the Commission believed that manufacturers would benefit more from relaxation of the transmitter equipment specifications than from relaxation in the antenna requirements.[109] Thus, the Commission determined that users need not bear the additional cost of ATPC. In fact, the Commission saw more benefits from allowing more flexibility in the manufacturing of the transceivers, which contain more expensive hardware, than in the manufacturing of the antennas.[110]

b. Petition

36. WCA asks the Commission to require ATPC for links with EIRP greater than 23 dBW.[111] The Petition states that industry simulations conducted confirm that use of ATPC for links that have EIRP greater than 23 dBW will have a significant, positive contribution toward managing interference in the 70/80 GHz bands and will facilitate high-density deployment of 70/80 GHz radios.[112]

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office park settings, are price sensitive and thus will not buy if the price is too high. *See* WCA Jan. 31, 2005 *Ex Parte* at 3.

[107] *See* WCA's January 27, 2005 *Ex Parte.*

[108] *See discussion supra* at ¶¶ 11-14. *Accord* Petition at 16 (the pre-registration interference analysis will ensure that the use of 1.2 degree beamwidth antennas does not preclude frequency re-use).

[109] *Id.*

[110] *Id.*

[111] Petition at 18-19. ATPC automatically increases or decreases the output power of a transmitter based on the received signal level.

[112] Petition at 19.

c. Discussion

37. We deny WCA's proposal to require ATPC for links with EIRP greater than 23 dBW. To require ATPC as one of several useful tools to help control interference would run counter to the flexible approach we have adopted to encourage development in the 70/80 GHz bands, particularly where the record does not show that requiring such tools is either necessary or sufficient to resolve adverse operating conditions. Moreover, we continue to believe that the more prudent course during the early stages of technology development in these millimeter wave bands is to allow manufacturers and licensees maximum flexibility and freedom to design a wide range of equipment necessary to provide services in these bands. Furthermore, although ATPC technology has been available to licensees in other frequency bands and is allowed under Part 101,[113] the Commission has not mandated its use in the past for any Part 101 microwave service in order to give licensees the discretion to identify their own equipment needs. Various technical and economic factors may provide incentives to licensees to use the technology but there are circumstances when its use may not be necessary or desirable.[114] The Commission is therefore reluctant to mandate the use of a specific technology which may not be necessary in all cases and may be a more expensive means to increase reliability or control interference than others that could achieve the same end result. Because the Commission is now requiring interference analyses to be completed before operations, we find that the interference potential is more confined than under our previous rules, and make ATPC a less desirable option where other mitigating factors can be used, such as shielding or spatial diversification. There are also techniques other than ATPC to increase reliability, such as the use of free space optical technology for diversity.[115] We find that licensees should be free to use ATPC or other technologies, coupled with the interference protections otherwise provided for this service, to preserve quality of services, and should have the flexibility to design and deploy systems to meet their needs without increasing the potential for interference to other systems.

3. Power Spectral Density Limit

a. Petition

38. WCA asks the Commission to adopt a limit on power spectral density to no more than 150 mW/100 MHz.[116] If there are no power spectral density limits, WCA believes it would be possible for a device to transmit an EIRP of 55 dBW in an arbitrarily small bandwidth (e.g., 1

[113] *See* In The Matter Of Reorganization And Revision Of Parts 1, 2, 21, And 94 Of The Rules To Establish A New Part 101 Governing Terrestrial Microwave Fixed Radio Services, WT Docket No. 94-148, *Report and Order*, 11 FCC Rcd 13449, 13470-71 ¶¶ 52-53 (1996) (modifying the Commission's rules to specifically authorize the use of ATPC transmitters in Part 101); 47 C.F.R. §§ 101.113, 101.143.

[114] For example in dry temperate regions where fading due to rain is not as prevalent, the added cost of ATPC may outweigh any potential benefit. In rural, uncongested areas the use of ATPC will have less benefit in terms of interference prevention.

[115] For example, SONAbeam (www.fsona.com) offers a number of free space optical products with capabilities of streaming data from 125Mbps to 2,448 Mbps. Omnilux (www.omnilux.net) offers less capable free space optical products used for up to 100 Mbps data rates.

