

Federal Communications Commission

FCC 97-5

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

In the Matter of
Amendment of the Commission's Rules to
Provide for Operation of Unlicensed NII
Devices in the 5 GHz Frequency Range
ET Docket No. 96-102
RM-8648
RM-8653

REPORT AND ORDER

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By the Commission: Commissioner Ness issuing a statement.

TABLE OF CONTENTS

INTRODUCTION 2
BACKGROUND 2
DISCUSSION 4
A. Need for U-NII Devices and Spectrum 4
B. Spectrum to be Made Available 9
C. Technical Standards 12
1. General 12
2. Power and Antenna Constraints 14
3. Emissions Outside the Band of Operation 18
4. Channeling Plan & Modulation Efficiency 20
D. Spectrum Etiquette 23
E. Spectrum Sharing Considerations 25
F. Alternative Regulatory Structure 29
G. New Part 16 Regulations 30
H. Equipment Authorization 33
ORDERING CLAUSE AND EFFECTIVE DATE 33
APPENDIX A: FINAL RULES 35
APPENDIX B: FINAL REGULATORY FLEXIBILITY ANALYSIS 42

INTRODUCTION

1. By this action, we amend Part 15 of our rules to make available 300 megahertz of spectrum at 5.15-5.35 GHz and 5.725-5.825 GHz for use by a new category of unlicensed equipment, called Unlicensed National Information Infrastructure ("U-NII") devices.¹ These devices will provide short-range, high speed wireless digital communications on an unlicensed basis. We anticipate that U-NII devices will support the creation of new wireless local area networks ("LANs") and will facilitate wireless access to the National Information Infrastructure ("NII").² In order to permit significant flexibility in the design and operation of these devices, we are adopting the minimum technical rules necessary to prevent interference to other services and to ensure that the spectrum is used efficiently. We believe that the rules set forth herein will foster the development of a broad range of new devices and service offerings that will stimulate economic development and the growth of new industries. We also expect that this action will promote the ability of U.S. manufacturers, including small businesses, to compete globally by enabling them to develop unlicensed digital communications products for the world market.³

BACKGROUND

2. On May 15, 1995, the Wireless Information Networks Forum ("WINForum") filed a Petition for Rule Making (RM-8648) requesting that we allocate 250 megahertz of spectrum at 5.10-5.35 GHz for the operation of new high speed Shared Unlicensed Personal Radio Network ("SUPERNet") devices. On May 24, 1995, Apple Computer, Inc. ("Apple") filed a Petition for Rule Making (RM-8653) requesting that we allocate 300 megahertz in the 5.15-5.3 GHz and 5.725-5.875 GHz bands to establish a new unlicensed wireless radio service to promote the full deployment of the NII. In response to these two proposals, the Commission adopted a *Notice of Proposed Rule Making ("NPRM")* proposing to make available 350 megahertz of spectrum at 5.15-5.35 GHz and 5.725-5.875 GHz for U-NII devices.⁴ The *NPRM* also proposed that such devices be subject to certain minimum technical standards, including power limits, emission limits, and a spectrum etiquette, to ensure that the spectrum is used efficiently, and to ensure that all U-NII devices have equal access to the spectrum. The *NPRM* solicited comments on whether we should adopt a channeling plan, whether we should adopt a minimum modulation efficiency, and whether we should regulate some U-NII operations, particularly those intended for long-range community network applications, as a licensed service. Further, the *NPRM* proposed to establish

¹ We note that in the Notice of Proposed Rule Making in this proceeding, we referred to these devices as "NII/SUPERNet" devices. However, on July 2, 1996, we received a letter from Smart & Thevenet, P.C. on behalf of its client, SuperNet, Inc., which requests that the Commission refrain from using the word "SUPERNet" because it would infringe upon its trademark registration of the name "Colorado Supernet." Accordingly, we have adopted the term "Unlicensed National Information Infrastructure" or "U-NII" to refer to the devices in this proceeding. See Letter from Harlan S. Abrahams of Smart & Thevenet, P.C., received on July 2, 1996.

² The National Information Infrastructure or NII is a group of networks, including the public switched telecommunications network, radio and television networks, private communications networks, and other networks not yet built, which together will serve the communications and information processing needs of the people of the United States in the future.

³ For instance, as discussed below, the rules adopted herein allow for the development of devices compatible with the European High Performance LAN ("HIPERLAN") standard. See *infra*, note 44.

⁴ See *Notice of Proposed Rule Making*, ET Docket No. 96-102, 11 FCC Rcd 7205 (1996).

"safe-harbor rules" that would set forth conditions under which unlicensed devices could operate without risk of being considered sources of harmful interference.

3. In response to the *NPRM*, 52 comments and 26 reply comments were filed. Most commenters support making available 5 GHz spectrum for unlicensed broadband operations. However, several incumbent and potential users of this spectrum express concern about the feasibility of spectrum sharing between these new unlicensed devices and incumbent and proposed primary services.

4. The frequency bands addressed in this proceeding currently are used primarily by Federal Government operations, particularly military radar operations. Other uses of the bands are as follows: the 5.00-5.25 GHz band is allocated on a primary basis to the aeronautical radionavigation, aeronautical mobile-satellite (R), fixed-satellite, and inter-satellite services for both Government and non-Government operations;⁵ the 5.25-5.35 GHz band is allocated to the non-Government radiolocation service on a secondary basis;⁶ the 5.650-5.925 GHz band is allocated on a secondary basis to the amateur service;⁷ the 5.725-5.875 GHz band is designated for industrial, scientific and medical ("ISM") applications and unlicensed Part 15 devices,⁸ and radiocommunication services operating within this band must accept harmful interference that may be caused by ISM applications;⁹ and the 5.850-5.925 GHz band is allocated on a primary basis to the fixed-satellite (Earth-to-space) service for non-Government operations and to the radiolocation service for Government operations.¹⁰

5. On November 2, 1995, the National Telecommunications and Information Administration ("NTIA"), which manages spectrum used by Federal Government operations and is the principal Executive Branch advisor on telecommunications policy, submitted a letter addressing the WINForum and Apple petitions.¹¹ In its letter, NTIA stated that the Administration strongly supports spectrum policies that will promote affordable, high-bandwidth wireless computer networks and that the proposed WINForum and Apple devices could provide an important means of unlicensed access to the NII. To protect public safety operations, however, NTIA indicated that making available the 5.0-5.15 GHz band for unlicensed device operations is not feasible because this band must remain fully available for air traffic control

⁵ See 47 CFR § 2.106, Table and notes 733 and 797. In addition, the 5.150-5.216 GHz sub-band is allocated on a primary basis to radiodetermination-satellite (space-to-Earth) service and to the fixed-satellite (space-to-Earth) service for feeder links used in conjunction with the radiodetermination-satellite service for both Government and non-Government operations. See 47 CFR § 2.106, notes 797A, US307.

⁶ See 47 CFR § 2.106, Table. Additionally, in the 5.25-5.35 GHz band, radiolocation stations installed on spacecraft may also be employed for the earth exploration-satellite and space research services on a secondary basis for both Government and non-Government operations. See 47 CFR § 2.106, note 713.

⁷ See 47 CFR § 2.106, Table. Additionally, the 5.65-5.67 GHz and 5.83-5.85 GHz sub-bands are allocated to the amateur-satellite service on a secondary basis. See 47 CFR § 2.106, notes 664 and 808.

⁸ On January 30, 1996, the Commission adopted a Notice of Proposed Rule Making in ET Docket No. 96-8, 11 FCC Rcd 3068 (1996), which proposed to amend the rules regarding the operation of spread spectrum transmission systems in the 902-928 MHz, 2.400-2.4835 GHz, and 5.725-5.850 GHz bands.

⁹ See 47 CFR § 2.106, note 806.

¹⁰ See 47 CFR § 2.106, Table of Frequency Allocations.

¹¹ See Letter from the Assistant Secretary for Communications and Information, United States Department of Commerce, to Chairman Hundt, received November 2, 1995.

operations.

6. Finally, the 1995 World Radiocommunication Conference ("WRC-95") modified some of the international spectrum allocations in the 5 GHz frequency range.¹² Of principal interest to this proceeding, WRC-95 allocated the 5.091 - 5.25 GHz band on a primary basis to the fixed-satellite (Earth-to-space) service ("FSS uplinks") to provide feeder links for non-geostationary satellite systems in the mobile-satellite service ("MSS") on a co-primary basis with Government aeronautical radionavigation.

DISCUSSION

A. *Need for U-NII Devices and Spectrum*

7. In the *NPRM*, the Commission recognized that recent developments in a number of different digital technologies have greatly increased the need to transfer large amounts of data from one network or system to another. For example, technological developments now permit digitization and compression of large amounts of voice, video, imaging, and data information, which can be rapidly transmitted from computers and other digital equipment to other devices within a network. The *NPRM* stated that these dramatic developments in digital technology have stimulated a need for spectrum to be used for wireless interconnection within and among these networks. The Commission tentatively concluded that providing additional spectrum for unlicensed wideband operation would benefit a vast number of users, including educational, medical, business, and industrial users. Further, the Commission recognized that unlicensed access to this spectrum would permit educational institutions to form inexpensive broadband wireless computer networks between classrooms, thereby providing cost-effective access to an array of multimedia services on the Internet. In addition, the *NPRM* requested comment on whether new U-NII operations should include longer-range community networks.

8. *Comments.* The Commission's proposal to provide spectrum to accommodate U-NII devices is strongly supported by the majority of the commenters ("U-NII proponents"). The U-NII proponents include a variety of potential users, some of whom represent educational, medical, business, or consumer interests. U-NII proponents argue that U-NII devices would facilitate connections among computers, televisions, appliance automation products, and on-premises network cable or telephone company access points within homes, schools and health care facilities.¹³ Further, they submit that unlicensed devices could potentially satisfy a collection of communications needs that otherwise would probably remain unmet if free and open consumer access to spectrum were not available. For example, Motorola states that licensed operations generally involve an expansive infrastructure needed to provide a level of reliability and coverage

¹² See Final Acts of the World Radiocommunication Conference (WRC-95), Geneva, 1995. The United States, by signing the Final Acts with declarations, is obligated to apply provisionally the subject modifications of the Radio Regulations, as of the dates identified in the Final Acts and to the extent consistent with U.S. law, until either (1) it deposits an instrument of ratification with the International Telecommunications Union (after ratification by the President) in which case U.S. rights and obligations under the Radio Regulations are modified, or (2) it informs the International Telecommunications Union that it does not accept the Final Acts in which case the United States retains its preexisting rights and obligations under the Radio Regulations to which it is party.

¹³ See Motorola Comments at 1.

for a specific communications need. It argues that development of these systems requires a significant investment unlikely to be made under an unlicensed regime. In contrast, unlicensed devices do not have to have the same level of reliability and can operate both as standalone and as an adjunct to wired and licensed wireless networks.¹⁴

9. Additionally, U-NII proponents argue that U-NII devices will provide communications that are flexible, mobile, have high data rates, and are low cost. They contend that existing wireless allocations and wireline alternatives may each be capable of providing some of these attributes, but not all of them. They contend that although some communication paths can be provided on wired networks or through currently allocated spectrum (like unlicensed Personal Communications Services ("U-PCS")), those capabilities are inadequate to meet communications needs in a large and growing number of circumstances because they are not capable of providing the necessary data rates and do not have a sufficient amount of spectrum available to meet all of the needs.¹⁵ Specifically, they argue that U-PCS does not provide sufficient capacity, wired networks lack flexibility and mobility, and other licensed wireless services are too costly. For example, Rockwell International Corporation ("Rockwell") claims that current unlicensed wireless systems are limited to data rates of about 2 megabits/second ("Mbits/sec"), far short of the 20 Mbits/sec and higher data rates necessary to support multimedia applications.¹⁶

10. U-NII proponents claim that unlicensed devices governed by flexible technical rules would enable the provision of a wide range of multi-media broadband digital communications at substantially lower costs than those offered by wired and licensed-wireless networks. For example, the joint comments of Educators¹⁷ support the proposal because U-NII devices could function as unlicensed LAN facilities that would be capable of providing the last-mile loop within educational settings in a cost effective manner.¹⁸ Educators claim that an affordable and convenient method for internal distribution of digital communications, such as would be provided by U-NII devices, would be embraced by the educational community; thus, the use of U-NII devices would likely extend into classrooms and other learning sites. Educators state that they are currently using the existing telecommunications infrastructure to deliver their services to some learning sites, but they face enormous financial and technical obstacles in distributing Internet access, data, voice or video services within these sites to the individual classrooms where they are needed.¹⁹ Further, Apple estimates that the cost of wiring America's K-12 schools would be \$50 billion, while equivalent wireless connections would cost substantially less. Apple adds that even though 30 to 50 percent of America's schools have access to the Internet, only two to five percent of America's classrooms have such access.²⁰ Additionally, comments from consumers and Internet service providers argue that it is extremely important for

¹⁴ See Motorola Comments at 1.

¹⁵ See Northern Telecom, Inc Comments at 4 and Apple Reply at 5. We note that U-PCS has access to 30 megahertz of spectrum at 1910-1930 MHz and 2390-2400 MHz.

¹⁶ See Rockwell Comments at 2.

¹⁷ California State University, Education Network of Maine, University of Maine System, Network for Instructional TV, Inc., San Diego County Superintendent of Schools, South Carolina Educational Television Commission, and State of Wisconsin--Educational Communications Board (collectively, the "Educators").

¹⁸ See Educators' Comments at 2.

¹⁹ See Educators' Comments at 2-4.