[116] Petition at 19-20.

megahertz).[117] According to WCA, such a device would have significantly different spectral and spatial properties from the "virtual fiber" radios for which the 70/80 GHz band is uniquely well suited since narrowband devices would have much longer ranges and much larger exclusion zones, significantly reducing potential deployment densities. Stating that there are already many bands at lower frequencies in which narrower bandwidths can be used, WCA seeks adoption of the limit in order to preserve the 70/80 GHz bands for high bandwidth radios as a wireless alternative for fiber-equivalent services.[118]

b. Discussion

39. We grant WCA's proposal to adopt a power spectral density limit of no more than 150 mW/100 MHz in order to preserve the 70/80 GHz bands for high bandwidth transmissions. Although narrow bandwidth emissions are not the intended use of these frequency bands, and we did not believe that a licensee would "waste" large amounts of power to do this, given the nature of the investment necessary, we agree with WCA that it could be possible for someone to use the flexibility in our present rules to use a narrow bandwidth with a high power density, especially if they were to use analog signals. Thus, we find that a minor rule change can easily eliminate this potential problem and retain our goal for wide bandwidth use of the 70-80-90 GHz bands. We conclude that the 150 mW/100 MHz power spectral density limit will facilitate deployment of the high data-rate transmissions envisioned in these bands, for so-called "fiber-equivalent" wireless services.

G. Conditional operating authority

1. Petition

40. WCA seeks to have the Commission amend section 101.31(b) to add the 70/80 GHz frequencies to the list of frequencies for which conditional operation is available, so that nationwide license applicants may get links up and running as soon as Federal Government coordination by NTIA and link registration have been completed.[119] The Petition asserts that conditional operating authority is an important element of licensing under Part 101 and therefore should also be available to 70/80 GHz licensees.

2. Discussion

41. We acknowledge that certain microwave services under Part 101 are permitted to operate while awaiting a license, but we are concerned that introducing conditional operating authority here could risk confusion as to the interference protection date for purposes of determining the first-in-time registered link. Furthermore, while the application for a nationwide license is a one-time burden for common carriers, we note that private and non-common carriers are not subject to the statutory 30-day Public Notice period and our licensing records reflect that their applications are routinely granted on virtually an overnight basis. Finally, we note that both NTIA and the FCC's ULS databases are configured so that link data submissions are reviewable

[117] Petition at 19.

[118] Petition at 20.

[119] Petition at 21-22.

and subject to approval after verification that the applicant has a valid call sign (*i.e.*, a license for the 71-76, 81-86, and 92-95 GHz service).

42. In *ex parte* discussions with the Bureau on July 22, 2004, WCA conceded that pre-license operating authority is less important if nationwide licensing occurs quickly, which has been the case to date.[120] Given that grant of the nationwide license carries with it a reconsideration period—which would allow the licensee to build-out notwithstanding a challenge--and link registrations are subject to challenge only after operations commence, there appears little need for conditional operating authority.[121] On our own motion, however, we are revising Section 101.1513 of the rules, 47 C.F.R. § 101.1513, to make clear that the ten-year license term runs from the initial grant date of the license.[122]

IV. CONCLUSION

43. We look forward to the development of new products and services such as high-speed, point-to-point wireless local area networks, increased access to broadband services for all Americans, enhanced economic opportunities and access for the provision of communications services, and the development of additional and innovative services in rural areas. We are confident that our decisions here will help ensure the viability of the "pencil beam" technology envisioned for this spectrum and complement the Commission's major policy initiatives and public interest objectives to stimulate rollout of wireless broadband. As the industry considers various deployment methods, including hub-and-spoke models utilizing fiber points-of-presence, and equipment manufacturers develop "millimeter wave" antennas for the 70/80 GHz bands,[123] our objective is to implement rules that will assist and foster the continued build-out and growth of services in these bands. Accordingly, we grant those portions of the Petition as set forth above, and otherwise deny the Petition.

V. PROCEDURAL MATTERS

A. Supplemental Final Regulatory Flexibility Analysis

44. Consistent with the Regulatory Flexibility Act, *see* 5 U.S.C. § 604, the Commission has prepared a Supplemental Final Regulatory Flexibility Analysis (FRFA) of the possible

[120] Letter to Marlene H. Dortch, Secretary, from Randall W. Sifers, Counsel to GigaBeam Corporation, *Notice of Ex Parte* meeting between the Wireless Communications Association International, Inc. Above 60 GHz Committee and the Wireless Telecommunications Bureau in WT Docket No. 02-146, dated July 22, 2004.

[121] We note that even under our conditional operating rules, parties must discontinue operations should a site be subject to a challenge.

[122] The current rule states that "the license renewal period will ten years from the registration of the first link[,]" 47 C.F.R. § 101.1513, which is accurate only if the licensee registers the first link on the date of the initial license grant. Otherwise, the expiration date is unknown until the licensee registers a link and cannot be determined from the license document, whereas we adopted the ten-year license term "for each license to provide a stable regulatory environment." *See Report and Order*, 18 FCC Rcd at 23348 ¶ 77.

[123] *See, e.g.,* Letter to Marlene H. Dortch, Secretary, from Mary L. Brown, Cisco Systems, Inc., *Ex parte* presentation of Cisco Systems, Inc. and other members of the Wireless Communications Association's Above 60 GHz Committee in WT Docket No. 02-146, dated August 24, 2004, at 4-7.

significant economic impact on small entities of the rules amended in this document. The Supplemental FRFA is set forth in Appendix A.

B. Paperwork Reduction Act of 1995 Analysis

45. This document contains new or modified information collection or third party disclosure requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104-13. It will be submitted to the Office of Management and Budget (OMB) for review under Section 3507(d) of the PRA. OMB, the general public, and other Federal agencies are invited to comment on the new or modified information collection requirements contained in this proceeding. In addition, we note that pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198, *see* 44 U.S.C. 3506(c)(4), we previously sought specific comment on how the Commission might "further reduce the information collection burden for small business concerns with fewer than 25 employees."

C. Congressional Review Act

46. The Commission will include a copy of this *Memorandum Opinion and Order on Reconsideration* in a report to be sent to Congress and the General Accounting Office pursuant to the Congressional Review Act. *See* 5 U.S.C. § 801(a)(1)(A).

D. Accessible Formats

47. To request materials in accessible formats for individuals with disabilities (braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202-418-0531 (voice), or 202-418-7365 (tty).

VI. ORDERING CLAUSES

48. Accordingly, IT IS ORDERED that pursuant to Sections 1, 4(i), 303(f) and (r), 309, 316, 332 of the Communications Act of 1934, as amended, 47 U.S.C. Sections 151, 154(i), 303(f) and (r), 309, 316, and 332, the *Memorandum Opinion and Order* and the rules specified in Appendix B ARE ADOPTED.

49. IT IS FURTHER ORDERED that the rules set forth in Appendix B WILL BECOME EFFECTIVE 30 days after publication in the Federal Register, except that new or modified information collection or third-party disclosure requirements discussed in paragraph 45 will not become effective prior to OMB approval.

50. IT IS FURTHER ORDERED, pursuant to Sections 4(i) and 405 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 405 and Section 1.106(a)(1) of the Commission's Rules, 47 C.F.R. § 1.106(a)(1), the Petition for Reconsideration filed by Wireless Communications Association International, Inc., on February 23, 2004 in WT Docket 02-146 IS GRANTED IN PART to the extent discussed herein, and otherwise IS DENIED.

51. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this *Memorandum Opinion and Order*, including the Supplemental Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A

SUPPLEMENTAL FINAL REGULATORY FLEXIBILITY ANALYSIS

As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[124] an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Notice of Proposed Rulemaking* in WT Docket No. 02-146 (*NPRM*).[125] The Commission sought written public comment on the proposals in the *NPRM*, including comment on the IRFA. In addition, a Final Regulatory Flexibility Analysis (FRFA) was incorporated in the *Report and Order* in WT Docket No. 02-146 (*Report and Order*).[126] This present Supplemental Final Regulatory Flexibility Analysis (Supplemental FRFA) for the *Memorandum Opinion and Order* conforms to the RFA.[127]

A. Need for, and Objectives of, Adopted Rules

The *Memorandum Opinion and Order* responds to the Petition for Reconsideration submitted by the Wireless Communications Association International, Inc. on February 23, 2004.[128] The need for and objectives of the rules adopted in this *Memorandum Opinion and Order* are the same as those discussed in the FRFA for the *Report and Order*. In the *Report and Order*, the Commission adopted rules for the licensing and operation of the 71-76 GHz, 81-86 GHz and 92-95 GHz (70-80-90 GHz) spectrum bands. Licensees may use the 70 GHz, 80 GHz, and 90 GHz bands for any point-to-point, non-broadcast service on a non-common carrier and/or on a common carrier basis.[129] At the time of adoption, there were no rules in place for these bands. The rules implemented non-exclusive, nationwide licensing with site-by-site registration for these bands.[130] The Commission concluded that this approach will also stimulate investment in new technologies, provide a critical means of achieving greater spectrum efficiency, and promote research and development.

Consistent with these policy goals, the *Memorandum Opinion and Order* adopts an interference analysis requirement and power spectral density limit and relaxes some of the existing technical standards for the 71-76 GHz and 81-86 GHz bands to stimulate development of a nascent industry. Specifically, the *Memorandum Opinion and Order* amends the existing technical rules by (1) eliminating the band segmentation and loading requirement and adopting an efficiency requirement of 0.125 bps/Hz, (2) modifying the interference protection criteria by deleting the minimum 36 dB C/I ratio, adopting for analog systems a 1.0 dB degradation limit for

[124] *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. §§ 601-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[125] *See* Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, *Notice of Proposed Rule Making,* WT Docket No. 02-146, RM-10288, 17 FCC Rcd 12,182 (2002) (*Notice*).