²⁰ See *supra*, NPRM at para. 14.

all individuals, particularly in remote, insular and rural areas, to be able to access the Internet inexpensively.²¹

11. Some U-NII proponents argue that the benefits of the NII will not be fully realized without the use of longer range community networks, as originally proposed by Apple, and that spectrum should be made available for such operations.²² They argue that there is a need for low cost, flexible, easily implemented means of communications networks spanning rural areas and extending information access throughout smaller municipalities. They also claim these networks are needed to unify school, library and hospital districts with broadband data connections but that, currently, longer distance connections are often unavailable or prohibitively expensive.²³ Specifically, Apple states that many schools and individuals do not have local access to the Internet and would have to pay long distance charges for such access. It claims that the needed T-1 connections may cost from hundreds to tens of thousands of dollars annually and often have high up-front costs and/or per minute charges.²⁴ Apple and other supporters of the community network concept state that no other technology serves the needs for wide-bandwidth, low-cost communications that would be served by community networks. Apple claims that the ISM bands at 900 MHz, 2.4 GHz, and 5.8 GHz do not include sufficient spectrum to accommodate high speed connections.

12. The Consumer Electronics Manufacturers' Association ("CEMA") and Motorola, Inc. ("Motorola") state that unlicensed longer range U-NII devices will not supplant licensed microwave facilities, but should be viewed as a complement to, rather than a replacement for, licensed services.²⁵ Further, Mulcay Consulting Associates ("Mulcay") asserts that the Commission should facilitate competition to licensed longer range communications services by providing for unlicensed community networks. Mulcay argues that, over the past 20 years, the computer industry, with the benefits of open competition and unhindered innovation, has enjoyed a performance-to-price ratio that has improved by several orders of magnitude. However, over the past 20 years, the corresponding improvement in the performance-to-price ratio of transmission equipment and services has been minimal because there has been no meaningful competition to local loop common carriers and because of restrictive regulations governing the use of radio frequency ("RF") spectrum.²⁶

13. On the other hand, parties with incumbent or proposed operations in the bands addressed in this proceeding argue that there has not been a sufficient demonstration of need for new unlicensed U-NII devices. For example, L/Q Licensee, Inc. ("L/Q"), an MSS applicant, argues that no U-NII proponent provided a demonstration of the market demand for new U-NII devices or an estimate of when such demand would materialize.²⁷ In addition to general

²¹ See, e.g., electronic filed comments of Jim Martindale, Mike Renfro, and Jean Armour Polly.

²² See Microsoft Comments at 5, the joint comments of the National School Board Association, Media Access Project, National Education Association, American Association of School Administrators, and People for the American Way (Joint Commenters) Comments at 5, and Consumer Electronics Manufacturers Association (CEMA) Comments at 5.

²³ See Apple Comments at 2.

²⁴ See Apple Comments at 5.

²⁵ See Motorola Comments at ii and CEMA Reply at 4.

²⁶ See Mulcay Reply at 4-5.

²⁷ See L/Q Comments at 12, 14.

opposition to providing spectrum for all U-NII devices, a number of parties oppose Apple's idea for longer range community networks. For example, Pacific Telesis Group ("PacTel"), a Regional Bell Operating Company, argues that unlicensed longer range links would violate requirements for regulatory parity between wireless services and increase the potential for interference from U-NII devices.²⁸ Similarly, the American Radio Relay League, Inc. ("ARRL") states that longer range community networks are not consistent with the typical low-power operations authorized by Part 15 and such high powered operations would not be in accordance with the licensing requirements of the Communications Act, which it claims require that systems with a significant interference potential be operated on a licensed basis.²⁹

14. Additionally, fixed microwave manufacturers argue that unlicensed longer range community networks are not needed because existing licensed microwave services can adequately supply the needed communications capabilities. For example, the Fixed Point-To-Point Communications Section, Network Equipment Division of the Telecommunications Industry Association ("TIA") states that unlicensed links longer than 1-2 km in length are not needed because fixed services in higher frequency bands can provide inter-community links more efficiently by utilizing existing equipment and related technologies, which are less expensive, more reliable and provide greater capacity and higher speeds than unlicensed equipment.³⁰ TIA adds that 1-2 km U-NII links would be sufficient to promote compatibility with High Performance LAN ("HIPERLAN") operations. Additionally, Part 15 spread spectrum interests argue that unlicensed community networks can presently be provided by longer range spread spectrum operations under Section 15.247 without the sharing problems associated with non-spread spectrum techniques.³¹

15. *Decision.* We find that there is a need for unlicensed wireless devices that will be capable of providing data rates as high as 20 Mbits/sec to meet the multimedia communication requirements envisioned by the U-NII proponents.³² To achieve these high data rates at a reasonable cost, we believe that these devices must use broad bandwidths of up to 20 megahertz each and therefore these devices must have access to a substantial amount of spectrum to accommodate a number of devices within the same area.³³ Further, we believe that accessibility to a substantial amount of spectrum is necessary for these devices to develop and mature to their full potential. The record in this proceeding supports our belief that recent developments in digital technologies have greatly increased the requirements for transferring large amounts of information and data in relatively short time frames from one network or system to another.³⁴ Specifically, we

" See PacTel Comments at 3.

" See ARRL Comments at 5-9.

" See TIA Comments at 2.

" See Cylink Comments at 6 and Western Multiplex Comments at 2.

" See, e.g., Apple Comments at 4-5; Hewlett-Packard Comments at 2, 6; Northern Telecom, Inc Comments at 10; Rockwell Comments at 2; and WINForum Comments at 7-14.

" We have assumed up to a 20 megahertz channel requirement for U-NII devices that will transmit data rates of 20 Mbits/sec, which equates to a spectrum efficiency of 1 Mbits/sec per hertz. We recognize that a number of commercially available transmitters and systems are capable of higher data rates per hertz, but they also are generally capable of achieving higher signal to noise ratios because they are not as restricted in power as U-NII devices. Accordingly, we believe our assumed 20 megahertz channel per device for these high data rates is appropriate due to the low powers of U-NII devices.

" See, e.g., Information Technology Industry Council Comments at 2-4, Northern Telecom, Inc Comments

note that computers have much faster central processing units and substantially increased memory capabilities, which have increased the demand for devices that can more quickly transfer larger amounts of data. Further, digital equipment is capable of switching and directing large amounts of information within networks. In addition to these technical advances in hardware capability, there has been substantial growth in the use, size, and complexity of digital networks as well. Many of these networks are not only growing internally in the amount and types of data they contain, but are also increasingly being used in combination and interaction with other such networks.

16. Further, it is clear from the record that educational institutions, business, industry, and consumers are all looking for ways to begin taking advantage of the innovative technological developments that promise the delivery of multimedia services comprising voice, video, imaging, and data. We agree with the commenters who argue that existing wireline and wireless services, in some cases, may not be able to meet all of the communications requirements and demands that these technological developments bring in a cost-effective manner.³⁵ The record here shows that U-NII devices may be able to provide cost-effective communications services that will both complement and compete with existing services.³⁶ For example, the spectrum and associated regulatory structure developed for U-PCS devices were not designed to handle broadband multimedia computer applications. Equipment in the U-PCS bands is limited to a maximum bandwidth of 2.5 megahertz and would not support data rates of 20 Mbits/sec or greater as envisioned for U-NII devices. Further, if we were to authorize broadband, high data rate equipment to use the 30 MHz of spectrum available for U-PCS, that spectrum would quickly become congested and would have limited use for the types of operations it is intended to accommodate. Additionally, we believe that as the NII and other telecommunications infrastructures grow, new communications alternatives that are flexible and inexpensive will be needed to assure delivery of information and services to all members of our society, regardless of income or location.

17. Accordingly, we find that it is appropriate to provide spectrum for wireless unlicensed digital network communications devices to meet the foreseeable communications demands of multimedia network systems resulting from developments of new digital technologies. We believe that this will facilitate rapid and inexpensive wireless access to information resources by educational institutions, business, industry, and consumers. We also believe that making this spectrum available for U-NII devices will further the Commission's mandate, in Section 257(b) of the Communications Act, to promote vigorous competition and technological advancement.³⁷ For example, allowing unlicensed devices access to the 5.15-5.35 GHz and 5.725-5.825 GHz bands would permit educational institutions to form inexpensive broadband wireless computer networks between classrooms, thereby providing cost-effective access to an array of multimedia services on the Internet. In addition, unlicensed wireless networks could help improve the quality and reduce the cost of medical care by allowing medical staff to rapidly and inexpensively obtain patient data, X-rays, and medical charts.

at 3, and Apple Reply at 2-3.

" See *e.g.*, WINForum Comments at 5-6, Apple Comments at 4, and Nortel Comments at 4.

" See Motorola Comments at ii and CEMA Reply at 4.

" See 47 U.S.C. § 257(b) ("the Commission shall seek to promote the policies and purposes of this Act favoring... vigorous economic competition, technological advancement, and promotion of the public interest, convenience, and necessity.").

18. While we agree that some of the communications requirements, particularly the longer range community networks, could be partially accommodated through licensed services, such as the fixed point-to-point and point-to-multipoint services, we believe that the unlicensed devices contemplated here will both complement and provide a cost-effective alternative to such services. They may also provide an additional and competitive means for educational institutions, libraries, and health care providers for rural areas to connect to basic and advanced telecommunications services, as envisioned by the Telecommunications Act of 1996.³⁸ Given that the communications needs of these institutions are expected to be very great and that the technical means best suited to meeting these needs may vary considerably from institution to institution, we believe it desirable that a variety of communications options, including unlicensed operations such as U-NII devices, be available to address these needs. Accordingly, we believe that some spectrum should be made available to accommodate some of the longer range community network requirements envisioned by the U-NII proponents.³⁹

B. *Spectrum to Be Made Available*

19. In the *NPRM*, the Commission proposed to make available 350 megahertz of spectrum at 5.150-5.350 GHz and 5.725-5.875 GHz to provide for a number of U-NII operations in each geographical area to meet the growing demand for new high speed data communications. The Commission stated that spectrum below 5 GHz is too congested, and that higher frequencies would both increase the cost of equipment and have even more limited propagation characteristics than 5 GHz. Additionally, the Commission tentatively concluded that U-NII devices could share spectrum in the 5 GHz range with other users.

20. *Comments.* The U-NII proponents support providing 350 megahertz of spectrum in the 5 GHz range for these devices. They argue that 350 megahertz of spectrum is needed to realize the full potential of today's broadband information technologies and to encourage further innovation in the delivery of new broadband digital communications.⁴⁰ They claim that providing unlicensed broadband devices access to this amount of spectrum will meet the needs of multiple users at a common location and should be sufficient to provide for open entry and equal access by all unlicensed devices.⁴¹ Further, they claim that this amount of spectrum is needed to provide an environment for robust development and growth, and to permit the communications infrastructure to keep pace with future computer advancements. They also argue that 350 megahertz is required to link mobile users and those not served by the broadband wireline infrastructure. U-NII proponents further argue that 350 megahertz is necessary for wide bandwidth U-NII networks because these devices will have to share the spectrum with other users, such as MSS, Amateur, and ISM.⁴² Motorola adds that the proposed bands will help

³⁸ See Section 254(b) of the Communications Act of 1934, as amended by Section 101 of the Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996), at Section 101; *see also* Section 706 of the Telecommunications Act of 1996.

³⁹ As addressed below, the power limits we are adopting here will generally limit the longer range community networks to several kilometers.

⁴⁰ See Rockwell Comments at 2, WINForum Reply at 6, and Hewlett-Packard Comments at 2.

⁴¹ See Motorola Comments at 2 and Hewlett-Packard Comments at 2.

⁴² See, e. g., WINForum Reply at 6.

establish U.S. leadership in an ever-increasing global market for telecommunication products.⁴³ Similarly, Northern Telecom, Inc. ("Nortel") notes that the proposed bands would align the spectrum available domestically for U-NII devices with the spectrum available for European HIPERLAN systems.⁴⁴

21. WINForum, however, argues that even more spectrum will be needed for U-NII broadband unlicensed devices. WINForum urges the Commission to consider future expansion of the U-NII band above 5.35 GHz as operations mature and demand increases.⁴⁵ In this regard, WINForum estimates an eventual need for 450 megahertz of spectrum for wireless multimedia networks.

22. Incumbent users of the 5 GHz band oppose making available the entire 350 megahertz of spectrum for unlicensed U-NII devices. While most incumbent users are not opposed to opening some spectrum for broadband unlicensed devices, they urge the Commission not to provide such spectrum in their own respective bands, alleging concern about potential interference from the unlicensed devices to their operations. Further, they state that WINForum originally requested only 250 megahertz of spectrum, and Apple only 300 megahertz, and that the record does not demonstrate a need for 350 megahertz. PacTel argues that 350 megahertz is excessive for unlicensed devices with unproven technology and untested market acceptance, that initially opening 100 megahertz of spectrum would be sufficient for the U-NII operations to develop, and that additional spectrum could be provided as needed.⁴⁶

23. Some incumbent users also argue that the record does not demonstrate that spectrum for broadband unlicensed devices should be located at 5 GHz. In this regard, commenter L/Q argues that unlicensed U-NII devices do not have to use spectrum in the 5 GHz range. They indicate that 185 megahertz of Government spectrum below 5 GHz will be made available for commercial use before the year 2004. They also assert that spectrum above the 5 GHz range could be used affordably by unlicensed devices, given that equipment prices will fall as the devices become widespread.⁴⁷ Further, Cylink Corporation ("Cylink") urges the Commission to explore whether there are other bands that are more appropriate than 5 GHz for medium-range, point-to-point communications.⁴⁸ For example, Cylink urges that the Commission consider use of the millimeter wave bands to provide wireless LAN communications for educational and industrial campus areas;⁴⁹ the 2.4 and 5.8 GHz ranges for outdoor point-to-point spread spectrum devices;⁵⁰

⁴³ See Motorola Comments at 2.