[126] *See* Allocations and Service Rules for the 71-76 GHz, 81-86 GHz and 92-95 GHz Bands, WT Docket No. 02-146, *Report and Order*, 18 FCC Rcd 23318 (2003) (*Report and Order*).

[127] *See* 5 U.S.C. § 604.

[128] Petition for Reconsideration in the 70/80 GHz Bands, WT Docket No. 02-146, filed Feb. 23, 2004 (Petition).

[129] *See* 47 C.F.R. §§ 101.1507, 101.1511.

[130] The *Memorandum Opinion and Order* does not change the rules for unlicensed operation adopted in the *Report and Order*.

the baseband S/N ratio, and reaffirming the existing 1.0 dB receiver T/I ratio degradation limit for digital systems; and (3) modifying the technical parameters to accommodate smaller, less expensive antennas with a minimum antenna gain of 43 dBi and 1.2 degrees half-power beamwidth. The Commission declined Petitioner's requests: to adopt 36 dB as the maximum required C/I ratio; to shorten the construction period from 12 months to 180 days; to provide conditional authorization during the pendency of an application for a nationwide, non-exclusive license; and to require ATPC for links with EIRP greater than 23 dBW.

B. Summary of Significant Issues Raised by Public Comments in Response to the FRFA

We received no comments directly in response to the FRFA in this proceeding. In addition, no comments were submitted concerning small business issues.

C. Description and Estimate of the Number of Small Entities to Which the Adopted Rules Will Apply

The RFA directs agencies to provide a description of and, where feasible, an estimate of the number of small entities that may be affected by the rules, if adopted.[131] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[132] In addition, the term "small business" has the same meaning as the term "small business concern" under section 3 of the Small Business Act.[133] Under the Small Business Act, a "small business concern" is one that: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the Small Business Administration (SBA).[134]

In this section, we further describe and estimate the number of small entity licensees and regulatees that may be affected by rules adopted pursuant to this *Memorandum Opinion and Order*. At this point in time, the Commission's Universal Licensing Systems (ULS) only lists three licensees, two registered links, and little or no equipment in the 70-80-90 GHz service. We further note that there are three third-party database managers. Each link must be registered prior to operation by licensees in the 70-80-90 GHz service. The *Report and Order* adopted rules to permit an unlimited number of non-exclusive, nationwide licenses for all 12.9 GHz of spectrum. Given that the service is still in the early stages of development, it is difficult to determine the exact number of small business entities that will be affected.

In the FRFA, the Commission stated that the SBA has developed a small business size standard for Cellular and Other Wireless telecommunication, which consists of all such firms

[131] *See* 5 U.S.C. § 603(b)(3).

[132] 5 U.S.C. § 601(6).

[133] 5 U.S.C. § 601(3) (incorporating by reference the definition of "small business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definitions(s) in the Federal Register."

[134] 15 U.S.C. § 632.

having 1,500 or fewer employees.[135] According to Census Bureau data for 1997, in this category there was a total of 977 firms that operated for the entire year.[136] Of this total, 965 firms had employment of 999 or fewer employees, and an additional twelve firms had employment of 1,000 employees or more.[137] Thus, under this size standard, the majority of firms can be considered small. Although the service is still developing, we apply this standard to the wireless telecommunication firms in the 70-80-90 GHz service that will utilize the "pencil beam" technology to provide wireless broadband services and high-speed, point-to-point wireless local area networks.

The applicable definition of small entity is the definition under the SBA rules applicable to manufacturers of "Radio and Television Broadcasting and Communications Equipment." According to the SBA's regulation, an RF manufacturer must have 750 or fewer employees in order to qualify as a small business.[138] Census Bureau data indicates that there are 858 companies in the United States that manufacture radio and television broadcasting and communications equipment, and that 778 of these firms have fewer than 750 employees and would be classified as small entities.[139] Therefore, we reiterate our belief that no more than 778 of the companies that manufacture RF equipment qualify as small entities. We note again that it is difficult to determine the exact number of small business entities that will be affected in this nascent industry but we apply this standard to the "pencil beam" antenna equipment manufacturers in the 70-80-90 GHz service.

D. Description of Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

In this section of the Supplemental FRFA, we analyze the projected reporting, recordkeeping, and other compliance requirements that may apply to small entities as a result of this *Memorandum Opinion and Order*. In the *Memorandum Opinion and Order*, we adopt an interference analysis requirement which will require all licensees to obtain an interference analysis and electronically submit a copy to the third party database manager as part of the link registration. Correspondingly, as part of their duties, the third-party database managers will retain these submissions electronically and make them available, online to the public.[140] The other decisions in the *Memorandum Opinion and Order* impose compliance requirements rather than reporting or recordkeeping requirements: we adopt a power spectral density limit and amend existing technical requirements by (1) eliminating the band segmentation and loading

[135] 13 C.F.R. § 121.201, NAICS code 517212 (changed from 513322 in October 2002).