⁴⁴ See Nortel Comments at 4-5. HIPERLAN is the new European standard for radio LANs currently being formulated by ETSI RES10 for operation at 5 GHz and 17 GHz. It is intended to be a suitable radio replacement of wired LANs and for ad hoc networking providing a user data rate of 10-20 Mbits/sec. The European Radiocommunications Committee ("ERC") identified the 5.15-5.25 GHz band for HIPERLAN throughout Europe and the 5.25-5.30 GHz band for HIPERLAN on national basis. See ETSI Final Draft, pr ETS 300 652, June 1886. We also note the European Space Agency has expressed concerns about sharing the 5.25-5.35 GHz band between Earth Exploration Satellite Service operations and HIPERLAN. See Letter from Edoardo Marelli of the European Space Agency to SFCG Delegates regarding HIPERLAN and C-band SAR sharing Analysis, dated March 6, 1996.

⁴⁵ See WINForum Reply at 6.

⁴⁶ See PacTel Comments at 3.

⁴⁷ See L/Q Comments at 14.

⁴⁸ See Cylink Comments at 2.

⁴⁹ See *First Report & Order and Second Notice of Proposed Rule Making*, ET Docket No. 94-124, 11 FCC

and the 59-64 GHz band for unlicensed high speed communications.⁵¹

24. MSS interests argue that the Commission should not permit U-NII devices, particularly longer range devices intended to serve community networks, in the 5.15-5.25 GHz band because such operations would interfere with MSS feeder links.⁵² Additionally, L/Q challenges the validity of the claim that U-NII devices need access to the 5.15-5.35 GHz band to be compatible with HIPERLAN. They assert that HIPERLAN is still only a proposal that may not ultimately be adopted in Europe.

25. Regarding the upper band, 5.725-5.875 GHz, incumbent interests argue that this spectrum is not needed for U-NII devices because the 200 megahertz proposed in the 5.15-5.35 MHz band should be sufficient.⁵³ Parties that manufacture unlicensed spread spectrum devices under Section 15.247 of the Commission's rules argue that the upper band should not be made available because U-NII devices might interfere with existing unlicensed spread spectrum devices operating in this band.⁵⁴ They oppose permitting non-spread spectrum U-NII devices to operate in the upper band without detailed technical analysis and equipment testing to determine which U-NII applications could be implemented, and what technical specifications will be needed to avoid interference to spread spectrum operations.⁵⁵ Amateur interests share a similar concern, arguing that U-NII devices would cause harmful interference to amateur operations in this band. For example, the Southern California Repeater and Remote Base Association ("SCRRBA") argues that the 5.15-5.30 GHz band would better accommodate U-NII devices because it would allow for the development of equipment consistent with HIPERLAN.⁵⁶ SCRRBA, however, states that the upper band could be used on a limited basis by U-NII devices if adequate technical limits (*i.e.*, spread spectrum requirement, short distance, and power limit similar to U-PCS) are imposed and if the secondary allocation of the amateur service in this band were upgraded to a primary allocation.⁵⁷ The San Bernardino Microwave Society ("SBMS"), on the other hand, opposes any U-NII operations in the upper band, arguing that these devices cannot share with amateur weak-signal operations.⁵⁸

26. Finally, several parties oppose allowing U-NII operations in the 5.85-5.875 GHz portion of the spectrum. The Federal Highway Administration ("FHWA") and the Intelligent Transportation Society of America ("ITS") state that U-NII devices at 5.85-5.875 GHz would interfere with their plans to seek an allocation of the 5.85-5.925 GHz band for Dedicated Short

Rcd 4481 (1996).

" See *Notice of Proposed Rule Making*, ET Docket No. 96-8, 11 FCC Rcd 3068 (1996).

" *Supra*, note 49.

" See Airtouch Reply at 2, Comsat Corporation and ICO Global Communications Reply at 2, and L/Q Reply at 4.

" See Cylink Comments at 4, Western Multiplex Comments at 3 and Wireless Field Test for Education Project ("WFTEP") Comments at 3.

" See Western Multiplex Comments at 3-4, Metricom Reply at 6 and Cylink Reply at 12.

" See, *e.g.*, Cylink Comments at 8.

" See SCRRBA Reply at 9.

" See SCRRBA Comments at 9.

" See SBMS Reply at 2-5.

Range Communications ("DSRC").⁵⁹ Further, Resound Corporation ("Resound"), a manufacturer of hearing health care products, argues that the 5.85-5.875 GHz band should not be provided for U-NII operations, because such operations would interfere with the current use of this spectrum for low power hearing assistance devices permitted under Section 15.249.⁶⁰

27. *Decision.* We continue to believe that it is appropriate to provide unlicensed devices with access to a substantial amount of spectrum at 5 GHz to accommodate the demand by educational, medical, business, industrial and consumer users for broadband multimedia communications. We are also cognizant, however, of the need for U-NII devices to share the spectrum with primary services without causing radio interference to those services. We believe that both of these concerns can be accommodated by adopting appropriate technical restrictions for U-NII devices, particularly transmit power and out-of-band emission limits (see technical discussion below), and by avoiding portions of the spectrum where sharing would be particularly difficult. Accordingly, we will make 300 megahertz of spectrum available for U-NII devices. Specifically, we are providing U-NII devices access to three 100 megahertz bands at 5.15-5.25 GHz, 5.25-5.35 GHz and 5.725-5.825 GHz. We recognize that this is less than the 350 megahertz that was proposed in the *NPRM*, but we believe that this amount of spectrum provides an appropriate balance between spectrum sharing concerns and providing sufficient spectrum to satisfy the needs of U-NII devices.

28. We believe that 300 megahertz of spectrum will provide sufficient spectrum to allow the full potential of broadband multimedia technologies to be realized. This spectrum should provide for open entry and equal access by all such devices and to allow access to the spectrum by multiple users at a common location using a variety of different devices. In this regard, we note that these broadband devices each may require 20 to 25 megahertz channel bandwidth to provide the high data rates envisioned by the petitioners.⁶¹ Furthermore, as discussed in greater detail in Section C below, the different sharing environments applicable to the three 100 megahertz sub-bands, 5.15-5.25, 5.25-5.35, and 5.725-5.825 GHz, require that U-NII operations comply with discrete technical standards for each sub-band.

29. This action will also open opportunities for American industry to be competitive in the global market for these new telecommunication products. Specifically, providing access to the 5.15-5.30 GHz band would permit U-NII devices to be compatible with the European HIPERLAN and would allow American industry flexibility to create products for both markets.⁶²

30. We also believe that the 300 megahertz of spectrum we are providing for U-NII devices avoids the use of spectrum that would be particularly difficult to share with primary

" See FHWA Comments at 2-3 and ITS Comments at 2. FHWA's comments state that DSRC communications could encompass several applications that require guaranteed channel access. For example one such application involves implementation with roadside speed- and location-sensing equipment, DSRC communications equipment, in-vehicle signing equipment and trajectory computing and control electronics. Using these components, as vehicles approach an intersection, their speed and location are compared with the traffic signal status and potential collision conditions are identified. DSRC is then used to warn drivers of danger.

" See Resound Comments at 4.

" See, e.g., Hewlett-Packard Comments at 6, Nortel Comments at 10, Rockwell Comments at 2, 3Com Comments at 5, and WINForum Comments at 7.

" See *supra*, n. 44.

operations. Specifically, as addressed below, we believe that U-NII devices can share with proposed and existing services in these bands including the MSS feeder link operations that may use the 5.15-5.25 GHz band. On the other hand, U-NII devices will not have access to spectrum used by microwave landing systems ("MLS") operated by the FAA in the 5.0-5.15 GHz band. Additionally, U-NII devices will not have access to the 5.825-5.875 GHz band. This will avoid potential interference with low power Part 15 hearing aid devices and potential ITS operations in the 5.850-5.875 GHz band, FSS operations in the 5.850-5.925 GHz band, and amateur operations in the 5.650-5.725 and 5.825-5.925 GHz bands.

31. We are not persuaded by arguments that U-NII devices should be accommodated in spectrum other than the 5 GHz bands. With regard to the argument that U-NII devices could use Government spectrum below 5 GHz that will be made available in the future for commercial use, we note that this amount of spectrum is substantially less than the amount we are here making available and is distributed over a wide range of frequency bands that would make the design of equipment difficult and expensive. We note that those bands will be the subject of future rule making proceedings that will determine the types of operations for which those bands may be used. We are also unpersuaded that spectrum above the 5 GHz range, particularly the millimeter wave bands above 40 GHz, could be used by unlicensed devices as easily or be made available as quickly as the 5 GHz bands. We note that signals at these higher frequencies have propagation constraints that will reduce the communication distances of devices operating at equal powers. Further, equipment that operates at a higher frequency is typically more expensive than equipment that operates at a lower frequency range.

C. *Technical Standards*

1. *General*

32. In the *NPRM*, we proposed rules to provide the maximum technical flexibility in the design and operation of U-NII devices, to ensure that they do not cause harmful interference to incumbent and future operations, and to facilitate basic spectrum sharing among unlicensed devices. We proposed a maximum peak power limit of 100 milliwatt ("mW") (-10 dBW) Equivalent Isotropically Radiated Power ("EIRP") for both the upper and lower 5 GHz U-NII bands. We also requested comment on whether to permit operations at up to 1 watt ("W") (0 dBW) of transmitter output power within the upper band in order to facilitate community networks. Additionally, we did not propose limits on channelization or modulation efficiency, but did request comment on these issues. Further, we proposed limits on emissions outside the bands of operation. Specifically, we proposed to require all emissions occurring from U-NII devices outside of the authorized bands to be attenuated by at least 50 dB or to the radiated emission limits set forth in Section 15.209,⁶³ whichever is the lesser attenuation.⁶⁴ In addition, we proposed to require any emissions occurring in the restricted bands⁶⁵ to comply with the radiated emission limits set forth in Section 15.209. We also proposed to require any unwanted emissions

" See 47 CFR § 15.209.

" See *supra*, *NPRM* at para. 49.

" Only spurious Part 15 emissions are permitted in restricted bands. The restricted frequency bands are those allocated for services involving safety-of-life or for services that are required by the nature of their operations to use signals received at very low received levels. See 47 CFR § 15.205. See, also, *First Report and Order*, GEN. Docket No. 87-389, 4 FCC Rcd. 3493 (1989).

to comply with the general field strength limits set forth in Section 15.209. Finally, we proposed to require that any U-NII devices using an AC power line must also comply with the conducted limits set forth in Section 15.207.⁶⁶

33. *Comments.* The commenters strongly support the adoption of only those technical regulations, such as power limits and emission limits, needed to prevent interference from U-NII devices to incumbent services.⁶⁷ They claim that this would provide technological flexibility in the design and types of new equipment that can be manufactured and would correspondingly provide consumers with greater choices in U-NII devices and communications options.

34. *Decision.* We continue to believe that the best regulatory framework to facilitate the introduction of U-NII devices is one that provides the maximum technical flexibility in their design and operation by imposing only the minimum technical rules necessary to prevent harmful interference to primary operations and to provide for basic spectrum sharing among unlicensed devices. The adoption of such an approach is overwhelmingly supported by the record. We believe that adoption of minimum technical rules would not only permit unlicensed devices to operate successfully on a shared basis, but would also encourage maximum flexibility in the types and designs of unlicensed digital devices that could use this band. Accordingly, as addressed below, we are adopting the minimum technical regulations which we believe will most facilitate the introduction of U-NII devices, will adequately protect primary services, and will promote sharing among U-NII devices.⁶⁸ These rules specify power limits (in terms of peak power and power spectral density), emission limits, radio frequency hazard requirements, and other basic technical rules appropriate for unlicensed Part 15 operations. Further, as addressed below, we are not adopting a channeling plan, spectrum modulation efficiency requirement or a spectrum etiquette as we believe such technical standards are unnecessary at this time, could preclude certain technologies, and could unnecessarily delay implementation of U-NII devices.⁶⁹

2. *Power and Antenna Constraints*

35. *Comments.* The comments vary substantially with regard to the power and antenna gain limits that should be adopted to allow for reliable communications while protecting the incumbent 5 GHz services and allowing for sufficient frequency reuse among U-NII devices. Some U-NII proponents support our proposed maximum power limit for within-building and short-range LAN operations, but also claim that higher power will be needed for both local-area campus communications and for community area networks. Incumbent interests generally support the proposed 100 mW EIRP limit which, they argue, is necessary to protect incumbent operations.

36. Most U-NII proponents support allowing higher power and higher antenna gain in the U-NII spectrum. They claim that the propagation characteristics at 5 GHz are such that operation at power levels higher than the proposed limit is required to provide reliable

⁶⁶ See 47 CFR § 15.207.

⁶⁷ See, e.g., CEMA Reply at 7, Educators Comments at 4, and WINForum Reply at 11.

⁶⁸ See para. 35-54 below.

⁶⁹ See para. 55-71 below.

communications for most local-area networks and for longer-range networks.⁷⁰ They state that the signal attenuation caused by walls is one of the primary reasons why higher power is needed for LANs. Higher power, they state, is also needed for community networks to achieve reliable communications over the necessary distances. For example, WINForum argues that, in order to meet on-premises communication requirements, the maximum transmitter output power limit in the 5.15-5.35 GHz band should be 100-250 mW (-10 to -6 dBW), and directional antennas should be permitted with up to 6 dBi gain.⁷¹ It also suggests allowing use of even higher gain antennas, as long as the transmitter power is decreased on a dB-for-dB adjustment basis (*i.e.*, transmitter output power would be decreased by one dB for every dB increase in antenna gain). WINForum states that these maximum power and gain parameters would provide a desirable balance between permitting sufficient in-building signal penetration by U-NII devices and ensuring adequate interference protection to incumbent 5 GHz and other U-NII operations.

37. Apple supports adoption of a maximum transmitter output power of 100 mW (-10 dBW) in the 5.15-5.25 GHz band.⁷² Apple states that this power limit would protect incumbent operations and would allow the lower power band to be used for personal/portable type operations that would generally operate indoors. Apple also argues for a higher limit on transmitter output power in the 5.25-5.35 GHz and 5.725-5.825 GHz bands. Specifically, Apple states that we should set the power limit at 316 mW (-5 dBW), with unrestricted antenna gain in these bands. It claims higher power is needed in these bands to provide for fixed point-to-point operations that would meet the requirements of community networks.

38. WINForum also urges the Commission to adopt higher power and antenna gain limits for the upper band, 5.725-5.825 GHz. It notes that Part 15 spread spectrum devices in this band are currently authorized to operate with up to 1 W transmitter output power and with up to 6 dBi of antenna gain. Further, it notes that even higher power limits for spread spectrum devices are currently under consideration by the Commission in ET Docket 96-8.⁷³

39. Motorola recommends adoption of a maximum transmitter output power limit of 250 mW in the 5.15-5.35 GHz band, and 1 W in the 5.725-5.825 GHz band, for bandwidths equal to or greater than a certain threshold, *e.g.*, 25 megahertz. Motorola also supports allowing transmitter antenna gains of up to 23 dB in both bands, without any associated reduction in transmitter output power.⁷⁴ Motorola argues that directional transmitter antennas will provide reliable communications with lower risk of interference. It further states that U-NII device power limitations should be based on the output power spectral density to reduce interference concerns irrespective of the emission bandwidth. That is, transmitter output power should be reduced in direct proportion to any reduction in emission bandwidth below some threshold. With regard to community network links, Motorola recommends that, consistent with the proposal in ET Docket No. 96-8, the Commission allow the use of even higher gain transmitter antennas whenever the

⁷⁰ See, *e.g.*, Benton Foundation and Computer Professionals For Social Responsibility ("Benton") Comments at 5 and Connectivity for Learning Coalition Comments at 3.

⁷¹ See WINForum Comments at 23-25.

⁷² See Apple Comments at 8. They also support adoption of the same 100 mW maximum transmitter output power limit for the 5825-5875 MHz band. Since we have decided not to make this spectrum available to U-NII devices, comments addressed to technical rules for this band are now moot.

⁷³ See *supra*, note 50.

⁷⁴ We note that 1 W transmitter power with 23 dBi gain would provide an EIRP of 200 W.

transmitter output power is reduced by 1 dB for each 3 dB of antenna gain above 23 dB.⁷⁵

40. Mulcay points out that the proposed 100 mW (-10 dBW) EIRP limit is substantially lower than the European HIPERLAN standard of 1 W (0 dBW) EIRP. Mulcay states that the maximum transmitter output power limit for U-NII devices should therefore be raised to 1 W (0 dBW) EIRP to be consistent with the HIPERLAN limit. It claims this would facilitate U.S. firms' ability to compete in global markets.⁷⁶

41. Parties currently utilizing the 5 GHz spectrum generally support the 100 mW EIRP limit proposed in the *NPRM*.⁷⁷ NTIA recommends adoption of the 100 mW EIRP limit in the 5.15-5.25 GHz band to provide adequate interference protection to primary operations in that band. L/Q adds that U-NII operations at any higher power would degrade the sharing capacity in that band and would greatly increase their potential to cause harmful interference to FSS operations in the band.⁷⁸ L/Q also opposes allowing directional antenna use by U-NII devices operating in the band. It contends that though interfering signals from a directional antenna may not be received by all satellites overhead, they could certainly be received by satellites close to the horizon and, thus, FSS capacity to operate in the band could be impaired. The ARRL argues that permitting the power of U-NII operations to exceed 100 mW EIRP or permitting the use of high-gain antennas by non-spread spectrum U-NII devices would represent a significant departure from the underlying precepts of Part 15, which require unlicensed operations not to cause interference to other services. Although the ARRL opposes the operation of U-NII devices in the 5.725-5.825 GHz band, it states that if a 100 mW EIRP limit and a power spectral density limitation of 0.03 mW in any 3 kHz bandwidth were adopted, then U-NII devices should be able to share this band with incumbent operations.⁷⁹ Finally, entities with spread spectrum interests oppose the operation of higher power, non-spread spectrum U-NII devices in the upper band on the basis that such operations could prevent existing spread spectrum devices from sharing that band.⁸⁰

42. *Decision.* We find that the 100 mW power limit proposed in the *NPRM* is not sufficient to accommodate the range and scope of communications envisioned for U-NII devices. We believe that increasing the U-NII device power limits will enable these devices to provide for a variety of operations including local areas networks, campus-type settings, or as part of community networks. At the same time, we recognize the need to ensure that primary operations are adequately protected from harmful interference. In this regard, we note that the primary users and the considerations that relate to interference with their operations, vary in different parts of the spectrum we are providing for U-NII devices. Specifically, the 5.15-5.25 GHz band will be shared with MSS feeder links; the 5.25-5.35 GHz band will be shared with Government radiolocation operations; and the 5.725-5.825 GHz band will be shared with Government radiolocation, Amateur, ISM, and other Part 15 operations. Therefore, the sharing environment for U-NII devices will be different for each of these three 100 megahertz segments. We find a balance between providing sufficient power limits for U-NII devices and protecting primary

⁷⁵ See Motorola Comments at 8.

⁷⁶ See Mulcay Reply at 9.

⁷⁷ See Pacific Telesis Comments at 4, TIA Comments at 2, and ARRL Comments at 7.

⁷⁸ See L/Q Reply at 5.

⁷⁹ See ARRL Comments at 10.

⁸⁰ See Larus Comments at 2 and Cylink Reply at 5.

operations may be struck by adopting different power levels for U-NII devices in each of the three 100 megahertz bands. This approach will provide the needed flexibility to allow U-NII proponents to design and manufacture equipment to meet a variety of communications needs while ensuring a successful spectrum sharing environment with other spectrum users.

43. Accordingly, we will divide the 300 megahertz available to U-NII devices into three bands of 100 megahertz each and will establish the following maximum U-NII device power limits for each band: a) in the 5.15-5.25 GHz band, the maximum peak transmitter output power limit will be 50 mW with up to 6 dBi antenna gain permitted, which equates to 200 mW EIRP; b) in the 5.25-5.35 GHz band, the maximum peak transmitter output power limit will be 250 mW with up to 6 dBi antenna gain permitted, which equates to 1 W EIRP; and c) in the 5.725-5.825 GHz band, the maximum peak transmitter output power limit will be 1 W with up to 6 dBi directional antenna gain permitted, which equates to 4 W EIRP. To permit manufacturers flexibility in designing U-NII equipment, we will permit the use of higher directional antenna gain provided there is a corresponding reduction in transmitter output power of one dB for every dB that the directional antenna gain exceeds 6 dBi.

44. In the 5.15-5.25 GHz sub-band, we believe a 50 mW peak output power with up to 6 dBi gain antenna will provide U-NII devices great flexibility in how this band is used. Specifically, these power limits will allow U-NII devices to provide a variety of short-range communications, such as those between computing devices (such as computers, servers, printers, etc.) within a very local area, such as in a room or in adjoining rooms. We also believe that restricting U-NII devices to this low power will allow U-NII devices to share this band with co-channel MSS feeder link operations. In this regard, we note that the initial European Conference of Postal and Telecommunications Administrations ("CEPT") studies conclude that HIPERLAN systems, which have technical characteristics similar to those of U-NII devices, can share this band with the MSS operations without causing harmful interference to the MSS feeder links.⁸¹ (See Section E "*Spectrum Sharing Considerations*" below.) While some commenters have argued that based on the CEPT studies that U-NII devices could operate at higher powers than we are adopting without causing interference, we recognize that since the CEPT study was made Globalstar has changed some of the parameters of its system and that its MSS feeder links potentially could be more susceptible to interference. In any event, we believe the power we are adopting is appropriate to ensure that U-NII devices do not cause harmful interference to MSS feeder link operations. We are also restricting U-NII use of this band to indoor operations. This will provide additional protection to co-channel MSS operations due to the attenuation of U-NII device signals as they pass through the walls and ceilings of buildings. Accordingly, we believe this power limit, along with the restriction on outdoor operations, will provide the desired balance of providing sufficient power for U-NII devices in this band, high frequency reuse, great flexibility in the types of U-NII operations that are accommodated in this band, and protection of co-channel MSS operations.

45. In the 5.25-5.35 GHz sub-band, we are adopting a higher maximum peak transmitter input power limit of 250 mW, along with the associated higher power spectral density limit noted below. We are not restricting U-NII devices to indoor operations in this band because it will not be shared with MSS operations. We believe that U-NII operations with a peak

⁸¹ See CEPT Recommendation T/R 22-06 (Madrid 1992); see also Proposed Modification of CEPT Recommendation T/R 22-06.

transmitter output power of up to 250 mW and a directional antenna with up to 6 dBi of gain will be sufficient to accommodate communications within and between buildings, such as are envisioned for campus-type LANs. The only operations in this band are Government radiolocation systems (radar), and NTIA has supported allowing higher power for U-NII operations in this portion of the band. These power and antenna gain limits are comparable to the 1 W EIRP limit used for HIPERLAN and therefore should provide manufacturers with economies of scale in developing equipment useable in both the domestic and international markets.

46. In the 5.725-5.825 GHz band, we note that spread spectrum Part 15 devices are already authorized to operate with 1 W transmitter peak output power and with up to 6 dBi gain transmitting antennas. Accordingly, we are authorizing similar peak power and antenna gain parameters for U-NII devices in this band. We believe that U-NII operations that comply with this power limit will be able to provide community networks with a typical range of several kilometers. Further, we believe that longer-range communications could be possible in areas with a low interference environment (*i.e.*, rural areas) where high gain receive antennas could be used.⁸² (Such antennas do not affect the transmitted emission level or EIRP.) We recognize that the commenters recommend that we allow the use of even higher gain transmitting antennas in this band. However, the record in this proceeding does not provide enough technical support for us to conclude that U-NII devices with 1 W transmitter power and high gain transmit antennas would not cause interference to the primary service, Government radiolocation. Specifically, NTIA has expressed concern about higher powers in this band and supports further experimentation before either higher power or gain is authorized.

47. In ET Docket No. 96-8, we are currently considering whether to authorize the use of transmitting antennas with higher gain for Part 15 spread spectrum operations in this band. If we decide in that proceeding to permit the use of higher antenna gain for spread spectrum operations, we may consider similar action for U-NII devices in this band in a separate rule making. However, we note that permitting use of high gain antennas with U-NII devices without requiring an equal reduction in power could have a significant impact on the interference environment in this band, and this issue would have to be addressed should a further rule making be initiated.

48. With regard to sharing this band with amateur operations, we believe that U-NII devices will cause little interference to amateur operations because of the relatively low power with which U-NII devices will operate. Further, we note that the amateur service has access to all spectrum within the 5.65-5.925 GHz range. We therefore believe that amateur operations will be able to avoid using frequencies within the 5.725-5.825 GHz band that are available to U-NII devices, in those rare cases where such avoidance may be necessary.

49. Additionally, in all three bands we are adopting peak power spectral density limits to ensure that the power transmitted by U-NII devices is evenly spread over the emission bandwidth. Specifically, we will require U-NII devices to decrease transmitter output power proportionally to any decrease in emission bandwidth below 20 MHz. These requirements will decrease the potential for interference to other services and will encourage the use of the U-NII bands for the broadband operations for which they are intended. For U-NII devices operating

⁸² High gain receive antennas would not be useful in areas where the ambient noise level is high, such as areas where there are a large number of U-NII devices operating co-channel.

with less than 20 megahertz of emission bandwidth, we will limit power spectral density as follows: a) in the 5.15-5.25 GHz band, the transmitter peak power spectral density will be 2.5 mW/MHz for an antenna gain of 6 dBi; b) in the 5.25-5.35 GHz band, the transmitter peak power spectral density will be 12.5 mW/MHz for an antenna gain of 6 dBi; and c) in the 5.725-5.825 GHz band, the transmitter peak power spectral density will be 50 mW/MHz for an antenna gain of 6 dBi.⁸³ Finally, to allow manufacturers flexibility in designing U-NII devices, we will allow operations with antenna gains exceeding 6 dBi if the peak power spectral density is reduced by the same amount the directional antenna gain exceeds 6 dBi.

50. In the 5.15-5.25 GHz band, we will require transmitting antennas to be an integral part of the U-NII device. This will ensure that our authorized power limits are not exceeded in this band. In the 5.25-5.35 GHz and 5.725-5.825 GHz bands, we shall require that the U-NII device use a permanently attached antenna or an antenna that uses a unique coupling to the U-NII devices in accordance with Section 15.203(a) of the rules.⁸⁴ These requirements will limit potential interference to other systems and will provide for greater frequency reuse by U-NII devices.