[136] U.S. Census Bureau, 1997 Economic Census, Subject Series: Information, "Establishment and Firm Size (Including Legal Form of Organization)," Table 5.

[137] *Id*. The census data do not provide a more precise estimate of the number of firms that have 1,500 or fewer employees; the largest category provided is "Firms with 1,000 employees or more."

[138] *See* 13 C.F.R. § 121.201, NAICS Code 334220.

[139] *See* U.S. Department of Commerce, 1992 Census of Transportation, Communications and Utilities (issued May 1995), NAICS category 334220.

[140] It is important for the "first-in-time" determination, and for adjudicating complaints filed with the Commission, that the interference analysis captures the exact snapshot in time (i.e., conditions at the time-of-link-registration) that will be dispositive in a dispute. Without the benefit of an interference analysis on file, it would be much more difficult for registrants to recreate conditions accurately after the fact. *See* ¶¶ 11-13, *supra*.

requirement and adopting an efficiency requirement of 0.125 bps/Hz; (2) modifying the interference protection criteria by deleting the minimum 36 dB C/I ratio, adopting for analog systems a 1.0 dB degradation limit for the baseband S/N ratio, and reaffirming the existing 1.0 dB receiver T/I ratio degradation limit for digital systems; and (3) modifying the technical parameters to accommodate smaller, less expensive antennas with a minimum antenna gain of 43 dBi and 1.2 degrees half-power beamwidth.

E. Steps Taken to Minimize Significant Economic Impact on Small Entities, and Significant Alternatives Considered

The RFA requires an agency to describe any significant alternatives that it has considered in reaching its adopted approach, which may include the following four alternatives (among others): (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.[141]

In choosing among the various alternatives in the *Memorandum Opinion and Order*, we sought to minimize the adverse economic impact on licensees, including those that are small entities. For instance, we decided that the purpose of the interference-analysis requirement would not be met by having licensees certify compliance, rather than submitting the analysis to the third-party database manager. In adopting the interference-analysis requirements, we considered the costs and benefits of imposing an interference analysis requirement, particularly for small entities, and concluded that the costs of performing such analyses would be relatively small, particularly when compared to the benefits of preventing harmful interference to existing operations for all licensees. We also find it important to facilitate entry and development of this industry by lowering the risk of interference and thereby ensuring continued investment. Finally, we find that that the additional assurance of no harmful interference provided by interference analyses in these bands will better serve the public interest.

Our decision to eliminate the band segmentation and loading requirements will provide licensees, including small entities, the freedom to produce radios utilizing a variety of modulation schemes, rather than only those that fit within a 1.25 GHz segment, thus lowering the cost of equipment for new entrants and spurring technological development and rollout. Moreover, it also allows users the maximum flexibility in link design and the freedom to upgrade as their needs evolve thus facilitating new entry in this nascent service. Our related decision to eliminate the 1 bps/Hz loading requirement in favor of a lower efficiency requirement of 0.125 bps/Hz for equipment certification will allow the use of certain inexpensive modulation schemes, thus decreasing equipment costs and allow for more product offerings. We also find that lower cost equipment will provide opportunities to develop the service, particularly in underserved rural areas where build-out costs are often the largest barrier to entry into those markets, and assist small entities interested in entering this service.

Our decision to modify our interference protection criteria by deleting the minimum 36 dB C/I ratio, adopting for analog systems a 1.0 dB degradation limit for the baseband S/N ratio,

[141] *See* 5 U.S.C. § 603(c)(1)-(c)(4).

reaffirming the existing 1.0 dB receiver T/I ratio degradation limit for digital systems, and rejecting Petitioner's proposal to adopt 36 dB as the maximum required C/I, will provide new entrants the flexibility to select and develop equipment best suited for their business models and relieves them of the burden of providing more interference protection than necessary. We believe that the emphasis on maximizing flexibility in equipment design and the freedom to utilize a variety of radio technologies, including lower cost equipment, reflected in the decisions of the *Memorandum Opinion and Order* will benefit small entities looking to enter this new developing service. Finally, we adopt a power spectral density limit in order to facilitate deployment in the 71-76 GHz and 81-86 GHz bands of the high data-rate transmissions envisioned in these bands, for so-called "fiber-equivalent" wireless services.

Our decision to grant WCA's request to modify our technical requirements to allow for a 43 dBi minimum antenna gain and 1.2 degree half-power beamwidth will provide new entrants the flexibility to select smaller, less expensive antennas and spur deployment of the service. We find that allowing smaller, wider beamwidth antennas is in the public interest because it will promote increased usage of the 71-76 GHz and 81-86 GHz bands in areas where those frequencies would otherwise be underutilized. By providing licensees the flexibility to select a wider range of equipment that best suits their particular business plans, our decision will facilitate entry by small business entities in this service and expand deployment of services in lower-density business locations, such as campuses or office park settings.