3. *Emissions Outside the Band of Operation*

51. In the *NPRM*, we proposed to require that all emissions from U-NII devices occurring outside of the U-NII bands be attenuated by at least 50 dB or to the radiated emission limits set forth in Section 15.209,⁸⁵ whichever is the lesser attenuation. In addition, we proposed that any emissions occurring in the restricted bands⁸⁶ comply with the radiated emission limits set forth in Section 15.209. We also proposed to amend Section 15.205 to delete 5.15 - 5.25 GHz as a restricted band. Further, we proposed to require that any unwanted emissions comply with the general field strength limits set forth in Section 15.209. Finally, for any U-NII devices that use an AC power line, we proposed to require such devices to comply also with the conducted limits set forth in Section 15.207.⁸⁷

52. *Comments.* Only a few parties commented on the emission limits proposed in the *NPRM*. Several commenters supported the proposal.⁸⁸ For example, Mulcay agrees with the proposal to limit emissions pursuant to Section 15.209. However, other commenters argue that the Commission should permit industry to develop limits on emissions that fall outside the bands of operation.⁸⁹ WINForum supports reliance on emission limits and measurement methods that would be developed by industry and argues that the rules regarding unwanted emissions should be stated in terms of burst average power and should be independent of the power of the fundamental emission.⁹⁰

⁸³ These power spectral density requirements shall be measured with a spectrum analyzer having a resolution bandwidth of 1 megahertz.

⁸⁴ See 47 CFR § 15.203.

⁸⁵ See 47 CFR § 15.209.

⁸⁶ See 47 CFR § 15.205.

⁸⁷ See 47 CFR § 15.207.

⁸⁸ See Mulcay Reply at 7 and Solectek Reply at 16.

⁸⁹ See Motorola Comments at iv.

⁹⁰ See WINForum Comments at 29.

53. *Decision.* Limits on emission levels outside the bands of operation and frequency stability requirements are necessary to protect adjacent spectrum occupants and sensitive operations that may operate on harmonic frequencies. However, in view of the higher and different power limits we are adopting for U-NII devices in each of these bands, we are making appropriate adjustments to the limits we proposed in the *NPRM* on the permissible emission levels outside the band. Specifically, we will require U-NII devices operating in the upper band to attenuate emissions below the maximum power spectral density by a factor of at least 40 dB for frequencies from the band edge to 10 megahertz from the band edge and by a factor of at least 50 dB for frequencies greater than 10 megahertz from the band edge. For the other two bands which have lower maximum power limits we will take this limit as an absolute limit. This will provide the same level of interference protection outside all three bands. Accordingly, the attenuation of peak levels of emissions outside of the frequency bands of operation below the maximum peak power spectral density contained within the bands of operation must be in accordance with the following limits:

- i) For transmitters operating in the band 5.15-5.25 GHz: all emissions within the frequency range 5.14-5.15 GHz and 5.35-5.36 GHz must be attenuated by a factor of at least 27 dB; within the frequency range outside these bands by a factor of at least 37 dB.
- ii) For transmitters operating in the 5.25-5.35 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge must be attenuated by a factor of at least 34 dB; for frequencies 10 MHz or greater above or below the band edge by a factor of at least 44 dB.
- iii) For transmitters operating in the 5.725-5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge must be attenuated by a factor of at least 40 dB; for frequencies 10 MHz or greater above or below the band edge by a factor of at least 50 dB.

As already specified in the rules, the measurements of such emissions shall be performed using a minimum resolution bandwidth of 1 MHz.⁹¹ Regardless of the attenuation levels shown above, we will not require emissions outside the frequency range of operation to be attenuated below the general radiated emission limits in Section 15.209 of our rules.⁹² Further, we will not specify these emission limits as a maximum power spectral density of the operating band, as requested by WINForum, because such a limit would have to be adjusted with changes in antenna gain in order to maintain a consistent interference potential. The emission limits being adopted are based on the peak power spectral density within the band of operation, and the power spectral density is varied to reflect changes in the gain of the antenna. We recognize that changes to the gain of the antenna at harmonic frequencies may not directly correlate with changes to the antenna gain at the fundamental frequency. However, we believe that the limits being adopted for spurious emissions are sufficient to reduce the probability of harmful interference. Further, the provisions in Section 15.205 of our rules will ensure that harmful interference does not result to critical safety services regardless of antenna gain.⁹³

" See 47 CFR § 15.35.

" See 47 CFR § 15.209.

" See 47 CFR § 15.205.

54. Further, we will adopt our proposal to remove the 5.15-5.25 GHz band from the restricted bands listed at Section 15.205 of the rules.⁹⁴ We note that U-NII devices will have to comply with the provisions of Section 15.205 in order to protect sensitive operations. We also note that the 4.5-5.15 GHz and 5.35-5.46 GHz bands remain restricted; therefore, U-NII devices operating close to the band edges at 5.15 GHz or 5.35 GHz will be required to sharply attenuate their signal at the band edge or avoid using the spectrum close to the band edge. We do not believe that this requirement will significantly affect U-NII operations overall. In any event, this requirement is needed to protect sensitive and safety-of-life operations in adjacent bands. Additionally, we adopt our proposal to require that emissions comply with the general field strength limits set forth in Section 15.209. Finally, any U-NII devices that use an AC power line must comply with the conducted limits set forth in Section 15.207.⁹⁵

4. Channeling Plan & Modulation Efficiency

55. In the *NPRM*, we did not propose to adopt limits on channelization or modulation efficiency, but did request comment on whether we should specify a channeling plan or a minimum modulation efficiency requirement for U-NII devices to ensure efficient use of the spectrum. We specifically requested comments on whether a 20 or 25 MHz channeling plan and/or a 1 bit/second/Hz ("bps/Hz") modulation efficiency should be adopted and whether these regulations would be beneficial in facilitating unlicensed broadband high data rate use of these bands.

56. *Comments.* Commenting parties disagree as to whether the Commission should adopt a mandatory channelization plan or minimum bandwidth requirement for unlicensed U-NII devices. Those supporting a channelization plan and/or minimum bandwidth requirement argue that the 5 GHz unlicensed bands should be dedicated for wideband systems. These parties contend that other unlicensed bands such as the U-PCS spectrum are already available for narrower bandwidth applications.⁹⁶ They claim that some channel limitations are needed. They contend that wideband devices with high signaling speed requirements suffer disproportionately from harmful interference caused by narrow bandwidth devices with low signaling speed requirements, and that complex rules would be required to correct this imbalance. WINForum, Lucent, and Nortel support a minimum channel spacing of 20-25 megahertz and suggest that the rules not prohibit U-NII devices from combining channels to enable very wide bandwidth communications.⁹⁷ In addition, Nortel states that a 20-25 megahertz minimum channel bandwidth would simplify any industry-developed access protocol by limiting the number of channels that would need to be scanned in order to detect the absence of communications from other devices before transmitting. Further, it notes that such a channeling plan would enable U-NII devices to be compatible with HIPERLAN equipment.⁹⁸

57. On the other hand, several NII proponents argue that, with so many open questions about the future needs for unlicensed wireless networking capabilities, it is premature

⁹⁴ See 47 CFR § 15.205.

⁹⁵ See 47 CFR § 15.207.

⁹⁶ See Lucent Comments at 3 and WINForum Comments at 25.

⁹⁷ See WINForum Comments at 25-27, Lucent Comments at 3, and Nortel Comments at 10.

⁹⁸ See Nortel Comments at 10.

and technically unwise to specify a channeling plan or a maximum channel bandwidth.⁹⁹ The channelization for these bands should be flexible, they state, because the bandwidth required for a given application is dependent on the data rate, communications distance, type of modulation, and specific error correction coding involved. They also claim that a minimum channel width or channelization requirement may limit both technical innovation and flexibility and therefore may increase costs and retard development of new communications options.¹⁰⁰ Finally, although Apple opposes mandatory channelization standards, it states that, in the bands used for high data rate systems, voluntary channelization plans or more informal channelization etiquettes could be developed by industry to promote efficient spectrum use.

58. Most U-NII proponents oppose the imposition of any requirement for modulation efficiency. They claim that such a requirement would increase system complexity and preclude certain modulation techniques, which would in turn increase costs and development time, and delay implementation of U-NII devices.¹⁰¹ Several commenters oppose the 1 bps/Hz modulation efficiency suggested in the *NPRM* on the grounds that it would preclude spectrum efficient technologies such as spread spectrum, which they observe is spectrally efficient because of its high interference rejection and spectral reuse but may not meet a 1 bps/Hz requirement.¹⁰² Further, several parties claim that efficiency can only be measured meaningfully when geographic frequency re-use (cell area) is also considered, such as bps/Hz/unit-area.¹⁰³ These parties argue that a robust system with low modulation efficiency that is capable of operating in the presence of higher potential interference may nevertheless have higher throughput per unit area than a less robust system.¹⁰⁴ Finally, they argue that it is unnecessary to mandate a standard for spectrum efficiency, since the market will decide what efficiency is needed.¹⁰⁵ In this regard, WINForum recommends forgoing the adoption of a modulation efficiency standard at this time in favor of allowing industry groups to consider the development of a more flexible spectral efficiency measure that would take into account frequency reuse characteristics.¹⁰⁶

59. A few U-NII proponents do support adoption of a modulation efficiency standard. For example, Hewlett-Packard Company ("Hewlett-Packard") recommends a minimum modulation efficiency standard of 0.66 bps/Hz, arguing that, though specification of a high bandwidth efficiency does not guarantee a high spectral efficiency, it can nevertheless prevent low transmission rate systems from using the spectrum inefficiently.¹⁰⁷ Lucent recommends a minimum modulation efficiency standard of 0.5 bps/Hz based on the use of a 3-dB bandwidth, as opposed to use of the full emission bandwidth. If, however, the emission bandwidth were used, Lucent recommends a higher minimum modulation efficiency standard. NTIA also recommends adoption of a bandwidth efficiency standard, but claims that imposition of a strict efficiency limitation at the outset may dampen rapid implementation. Therefore, NTIA recommends that the

⁹⁹ See, e.g., 3Com Comments at 5 and Business Software Alliance Comments at 2.

¹⁰⁰ See Microsoft Comments at 3-6, Solectek Reply at 21, and 3Com Comments at 5.

¹⁰¹ See Microsoft Comments at 6, California Wireless, Inc. Comments at 1, and 3Com Comments at 6.

¹⁰² See Motorola Comments at 11 and WINForum Comments at 27.

¹⁰³ See Mulcay Reply at 11; Lucent Comments at 4; and Lace, Inc. ("Lace") Reply at i, 5.

¹⁰⁴ See, e.g., Lucent Comments at 4.

¹⁰⁵ See, e.g., California Wireless Comments at 1.

¹⁰⁶ See WINForum Reply at 20.

¹⁰⁷ See Hewlett-Packard Comments at 7.

Commission adopt an effective bandwidth efficiency standard that would come into effect at some reasonable future date, such as three years after conclusion of this rule making proceeding.¹⁰⁸

60. Finally, some parties, particularly incumbents, argue that a modulation efficiency standard should be required in order to ensure that spectrum is not wasted. They state that highly efficient technologies currently exist and that it is not unreasonable to require U-NII devices to have modulation efficiencies higher than 1 bps/Hz. Alstatt Associates, for example, argues that, since digital television set-top boxes have a modulation efficiency of 6.66 bps/Hz, and Part 21 and 94 devices have a minimum modulation efficiency of 4.46 bps/Hz, U-NII devices should be required to have a minimum efficiency of 3 bps/Hz.¹⁰⁹ Larus Corporation ("Larus") agrees that we should adopt a modulation efficiency standard of no less than 3 bps/Hz,¹¹⁰ while the Northern Amateur Relay Council of California, Inc. ("NARCC") argues that a spectrum efficiency of 2 bps/Hz is appropriate and has in fact been achieved for years.¹¹¹

61. *Decision.* One of our goals in this proceeding is to provide rules which permit maximum technical flexibility in the design and development of U-NII devices capable of providing high data rate communications for a variety of multimedia applications in a shared spectrum environment. Such devices have not yet been designed, built, or tested. Accordingly, we believe that adopting a rigid channelization plan or mandating a modulation efficiency standard at this time would not meet this goal, and could delay implementation of U-NII devices by precluding certain technologies or applications. Further, we believe that the low power limits we are adopting will ensure efficient use of the spectrum by providing for high frequency reuse, which will allow for large numbers of U-NII devices to share the spectrum in any geographic area. We also believe that establishing a channelization plan or modulation efficiency at this early stage in the technological development of the devices might have several undesirable effects, such as increasing costs and delaying the benefits of U-NII devices to the public. Accordingly, we will not adopt a channeling plan or a modulation efficiency standard at this time.

62. Nevertheless, we note that the focus of this proceeding is to make available spectrum for broadband high data rate unlicensed devices capable of meeting the communications requirements of new multimedia applications. We therefore agree with those commenting parties that suggest the purpose of making these bands available is to support use of high data rate devices. Accordingly, we are adopting a definition for the type of devices that will be approved for this band. Specifically, the Part 15 rules will state that unlicensed U-NII operations in the 5.15-5.35 GHz and 5.725-5.825 GHz bands will be limited to wide bandwidth, high data rate digital operations. Unlicensed devices accessing the 5.725-5.825 GHz band under other Part 15 rules would not be subject to this definition. This will give equipment manufacturers the flexibility to design and manufacture a variety of broadband devices using different technologies and modulation techniques, while ensuring that this spectrum is used for its intended purpose. This definition will be enforced through the Commission's equipment certification process.

D. *Spectrum Etiquette*

¹⁰⁸ See NTIA Reply at 12.

¹⁰⁹ See Alstatt Comments at 2.

¹¹⁰ See Larus Comments at 2.

¹¹¹ See NARCC Comments at 6.

63. In the *NPRM*, we proposed a basic "listen-before-talk" ("LBT") spectrum sharing etiquette, similar to that established for U-PCS devices,¹¹² to ensure that the U-NII spectrum is used by devices in a manner that would permit them to share with one another.¹¹³ We suggested that the proposed etiquette could serve as an interim protocol standard until industry developed a spectrum sharing etiquette. In this regard, the *NPRM* encouraged industry to develop appropriate etiquette protocols for these devices through a consensus process and stated that, if appropriate, we would consider those protocols in this or a further rule making proceeding. Finally, we solicited comments on whether such an etiquette should be required at all, or whether the minimal technical requirements would be sufficient to ensure spectrum sharing among U-NII devices.

64. *Comments.* The commenters overwhelmingly oppose the LBT spectrum etiquette proposed in the *NPRM* for U-NII devices. Several parties argue that the LBT protocol is unnecessary and would be detrimental to U-NII devices at 5 GHz. For example, Motorola states that LBT would be ineffective in controlling interference among U-NII devices, particularly in buildings with many rooms and hallways. Several commenters also assert that LBT would be detrimental because it would preclude isochronous multimedia applications and other technologies such as Asynchronous Transfer Mode ("ATM") that would not be able to comply with strict transmission time-frame requirements.¹¹⁴ Motorola claims that LBT would unduly restrict the utilitarian choices which manufacturers of U-NII devices could offer to consumers.¹¹⁵

65. Additionally, some commenters oppose establishing any interim etiquette on the grounds that devices developed under such an interim etiquette could be rendered useless once a permanent etiquette is adopted.¹¹⁶ In this regard, Lucent asserts that adoption of an interim etiquette would hinder introduction of future systems and would inhibit the process of developing an industry consensus for spectrum sharing rules. Cylink contends that interim rules would harm the competitiveness of small businesses. It claims that only larger companies could afford to cover the risk of betting on the eventual outcome of industry working group deliberations aimed at adopting a consensual etiquette. Similarly, WINForum expresses concerns about the compatibility of interim devices with any subsequent permanent spectrum etiquette and suggests that any interim operations should be constrained to 50 megahertz in the upper band with a date-certain changeover mandate.

66. Several commenters, while not supporting the proposed LBT etiquette, do support the development of a spectrum etiquette, or of multiple etiquettes, by industry consensus in order to help minimize interference among U-NII devices.¹¹⁷ For example, WINForum states that high-level protocols, like that adopted for U-PCS, may be excessively complex for U-NII devices, but simple RF rules (*e.g.*, power limits, channelization, unwanted emission limits) may prove insufficient to ensure fair, efficient, and open access.¹¹⁸ It adds that the development of such

¹¹² See 47 CFR § 15.321.

¹¹³ See *supra*, *NPRM* at para. 52.

¹¹⁴ See, *e.g.*, Lucent Comments at 5, Nokia Mobile Phones Americas, Inc. Comments at 2, and WINForum Comments at 20.

¹¹⁵ See Motorola Comments at 2.

¹¹⁶ See Lucent Comments at 5, Cylink Reply at 17, WINForum Comment at 20, and Mulcahy Reply at 6.

¹¹⁷ See Rockwell Comments at 3, WINForum Reply at 21, and CEMA Reply at 6.

¹¹⁸ See WINForum Reply at 21.

standards is appropriately left to voluntary standards organizations. NTIA also supports some type of channel monitoring protocol or U-NII etiquette to minimize interference, both to and from radar systems.¹¹⁹ Further, several other commenters aver that industry should be permitted to develop etiquettes within a time frame mandated by the Commission.¹²⁰

67. Some commenters oppose the adoption of any spectrum etiquette, stating that a required etiquette would inevitably limit innovation in the development of new U-NII products, and that the use of etiquettes has not always been proven to avoid interference. The Connectivity for Learning Coalition ("Coalition") asserts that while such protocols mandate a manner in which some technologies may share the spectrum, use of those technologies may or may not meet the needs of the education or library communities.¹²¹ Metricom, Inc. ("Metricom") states that, in theory, an etiquette may appear to allow for spectrum sharing, but there is no practical evidence that complex etiquettes prevent interference.¹²² Metricom states that creative engineers guided by minimal technical standards will best be able to design communications solutions to match consumer needs. Finally, 3Com Corporation ("3Com") claims that a formal spectrum etiquette would limit ingenuity and development of U-NII devices, and it urges the Commission to encourage the development of voluntary spectrum etiquettes to permit interoperability.¹²³

68. *Decision.* In general, we believe that a spectrum etiquette can provide benefits by facilitating compatibility among devices and allowing for equal access to the spectrum by devices that use different technologies. However, we do not believe that the interim LBT etiquette proposed in the *NPRM* would provide such benefits for unlicensed U-NII devices in the 5 GHz band. As pointed out in the comments, that LBT etiquette would be ineffective in controlling interference among devices and would preclude some technologies that may be desirable for U-NII devices. Accordingly we will not adopt our proposed etiquette.

69. We also note that the record does not provide an alternative spectrum etiquette to our proposed LBT etiquette that we could adopt at this time. Additionally, we do not think that it would be in the public interest to wait for an industry group to develop a satisfactory new etiquette as suggested by WINForum. We are concerned that it could take industry a substantial period of time to develop an etiquette for unlicensed U-NII devices at 5 GHz, because of the wide range of interests that would have to be accommodated in establishing a single etiquette for all the broad multimedia applications envisioned for U-NII devices. Further, after such an etiquette is developed, we would have to conduct a rule making proceeding to adopt the etiquette as a mandatory standard. Completing these activities would take at least a year, and possibly considerably longer. We do not believe that such a delay in implementing rules permitting U-NII operations would serve the public interest.

70. We recognize that there are trade-offs in adopting any etiquette and that the benefits of an etiquette must be weighed against its drawbacks. For example, an etiquette could beneficially facilitate compatibility among devices and thus promote spectrum sharing, inter-communications among different devices, and equal access to the spectrum by devices built by

¹¹⁹ See NTIA Reply at 11.

¹²⁰ See Apple Reply at 29 and CEMA Reply at 6, 7.

¹²¹ See Coalition Reply at 4.

¹²² See Metricom Comments at 14.

¹²³ See 3Com Comments at 7.

various manufacturers. Drawbacks of an etiquette include an increase in the complexity of equipment design and, hence, an increase in cost to the manufacturer and the user, as well as a potential limitation on access to the spectrum by some technologies and equipment. In the instant case, it is early in the developmental stage for equipment to operate in these shared bands as intended. Therefore it may be very difficult to develop a spectrum etiquette at this time that will not limit the types of equipment that could most efficiently or effectively provide the desired broadband communications.

71. Accordingly, we are not adopting a spectrum sharing etiquette at this time, nor will we delay access to the 5 GHz bands by U-NII devices until industry develops an etiquette. We believe the minimal technical rules we are adopting, particularly the maximum power limits discussed above, will generally allow for equal access and sharing of these bands by U-NII devices and thereby accomplish the intent of our proposed spectrum etiquette. Finally, our course of action will not preclude industry from developing any voluntary standards that it deems appropriate in the future. In this regard, we continue to encourage industry to develop appropriate etiquette protocols through a cooperative consensus process. If standards are developed that would better facilitate sharing of this band without precluding U-NII devices or technologies, we would consider adopting those protocols in a further rule making proceeding. We note that WINForum states that it has already begun setting the foundation for joint industry action in this area. We encourage all interested parties to take part in this process and to cooperate in good faith.

E. *Spectrum Sharing Considerations*

72. In the *NPRM*, we recognized that a number of primary services now use, or soon will use, the spectrum which we proposed for U-NII devices. The existing operations include Government radiolocation systems; mobile satellite feeder links; amateur operations; industrial, scientific, and medical operations; other unlicensed Part 15 operations; and proposed ITS. We stated in the *NPRM* that it would be necessary to develop spectrum sharing criteria between primary operations and the new U-NII devices. We tentatively concluded in the *NPRM* that sharing would be feasible, but requested comments on this issue.

73. *Comments.* NTIA, the Government agency responsible for the spectrum management for Government operations, supports our proposal to permit U-NII devices to share these bands with primary Government operations.¹²⁴ However, NTIA urges us to adopt sharing protocols and power limitations to facilitate sharing. NTIA states that the success of community networks will depend on their geographic separation from high powered radar systems operating in these bands. NTIA adds that Federal radar systems serve the interests of national security and that, therefore, all efforts should be made to avoid operating community network links near military radar sites. Additionally, NTIA states that compatibility analyses of long range links with existing radar needs to be completed for both U-NII and spread spectrum systems before higher powers are authorized.

¹²⁴ NTIA also states that U-NII devices should not be permitted to operate below 5.15 GHz, where Microwave Landing Systems ("MLS") operate. Also, NTIA requests that future ITS operations in the 5.85-5.875 GHz band be protected by limiting U-NII devices in this band to the proposed 100 mW EIRP. We are not making either of these spectrum bands available for use by U-NII devices.

74. In the 5.15-5.25 GHz band, parties with MSS interests argue that sharing is not feasible between MSS feeder links and new U-NII devices. In particular, L/Q asserts that only 1070 simultaneous users of U-NII devices could operate in the 5.15-5.25 GHz segment in the continental United States before unacceptable interference would be caused to the feeder links for Globalstar, its proposed mobile satellite system.¹²⁵ Airtouch Communications, Inc. ("Airtouch"), a limited partner in Globalstar, claims that its analysis indicates that U-NII operations in the 5.15-5.25 GHz band would reduce the capacity of Globalstar in the U.S. by over 27%.¹²⁶ Further, Airtouch and L/Q argue that the European sharing analysis for HIPERLAN, addressed in the NPRM, cannot be applied in this proceeding because U-NII devices and HIPERLAN do not have similar technical parameters and the International Telecommunication Union ("ITU") analysis is not based on current data.

75. On the other hand, U-NII proponents claim that U-NII devices would be able to share with Government radiolocation and MSS feeder uplinks operations because of the very low power with which U-NII devices will operate in the 5.15-5.25 GHz band and because of the attenuation characteristics of radio signals in the 5 GHz range. With regard to sharing with MSS feeder uplink operations, they conclude that MSS feeder operations would also be able to share with U-NII devices. They base this conclusion on the ITU study, which predicted that HIPERLAN systems would be able to co-exist with the MSS feeder links in the 5.15-5.25 GHz band in Europe. Further, they note that HIPERLAN devices will be operating at 1 W, a power level substantially higher than the power limit proposed for U-NII devices in this band, and that global MSS systems must be built to be robust enough to share with HIPERLAN. WINForum and Solectek Corporation ("Solectek") also counter L/Q's claim that only 1070 U-NII devices could use the band in the United States before causing interference to MSS feeder links, pointing out that L/Q made strict assumptions that are not representative of the U-NII device environment.¹²⁷ Specifically, WINForum notes that ITU's studies assume a more reasonable performance margin of 0.41 dB rather than the 0.004 dB that L/Q used. Based upon these more realistic criteria, WINForum claims that over 540 million U-NII devices could be deployed in the United States without causing harmful interference to the FSS uplink systems.

76. Additionally, some parties argue that use of directional antennas will decrease the radiation perceived by a satellite above the users in the vertical plane. Further, Lace, Inc. ("Lace") argues that a 10% power increase in the MSS feeder link would easily resolve the interference problem, if indeed that problem ever occurs.¹²⁸ Lace and Solectek argue that there are other means to mitigate interference such as power spectral density limits, transmitter on-time limits, station antenna directivity, relay link antenna directivity, out-of-band noise rejection, and positioning long range outdoor links above 5.25 GHz.

77. In the 5.725-5.825 GHz band, incumbent operators either oppose allowing U-NII operation due to interference concerns or urge that sharing studies be completed before that band is made available to U-NII devices. For example, the San Bernardino Microwave Society ("SBMS") argues that sharing between U-NII devices and amateur operations is not possible.¹²⁹

¹²⁵ See L/Q Comments at 8.

¹²⁶ See Airtouch Reply at 7.

¹²⁷ See Solectek Reply at 20 and WINForum Reply at 8-10.

¹²⁸ See Lace Reply at 2.

¹²⁹ See SBMS Reply at 1.

However, the ARRL states that the proposed U-NII maximum power limit of 100 mW EIRP appears to be sufficient to avoid significant interference to the amateur service, but it argues that the ubiquitous nature, mobility, and potential aggregate interference potential of these devices necessitates that sharing studies be performed.¹³⁰ Additionally, Section 15.247 spread spectrum interests oppose U-NII operations in this band and argue that without a means to control usage, operations in this band would rapidly degrade and become unusable.¹³¹ Further, incumbents oppose high power U-NII operations in this band because they argue it is more likely to cause interference to incumbent operations.¹³² The ARRL also claims that higher power U-NII operations should not be permitted because the Commission is unlikely to enforce the requirement that unlicensed device users cease operation if they are causing harmful interference to allocated services. Finally, Metricom states that to avoid interference, U-NII devices in the upper band should be required to operate in spread spectrum mode.¹³³

78. On the other hand, U-NII proponents argue that U-NII devices can share with Government radiolocation, amateur operations, ISM devices, other Part 15 devices and proposed ITS operations. They argue that these incumbent operations already share this band with other types of unlicensed devices. In this regard, Mulcay notes that a substantial number of devices, including Part 15 direct sequence spread spectrum radios with 1 W output power and antenna gains of 30 dBi, frequency hopping radios with omni-directional antennas and non-communication devices under Part 18 with no limit on radiated power, already share the 2.4 and 5.8 GHz bands on an unlicensed, non-coordinated basis without causing interference.¹³⁴ WINForum likewise argues that U-NII devices operating under equivalent technical standards can also share this band without causing harmful interference.¹³⁵ Apple notes that U-NII devices will only share a part of the 275 megahertz wide amateur band at 5.65-5.925 GHz and, therefore, claim that U-NII operations will not significantly affect the amateur radio service.¹³⁶ With regard to sharing with other Part 15 devices, U-NII proponents contend that the record demonstrates that U-NII devices can be designed to coexist with spread spectrum devices. CEMA argues that industry can develop technical guidelines and methodologies to allow community network systems and other systems to share unlicensed bands.¹³⁷ Further, Apple claims that directional antennas will reduce the probability that multiple devices will compete for spectrum in overlapping areas.