We reject the Petitioner's proposal that we shorten the construction period from 12 months to 180 days because we do not want to prematurely foreclose new entrants, particularly small entities, who may not have readily available capital to build out within a short timeframe. Mandating a 180-day build-out period on a nascent service with little or no equipment available may result in a flood of waiver requests and impose unnecessary costs or burdens on new entrants. We noted that it is our understanding that equipment production is underway, so we are hesitant to compress build-out where the timing of equipment rollout is not certain. We also do not want to set regulatory standards so high that it is more likely to impede build-out than encourage development of the service. In the *Report and Order*, the Commission reserved the discretion to revisit the issue if experience indicates that additional measures are necessary[142] and in the *Memorandum Opinion and Order* we continue to find that to be the prudent approach in this developing service.

We also reject Petitioner's proposal that we provide conditional authorization during the pendency of an application for a nationwide, non-exclusive license. We are concerned that introducing conditional operating authority could risk confusion as to the interference protection date for purposes of determining the first-in-time registered link for link registrants, including small entities. Further, our licensing records reflect that applications are routinely granted on virtually an overnight basis and Petitioner has conceded that conditional operating authority is less important if nationwide licensing occurs quickly.

Finally, we reject the Petitioner's proposal that we require ATPC for links with EIRP greater than 23 dBW, because we continue to believe that the more prudent course during the early stages of technology development in these millimeter wave bands is to allow manufacturers and licensees, including many small entities, maximum flexibility and freedom to design a wide

[142] *Report and Order*, 18 FCC Rcd at 23349 ¶ 80.

range of equipment necessary to provide services in these bands. The Commission is reluctant to mandate the use of a specific technology which may not be necessary in all cases and may be a more expensive means to increase reliability or control interference than others that could achieve the same end result. Notably, although ATPC technology has been available to licensees in other frequency bands and is allowed under Part 101, the Commission has not mandated its use in the past for any Part 101 microwave service in order to give licensees the discretion to identify their own equipment needs. Various technical and economic factors may provide incentives to licensees to use the technology but there are circumstances when its use may not be necessary or desirable. We find that licensees should be free to use ATPC or other technologies, coupled with the interference protections otherwise provided for this service, such as the interference analysis requirement at link registration, to preserve quality of services, and should have the flexibility to design and deploy systems to meet their needs without increasing the potential for interference to other systems.

F. Federal Rules That Overlap, Duplicate, or Conflict with These Proposed Rules

None.

G. Report to Congress

The Commission will send a copy of the *Memorandum Opinion and Order*, including this Supplemental FRFA, in a report to be sent to Congress pursuant to the Congressional Review Act.[143] In addition, the Commission will send a copy of the *Memorandum Opinion and Order*, including the Supplemental FRFA, to the Chief Counsel for Advocacy of the Small Business Administration. A copy of the *Memorandum Opinion and Order* and Supplemental FRFA (or summaries thereof) also will be published in the Federal Register. *See* 5 U.S.C. § 604(b).

[143] *See* 5 U.S.C. § 801(a)(1)(A).

APPENDIX B

FINAL RULES

1. For the reasons discussed in the preamble, the Federal Communications Commission hereby amends 47 C.F.R. Part 101 as follows:

PART 101 – FIXED MICROWAVE SERVICES

2. The authority citation for Part 101 continues to read as follows:

Authority: 47 U.S.C. 154 and 303, unless otherwise noted.

3. Section 101.105 is amended by renumbering existing paragraph (a)(5) as (a)(7), and by adding new paragraphs (a)(5) and (a)(6), and by revising paragraphs (c)(2)(i) and (c)(2)(ii) to read as follows:

§ 101.105 Interference protection criteria.

(a) * * *

* * * * *

(5) *71,000–76,000 MHz; 81,000–86,000 MHz.* In these bands the following interference criteria shall apply:

(i) For receivers employing digital modulation: based upon manufacturer data and following TSB 10-F or other generally acceptable good engineering practice, for each potential case of interference a threshold-to-interference ratio (T/I) shall be determined that would cause 1.0 dB of degradation to the static threshold of the protected receiver. For the range of carrier power levels (C) between the clear-air (unfaded) value and the fully-faded static threshold value, in no case shall interference cause C/I to be less than the T/I so determined unless it can be shown that the availability of the affected receiver would still be acceptable despite the interference.