79. *Decision.* We continue to believe that U-NII devices can share these bands with existing and future operations. Specifically, we believe that the power limits, power spectral density requirements and emission limits that we are adopting herein will permit the robust development of U-NII devices without a significant impact on other spectrum users. With regard to Government operations, we agree with NTIA that MLS operations below 5.15 GHz must be protected. Accordingly, we are not allowing U-NII devices access to spectrum below 5.15 GHz. We believe that this decision, along with the power limits and out-of-band emission limits, will

¹³⁰ See ARRL Comments at 9-11.

¹³¹ See US West Reply at 3 and Larus Comments at 2.

¹³² See ARRL Reply at 8 and WFTEP Reply at 1.

¹³³ See Metricom Reply at 12.

¹³⁴ See Mulcay Reply at 8.

¹³⁵ See Winforum Reply at 11.

¹³⁶ See Apple Comments at 16.

¹³⁷ See CEMA Reply at 4,5.

adequately protect MLS operations. We also agree with NTIA that co-channel sharing with Government radiolocation is possible. We believe the power limits we are adopting will allow for this sharing as detailed below. Further, we believe that there will be no interference from U-NII devices to possible ITS operations, since we are not allowing U-NII devices access to the 5.85-5.875 GHz band.

80. In the 5.15-5.25 GHz band, we note that the sharing analyses completed to date often reach different results because they are based on different assumptions. For example, since the CEPT studies were made, Globalstar has changed some of the parameters of its system, and, therefore, MSS feeder links potentially could be more susceptible to interference than those studies concluded. Based upon the information before us, we conclude that the limits we are adopting will ensure that U-NII devices do not cause harmful interference to MSS feeder link operations.

81. In the 5.25-5.35 GHz band, we believe that the 1 W EIRP limit and the power spectral density requirements we are adopting for U-NII devices will adequately protect the primary radiolocation operations. We note that Government radiolocation systems are limited in number and generally located at remote military sites, on board ships, in aircraft and in spacecraft, and that these considerations in conjunction with the U-NII power limits should adequately protect the radiolocation service. Further, U-NII devices will have to accept interference from the radiolocation service.

82. In the 5.725-5.825 GHz band, we believe that the 4 W EIRP limit and the power spectral density requirements we are adopting for U-NII devices will adequately protect the primary radiolocation operations and amateur operations. These limits provide U-NII devices with power levels equivalent to Part 15 spread spectrum devices that already share this band with incumbent services. Therefore, U-NII devices should likewise be able to share this band without causing interference to the primary services. Further, with regard to spectrum sharing with the amateur service, we note that the amateur service has access to 275 megahertz of spectrum in the 5.65-5.925 GHz band. We believe amateur licensees will, if necessary, be able to operate around U-NII devices, which only have access to 100 megahertz in this portion of the 5 GHz spectrum. Additionally, we note that we are not at this time providing spectrum above 5.825 GHz for U-NII devices. This eliminates any sharing concerns with users or potential users of the 5.825-5.875 GHz band, which includes lower power Part 15 devices such as hearing aid devices, as well as ITS operations, and FSS operations.

83. We also believe our power spectral density requirements will permit U-NII devices to share this spectrum with unlicensed spread spectrum devices as the potential for interference to these devices from new U-NII devices will be no greater than that which would be expected from additional spread spectrum devices. Thus we see no reason to restrict U-NII devices in this band to spread spectrum technologies as requested by some commenters. Accordingly, we will allow U-NII devices in this band to operate on a technology-neutral basis. We believe this will provide manufacturers flexibility in designing U-NII products and thus will provide consumers with greater choices.¹³⁸

¹³⁸ Allowing U-NII devices in this band to operate on a technology-neutral basis will give manufacturers choices in that U-NII spread spectrum devices will be more robust and will provide longer communication distances but will not be able to provide the higher data rates of U-NII devices operating with the same power but with a more conventional digital modulation technology.

F. *Alternative Regulatory Structure*

84. In the *NPRM*, we proposed to allow U-NII devices to operate on an unlicensed basis. We tentatively concluded that the low power and limited range of U-NII devices would make licensing administratively difficult for users and the Commission. Further, we noted that this spectrum may be of very limited use to licensed services due to the presence of incumbent operations. Nonetheless, we requested comment on whether new U-NII operations should be provided on a licensed basis. We also solicited comments with regard to whether we should license higher power community networks if we were to allow such operations. We also asked whether, in the case of mutually-exclusive applications, we should use competitive bidding to award such licenses.¹³⁹

85. *Comments.* Most U-NII proponents support our proposal to allow U-NII devices to operate on an unlicensed basis. They oppose licensing and auctions of any U-NII operations, arguing that the benefits of authorizing Part 15 devices and systems would be undermined completely if licensing were required.¹⁴⁰ They state that licensing -- even expedited licensing -- would impede deployment, reduce innovation, reduce spectrum efficiency, increase costs, undermine the development of community networking and deny the benefits of low cost and flexible alternatives to existing media.¹⁴¹ Apple also contends that unlicensed community networks would not create problems of regulatory parity for common carriers and other profit making service providers. It states that those electing to use unlicensed bands would accept the fact that they will not control their spectrum environment and will be limited to low power operations; in exchange, they would be freed from the costs and burdens associated with licensing.¹⁴²

86. However, AT&T, PacTel, TIA and some microwave equipment manufacturers state that if the Commission permits the operation of longer range community networks, those networks should be subject to licensing and auctions. AT&T states that allowing unlicensed community networks would be unfair to the holders of existing spectrum licenses, particularly those who received their licenses through the auction process, and would undermine the Congressional objective of promoting regulatory parity among wireless services.¹⁴³ AT&T further states that the type of operation envisioned for community networks requires a degree of reliability and quality that can only be realized through licensed services. PacTel argues that unlicensed community networks would create an inequitable regulatory structure where unlicensed service providers operate in competition with licensed service providers without the common carrier obligations of a licensee.¹⁴⁴ TIA states that implementing long range networks requires frequency coordination, use of narrow beam antennas and other fundamental components of licensing in order to succeed.¹⁴⁵

¹³⁹ See 47 U.S.C. § 309(j)(2)(A).

¹⁴⁰ See Apple Comments at 20, CEMA Comments at 5, and WINForum Reply at 25.

¹⁴¹ See ITIC Comments at 5 and Cylink Comments at 10.

¹⁴² See Apple Reply at 17.

¹⁴³ See AT&T Comments at 4.

¹⁴⁴ See PacTel Comments at 5.

¹⁴⁵ See TIA Reply at 8.

87. *Decision.* We continue to believe that low power U-NII devices and associated operations are more amenable to an unlicensed structure and should be regulated under the Part 15 rules. Specifically, the rules governing U-NII devices are similar in their low power and flexible regulatory nature to those governing Part 15 devices. While some U-NII devices in the upper band could have ranges of several kilometers, we believe that most devices will have typical communication ranges of a few meters to a few hundred meters. Additionally, like other existing unlicensed devices, we believe that trying to license U-NII devices individually would be administratively difficult if not impossible for both the Commission and the consumer and would greatly delay the implementation and use of this band by U-NII devices. Further, we do not think it would be advisable at this time to license spectrum blocks and large service areas to providers.

88. We also are unpersuaded by the arguments that U-NII devices and associated operations need to be licensed in order to provide regulatory parity with licensed services. With regard to unlicensed U-NII devices that are used for community networks in the upper band, we note that these will also be of very limited range in comparison to the distances of fixed point-to-point operations, will have to operate in a Part 15 sufferance mode and may not always be able to provide the same grade of service as the licensed operations. That is, they will receive no protection from other users of the spectrum. Further, we note that in the upper band unlicensed devices are already providing point-to-point links for data transmissions, typically of up to 1.5 Mbits/sec. Further, we believe that the vast majority of U-NII devices will provide communications that are complementary to, rather than competitive with, the licensed services. We believe that the relationship between U-NII devices and the licensed point-to-point services will be analogous to the relationship between cordless telephones and PCS or the cellular telephone service. That is, U-NII devices will provide a variety of broadband high data rate services but only in a very limited range and generally on the premises of the users, while licensed fixed point-to-point microwave services provide communication links that are substantially longer, up to 30 and 40 miles, and in a controlled radio environment where the licensee has the right of protection from interference.

89. We do believe, however, that this proceeding has raised a number of spectrum issues that warrant further attention. Users and manufacturers of unlicensed devices, for example, may have little incentive to make the investment necessary to improve spectrum efficiency and thus allow more users to benefit. As we continue to implement spectrum policies that promote competition and efficiency we may also need to consider how to harmonize these policies with those for unlicensed devices.

G. *New Part 16 Regulations*

90. In the *NPRM*, we tentatively concluded that the technical and operational flexibility afforded under Part 15 is the appropriate structure for regulating U-NII devices, rather than a new Part 16 regulatory scheme. Under the Part 16 concept, unlicensed devices could be treated as a recognized radio service with spectrum rights, including interference protection. Alternatively, we proposed to establish a "safe harbor" or clear technical operating parameters under which users of unlicensed U-NII devices could operate without being considered sources of harmful interference.¹⁴⁶ Consistent with Part 15 operations, we also proposed that U-NII devices have to

¹⁴⁶ See *supra* *NPRM*, at Para. 54, 60.

accept any interference.

91. *Comments.* NII proponents support the principles underlying either "safe harbor" or the Part 16 approach. Apple argues that for U-NII devices to become viable, these devices must be treated as a recognized radio service, and their operations must be in protected spectrum reflected in Section 2.106 of the rules, the Table of Frequency Allocations.¹⁴⁷ Further, Apple states that the Commission should make clear that it will not introduce new, incompatible services into the NII bands in the future. Apple argues this is fully consistent with both the Communications Act and Commission precedent; in that, it is identical to the approach adopted for unlicensed-PCS and millimeter wave bands. Further, Apple argues that this approach is consistent with the Commission's obligation under Section 303(g) of the Communications Act to 'study new uses for radio... and generally encourage the larger and more effective use of radio in the public interest.' CEMA also argues that the Commission has the authority to elevate the status of unlicensed devices and suggests upgrading the status of U-NII devices to co-primary within the allocated bands. It claims that otherwise these devices will remain, by regulatory design, second class citizens in the RF environment.¹⁴⁸ Further, WINForum claims that some rural and educational users may not be willing to risk investment in equipment absent some reassurance that their communication needs will be met now and in the future.¹⁴⁹ Finally, Cylink, Metricom and existing unlicensed spread spectrum device providers argue that if additional protection is provided to unlicensed U-NII devices in this range of the spectrum, then this protection also should be extend to unlicensed spread spectrum devices.

92. However, Airtouch and other parties with interests in the 5.15-5.35 GHz and 5.725-5.825 GHz bands state that the "safe harbor" concept conflicts with the Part 15 regulatory scheme and would relieve unlicensed users of their obligation to avoid interference to licensed users.¹⁵⁰ L/Q argues that an analogy cannot be made to the protection provided to unlicensed Data-PCS devices because unlicensed Data-PCS devices received an allocation of exclusive spectrum, but U-NII devices will not operate on exclusive spectrum. SBMS and other amateur interests oppose "safe harbor" rules because there will be no means of enforcement to prevent U-NII devices from causing interference.

93. *Decision.* We generally have provided spectrum for low power unlicensed devices on a non-interference basis, meaning that unlicensed devices must not cause interference to licensed users and must accept any interference they receive. This regulatory approach to accommodating unlicensed devices has protected licensed use while permitting the development of a wide variety of low power unlicensed devices. While we seek to encourage the important and valuable telecommunication operations which will be provided by U-NII devices, we find that the current record does not provide a compelling reason to believe that such devices require higher or more protected status than we have provided for low power unlicensed devices in the past. Accordingly, we do not believe that it is necessary to create a new Part 16 or "safe harbor" rules to provide additional protection for U-NII devices. We therefore, as discussed below, will regulate these devices in the same manner that we regulate other low-power unlicensed devices. We do conclude, however, that some special consideration is warranted with regard to the use of

¹⁴⁷ See Apple Comments at 27-28.

¹⁴⁸ See CEMA Comments at 7.

¹⁴⁹ See WINForum Reply at 23.

¹⁵⁰ See Airtouch Reply at 3; L/Q Reply at 13, 16, 17; and SBMS Reply at 3.

unlicensed devices in the lower band, 5.15-5.25 GHz, which will be shared with MSS.

94. In the 5.25-5.35 GHz and 5.725-5.825 GHz bands, where the radio environment is well established with mature services, we can adopt rules in Part 15 for U-NII devices in which all parties can have confidence that sharing is possible with little or no threat of interference. In both of these bands, we believe U-NII device manufacturers and users can feel confident that their operations will not cause interference to primary operations, because in the 5.25-5.35 GHz band the only party authorized to use this spectrum is Government radar operations, with which we believe low power U-NII devices can share spectrum without causing interference, and because the U-NII devices in the 5.725-5.825 GHz band will operate with powers equivalent to those of existing unlicensed operations that currently share this band without causing interference. Additionally, if interference problems did occur in these bands they would be localized and could probably be identified and resolved. In these cases we believe that the current Part 15 at sufferance rules are appropriate.