(ii) For receivers employing analog modulation: manufacturer data or industry criteria will specify a baseband signal-to-noise requirement (S/N) of the receiver that will result in acceptable signal quality for continuous operation. Following TSB 10-F or other generally acceptable good engineering practice, for each potential case of interference a C/I objective shall be calculated to ensure that this S/N will not be degraded by more than 1.0 dB. For the range of carrier power levels (C) between the clear-air (unfaded) value and the fully-faded threshold value, in no case shall interference cause the C/I to be less than the objective so determined unless it can be shown that the signal quality and availability of the affected receiver would still be acceptable despite the interference.

(6) *92,000–94,000 MHz; 94,100–95,000 MHz.* In these bands prior links shall be protected to a threshold-to-interference ratio (T/I) level of 1.0 dB of degradation to the static threshold of the protected receiver. Any new link shall not decrease a previous link's desired-to-undesired (D/U)

signal ratio below a minimum of 36 dB, unless the earlier link's licensee agrees to accept a lower D/U.

(7) All stations operating under this part must protect the radio quiet zones as required by § 1.924 of this chapter. Stations authorized by competitive bidding are cautioned that they must receive the appropriate approvals directly from the relevant quiet zone entity prior to operating.

* * * * *

(c) * * *

* * * * *

(2) * * *

(i) *Co-Channel Interference.* Both side band and carrier-beat, applicable to all bands; the existing or previously authorized system must be afforded a carrier to interfering signal protection ratio of at least 90 dB, except in the 952 – 960 MHz band where it must be 75dB, and in the 71,000-76,000 MHz and 81,000-86,000 MHz bands where the criteria in paragraph (a)(5) applies, and in the 92,000–94,000 MHz and 94,100–95,000 MHz bands, where the criteria in paragraph (a)(6) applies; or

(ii) *Adjacent Channel Interference.* Applicable to all bands; the existing or previously authorized system must be afforded a carrier to interfering signal protection ratio of at least 56 dB, except in the 71,000-76,000 MHz and 81,000-86,000 MHz bands where the criteria in paragraph (a)(5) applies, and in the 92,000–94,000 MHz and 94,100–95,000 MHz bands, where the criteria in paragraph (a)(6) applies.

* * * * *

4. Section 101.109 is amended by revising two entries in the table in paragraph (c), and note 3 to that table, as follows:

§ 101.109 Bandwidth

(c) * * *

Frequency band (MHz)	Maximum authorized bandwidth
*	*
71,000 to 76,000……...	5000 MHz
81,000 to 86,000……...	5000 MHz
*	*

* * *

\ 3\ To be specified in authorization. For the band 92 to 95 GHz, maximum bandwidth is licensed in one segment of 2 GHz from 92-94 GHz and one 0.9 GHz segment from 94.1 to 95 GHz, or the total of the loaded band if smaller than the assigned bandwidth.

* * * * *

5. Section 101.113 is amended by adding a new note 13 to two entries in the table in paragraph (a), to read as follows:

§ 101.113 Transmitter power limitations

(a) * * * * *

Frequency band (MHz)	Maximum Allowable EIRP [1, 2]	
	Fixed [1, 2](dBW)	Mobile (dBW)
*	*	*
71,000-76,000[13]	+55	+55
81,000-86,000[13]	+55	+55
*	*	*

* * * * *

\ 13 \ The maximum transmitter power is limited to 3 watts (5 dBW) unless a proportional reduction in maximum authorized EIRP is required under § 101.115. The maximum transmitter power spectral density is limited to 150 mW per 100 MHz.

* * * * *

6. Section 101.115 is amended by deleting the existing entries pertaining to the 71,000 to 76,000 MHz and 81,000 to 86,000 MHz bands in the table that follows paragraph (b)(2), and by adding four new entries to this table, and a new explanatory note 15 immediately following the table, as follows:

§ 101.115 Directional Antennas

(b) * * *

(2) * * *

Frequency (MHz)	Category	Maximum beam width to 3 dB points[1] (included angle in degrees)	Minimum antenna gain (dBi)	Minimum radiation suppression to angle in degrees from centerline of main beam in decibels						
				5° to 10°	10° to 15°	15° to 20°	20° to 30°	30° to 100°	100°to 140°	140° to 180°
*	*	*	*	*	*	*	*	*	*	*
71,000 to 76,000 (co-polar) [15]	N/A	1.2	43	35	40	45	50	50	55	55
71,000 to 76,000 (cross-polar) [15]	N/A	1.2	43	45	50	50	55	55	55	55
81,000 to 86,000 (co-polar) [15]	N/A	1.2	43	35	40	45	50	50	55	55

81,000 to 86,000 (cross-polar) [15]	N/A	1.2	43	45	50	50	55	55	55	55
*	*	*	*	*	*	*	*	*	*	*

* * * * *

\ 15 \ Antenna gain less than 50 dBi (but greater than or equal to 43 dBi) is permitted only with a proportional reduction in maximum authorized EIRP in a ratio of 2 dB of power per 1 dB of gain, so that the maximum allowable EIRP (in dBW) for antennas of less than 50 dBi gain becomes +55 – 2(50-G), where G is the antenna gain in dBi. In addition, antennas in these bands must meet two additional standards for minimum radiation suppression: (1) at angles between 1.2 and 5 degrees from the centerline of the main beam, co-polar discrimination must be G – 28, where G is the antenna gain in dBi; and (2) at angles of less than 5 degrees from the centerline of main beam, cross-polar discrimination must be at least 25 dB.

* * * * *

7. Section 101.139 is amended by adding new paragraphs (h) and (i) to read as follows:

§ 101.139 Authorization of transmitters.

* * * * *

(h) *71,000–76,000 MHz; 81,000–86,000 MHz.* For equipment employing digital modulation techniques, the minimum bit rate requirement is 0.125 bit per second per Hz.

(i) *92,000–94,000 MHz; 94,100–95,000 MHz.* For equipment employing digital modulation techniques, the minimum bit rate requirement is 1.0 bit per second per Hz.

* * * * *

8. Section 101.147 is amended by deleting subparagraph (z)(3) and amending (z)(1) and (z)(2), to read as follows:

§ 101.147 Frequency Assignments.

(a)* * *

* * * * *

(z) *71,000–76,000 MHz; 81,000–86,000 MHz; 92,000–94,000 MHz; 94,100–95,000 MHz*.
(1) Those applicants who are approved in accordance with FCC Form 601 will each be granted a single, non-exclusive nationwide license. Site-by-site registration is on a first-come, first-served basis. Registration will be in the Universal Licensing System until the Wireless Telecommunications Bureau announces by public notice, the implementation of a third-party database. *See* 47 C.F.R. § 101.1523. Links may not operate until NTIA approval is received. Licensees may use these bands for any point-to-point non-broadcast service..

(2) Prior links shall be protected using the interference protection criteria set forth in section 101.105. For transmitters employing digital modulation techniques and operating in the 71,000-76,000 MHz or 81,000-86,000 MHz bands, the licensee must construct a system that meets a

minimum bit rate of 0.125 bits per second per Hertz of bandwidth. For transmitters that operate in the 92,000–94,000 MHz or 94,100–95,000 MHz bands, licensees must construct a system that meets a minimum bit rate of 1.0 bit per second per Hertz of bandwidth. If it is determined that a licensee has not met these loading requirements, then the database will be modified to limit coordination rights to the spectrum that is loaded and the licensee will lose protection rights on spectrum that has not been loaded.

* * * * *

9. Section 101.1505 is amended by revising paragraphs (a) and (b) to read as follows:

§ 101.1505 Segmentation plan.

(a) An entity may request any portion of the 71-76 GHz and 81-86 GHz bands, up to 5 gigahertz in each segment for a total of 10 gigahertz. Licensees are also permitted to register smaller segments.

(b) The 92–95 GHz band is divided into three segments: 92.0–94.0 GHz and 94.1–95.0 GHz for non-government and government users, and 94.0–94.1 GHz for Federal Government use. Pairing is allowed and segments may be aggregated without limit. The bands in paragraph (a) of this section can be included for a possible 12.9 gigahertz maximum aggregation. Licensees are also permitted to register smaller segments than provided here.

* * * * *

10. Section 101.1513 is amended to read as follows:

§ 101.1513 License term and renewal expectancy.

The license term is ten years, beginning on the date of the initial authorization (nationwide license) grant. Registering links will not change the overall renewal period of the license.

* * * * *

11. Section 101.1523 is amended by revising paragraph (b) to read as follows:

§ 101.1523 Sharing and coordination among non-government licensees and between non-government and government services.

* * * * *

(b) The licensee or applicant shall (1) complete coordination with Federal Government links according to the coordination standards and procedures adopted in Report and Order, FCC 03-248, and as further detailed in subsequent implementation public notices issued consistent with that order; (2) provide an electronic copy of an interference analysis to the third-party database manager which demonstrates that the potential for harmful interference to or from all previously registered non-government links has been analyzed according to the standards of section 101.105 and generally accepted good engineering practice, and that the proposed non-government link will neither cause harmful interference to, nor receive harmful interference from, any previously registered non-government link; and (3) provide upon request any information related to the interference analysis and the corresponding link. The third-party database managers shall receive and retain the interference analyses electronically and make them available to the public. Protection of individual links against harmful interference from other links shall be granted to first-in-time registered links. Successful completion of coordination via the NTIA automated

mechanism shall constitute successful non-Federal Government to Federal Government coordination for that individual link.

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