95. We recognize that it is likely that two new uses of the 5.15-5.25 GHz band, MSS feeder link operations and U-NII devices, will be developing at the same time. In view of this fact, as indicated above, we are adopting relatively conservative operating parameters for U-NII devices. We believe that the very low power limits and indoor use restriction on unlicensed operations will ensure that millions, or even tens of millions, of U-NII devices can successfully co-exist and share the spectrum with MSS feeder links. Further, we note that interference from U-NII devices to MSS operations could potentially occur only as a result of the cumulative effect of many millions of U-NII devices and not by any single device. To the receiver on the MSS satellite, the operation of many low power U-NII devices looks like an increase in the ambient noise floor. This has the effect of decreasing the desired signal-to-noise ratio received from the higher power MSS feeder link and can ultimately reduce the capacity of or cause interference to MSS operations.

96. While we believe that this approach for U-NII devices is technically conservative and will fully protect MSS operations, we note that MSS interests have also suggested that we limit the aggregate EIRP density of emissions from unlicensed devices on the Earth's surface to the MSS satellite to 10 dBW/MHz.¹⁵¹ They argue that MSS operations could begin to be affected when emissions from unlicensed devices approach such a level.¹⁵² Alternatively, they suggest that the Commission should review the technical parameters for U-NII operations in a future rule making as such a limit is approached. They state this would allow the Commission to review, for example, whether some future reduction in permitted power of U-NII devices in this band should be imposed. They state that all existing U-NII devices would be grandfathered. We concur that such an approach would provide further assurance that future potential conflicts between U-NII devices and MSS operations are taken into account and that MSS operations are protected appropriately. Accordingly, we invite MSS parties to monitor the emissions from U-NII devices

¹⁵¹ This equates to a power flux density of -124 dBW/MHz/m² at a satellite with a slant range of 1414 km. See *ex parte* filing of Airtouch, December 5, 1996; see also, *Draft New Recommendation - Power Flux Density Limits for Wireless Data Networks In The 5150-5250 MHz Band Sharing Frequencies With Systems In The Fixed Satellite Service*, to ITU-R Working Party 4-9S, David E. Weinreich of Globalstar, November 27, 1996.

¹⁵² Given the indoor restriction and power limits we are imposing on U-NII devices and taking into account other factors such as duty cycle, it would take millions, or even tens of millions of devices, to achieve this level of 10 dBW/MHz.

in the 5.15-5.25 GHz band and, if emissions approach the 10 dBW/MHz level, to request that we initiate a rule making to reassess the use of this band.¹⁵³ At that time the Commission could determine if future U-NII devices should be required to operate at different technical standards. In this regard, we note that it may also be appropriate to reassess the technical parameters governing U-NII devices in light of second generation MSS systems. For example, second generation MSS systems may be more sensitive and therefore more susceptible to interference from U-NII devices. On the other hand, if European HIPERLAN systems proliferate and operate at more power than U-NII devices, second generation MSS systems may of necessity be designed to be more robust and immune to interference from such devices.

97. We believe that this approach will provide both MSS feeder link and U-NII operations with an appropriate level of protection and assurance for the continuation of their operations. While we think it unlikely that an interference situation will arise, this approach will permit us to develop regulatory solutions that will adequately protect the investments of both services, if such a situation were to develop. Accordingly, we believe that this approach will provide both the MSS community and the U-NII device manufacturers with adequate certainty concerning their operations, and we do not believe that a "Part 16" or "safe harbor" rule is necessary for U-NII devices at this time.

H. *Equipment Authorization*

98. In the *NPRM*, we proposed that U-NII devices would be subject to our certification requirements pursuant to Section 15.201(b), prior to marketing. Motorola recommends that we take this opportunity to streamline our equipment approval process so that all products, including U-NII devices, may be approved and provided to the public with minimal costs and delays.¹⁵⁴ However, Motorola made no specific suggestion in reference to this proceeding and its comments in reference to PP Docket No. 96-17 will be considered therein. We do not believe that applying the certification process to U-NII devices will significantly delay the provision of this equipment to the public. We believe this process helps prevent non-compliant devices from interfering with other devices or services. Accordingly, we are adopting our proposal to require U-NII devices to comply with the existing certification requirements for intentional radiators under Part 15.

99. Finally, we will require U-NII devices to comply with the RF hazard requirements set forth in Sections 1.1307(b), 1.1310, 2.1091, and 2.1093 of our rules.¹⁵⁵ For purposes of these rules, all U-NII equipment will be deemed to operate in an "uncontrolled" environment. Any application for equipment certification for these devices must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.

¹⁵³ We also note that it may also be appropriate to reassess the technical parameters governing U-NII devices in light of second generation MSS systems. For example, second generation MSS systems may be more sensitive and therefore more susceptible to interference from U-NII devices. On the other hand, if European HIPERLAN systems proliferate and operate at more power than U-NII devices, second generation MSS systems may be required to more robust and immune to interference from such devices.

¹⁵⁴ See Motorola Comments at 12.

¹⁵⁵ See 47 CFR §§ 1.1307(b), 1.1310, 2.1091, and 2.1093.

ORDERING CLAUSE AND EFFECTIVE DATE

100. Accordingly, IT IS ORDERED that Part 15 of the Commission's Rules, 47 C.F.R. Part 15 IS AMENDED as set forth in the attached Appendix, effective 60 days after publication in the Federal Register. This action is taken pursuant to Sections 4(i), 303(c), 303(f), 303(g) and 303 (r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 303(c), 303(f), 303(g) and 303(r).

101. *Regulatory Flexibility Analysis.* As required by Section 603 of the Regulatory Flexibility Act ("RFA"),¹⁵⁶ an Initial Regulatory Flexibility Analysis ("IRFA") was incorporated in the *NPRM* in this proceeding. The Commission sought written public comments on the proposals in the *NPRM* including on the IRFA. The Commission's Final Regulatory Flexibility Analysis ("FRFA") in this Report and Order is attached as Appendix B.

FEDERAL COMMUNICATIONS COMMISSION

William F. Caton
Acting Secretary

¹⁵⁶ See 5 U.S.C. § 603.

APPENDIX A: FINAL RULES

Parts 1, 2 and 15 of title 47 of the Code of Federal Regulations are revised as follows:

Part 1 - PRACTICE AND PROCEDURE

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

AUTHORITY: 47 U.S.C. 151, 154, 303 and 309(j) unless otherwise noted.

2. Section 1.1307 is amended by revising paragraph (b)(2) to read as follows:

§ 1.1307 Actions which may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

* * * * *

(b) * * *

(1) * * *

(2) Mobile and portable transmitting devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services (PCS), the Satellite Communications Services, the Maritime Services (ship earth stations only) and covered Specialized Mobile Radio Service providers authorized under subpart H of part 22, part 24, part 25, part 80, and part 90 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, as specified in §§ 2.1091 and 2.1093 of this chapter. All unlicensed PCS, unlicensed NII and millimeter wave devices are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, as specified in § 15.253(f), § 15.255(g), § 15.319(i), and § 15.407(f) of this chapter. All other mobile, portable, and unlicensed transmitting devices are categorically excluded from routine environmental evaluation for RF exposure under §§ 2.1091 and 2.1093 of this chapter except as specified in paragraphs (c) and (d) of this section.

* * * * *

PART 2 -- FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS

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

AUTHORITY: Sec. 4, 302, 303 and 307 of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154, 302, 303 and 307, unless otherwise noted.

2. Sections 2.1091(c) and 2.1091(d) of Part 2 are revised to read as follows:

§ 2.1091 Radiofrequency radiation exposure evaluation: mobile and unlicensed devices.

* * * * *

(c) Mobile devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services, the Satellite Communications Services, the Maritime Services and the

Specialized Mobile Radio Service authorized under subpart H of part 22 of this chapter, part 24 of this chapter, part 25 of this chapter, part 80 of this chapter (ship earth station devices only) and part 90 of this chapter ("covered" SMR devices only, as defined in the note to Table 1 of § 1.1307(b)(1) of this chapter), are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if their effective radiated power (ERP) is 1.5 watts or more. Unlicensed personal communications service, unlicensed millimeter wave devices and unlicensed NII devices authorized under § 15.253, § 15.255 and subparts D and E of part 15 of this chapter are also subject to routine environmental evaluation for RF exposure prior to equipment authorization or use, regardless of their power used, unless they meet the definition of a portable device as specified in § 2.1093(b). All other mobile and unlicensed transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization, except as specified in §§ 1.1307(c) and 1.1307(d) of this chapter. Applications for equipment authorization of mobile and unlicensed transmitting devices subject to routine environmental evaluation must contain a statement confirming compliance with the limits specified in paragraph (d) of this section as part of their application. Technical information showing the basis for this statement must be submitted to the Commission upon request.

(d) The limits to be used for evaluation are specified in § 1.1310 of this chapter. All unlicensed personal communications service (PCS) devices and unlicensed NII devices shall be subject to the limits for general population/uncontrolled exposure.

* * * * *

3. Section 2.1093(c) of Part 2 is revised to read as follows:

§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices.

* * * * *

(c) Portable devices that operate in the Cellular Radiotelephone Service, the Personal Communications Services, the Satellite Communications services, the Maritime Services and the Specialized Mobile Radio Service authorized under subpart H of part 22 of this chapter, part 24 of this chapter, part 25 of this chapter, part 80 of this chapter (ship earth station devices only), part 90 of this chapter ("covered" SMR devices only, as defined in the note to Table 1 of § 1.1307(b)(1) of this chapter), and portable unlicensed personal communication service, unlicensed NII devices and millimeter wave devices authorized under § 15.253, § 15.255 or subparts D and E of part 15 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use. All other portable transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization, except as specified in §§ 1.1307(c) and 1.1307(d) of this chapter. Applications for equipment authorization of portable transmitting devices subject to routine environmental evaluation must contain a statement confirming compliance with the limits specified in paragraph (d) of this section as part of their application. Technical information showing the basis for this statement must be submitted to the Commission upon request.

* * * * *

PART 15 -- RADIO FREQUENCY DEVICES

1. The authority citation for Part 15 continues to read as follows:

AUTHORITY: Secs. 4, 302, 303, 304, 307 and 624A of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154, 302, 303, 304, 307 and 544A.

2. Section 15.17(a) of Part 15 is revised to read as follows:

(a) Parties responsible for equipment compliance are advised to consider the proximity and the high power of non-Government licensed radio stations, such as broadcast, amateur, land mobile, and non-geostationary mobile satellite feeder link earth stations, and of U.S. Government radio stations, which could include high-powered radar systems, when choosing operating frequencies during the design of their equipment so as to reduce the susceptibility for receiving harmful interference. Information on non-Government use of the spectrum can be obtained by consulting the Table of Frequency Allocations in § 2.106 of this chapter.

* * * * *

3. Section 15.205(a) of Part 15 is amended by removing the 5.15-5.35 GHz portion from the restricted bands table to read as follows:

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(²)
13.36-13.41			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

* * * * *

4. Part 15 is amended by adding a new Subpart E to read as follows:

Subpart E - Unlicensed National Information Infrastructure devices

§ 15.401 Scope.

This subpart sets out the regulations for unlicensed National Information Infrastructure (U-NII) devices operating in the 5.15 - 5.35 GHz and 5.725 - 5.825 GHz bands.

§ 15.403 Definitions.

(a) *U-NII devices [Unlicensed]*. Intentional radiators operating in the frequency bands 5.15 - 5.35 GHz and 5.725 - 5.825 GHz that provide a wide array of wideband, high data rate, digital, mobile and fixed communications for individuals, businesses, and institutions.

(b) *Peak transmit power*. The peak power output as measured over an interval of time equal to the frame rate or transmission burst of the device under all conditions of modulation. Usually this parameter is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used.

§ 15.405 Cross reference.

(a) The provisions of subparts A, B, and C of this part apply to unlicensed U-NII devices, except where specific provisions are contained in subpart E. Manufacturers should note that this includes the provisions of Sections 15.203 and 15.205.

(b) The requirements of subpart E apply only to the radio transmitter contained in the U-NII device. Other aspects of the operation of a U-NII device may be subject to requirements contained elsewhere in this chapter. In particular, a U-NII device that includes digital circuitry not directly associated with the radio transmitter also is subject to the requirements for unintentional radiators in subpart B.

§ 15.407 General technical requirements.

(a) Power limits:

(1) For the band 5.15-5.25 GHz, the peak transmit power over the frequency band of operation shall not exceed 50 mW. In addition, the peak power spectral density shall not exceed 2.5 mW/MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed 250 mW. In addition, the peak power spectral density shall not exceed 12.5 mW/MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(3) For the band 5.725-5.825 GHz, the peak transmit power over the frequency band of operation shall not exceed 1 W. In addition, the peak power spectral density shall not exceed 50 mW/MHz. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(4) The peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

(5) The peak power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. Measurements are made using a resolution bandwidth of 1 MHz. If the device can not be connected directly, alternative techniques acceptable to the Commission may be used.

(b) The peak levels of emissions outside of the frequency band of operation shall be attenuated below the maximum peak power spectral density contained within the band of

operation in accordance with the following limits:

(1) For transmitters operating in the band 5.15-5.25 GHz: all emissions within the frequency range 5.14-5.15 GHz and 5.35-5.36 GHz must be attenuated by a factor of at least 27 dB; within the frequency range outside these bands by a factor of at least 37 dB.

(2) For transmitters operating in the 5.25-5.35 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge must be attenuated by a factor of at least 34 dB; for frequencies 10 MHz or greater above or below the band edge by a factor of at least 44 dB.

(3) For transmitters operating in the 5.725-5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge must be attenuated by a factor of at least 40 dB; for frequencies 10 MHz or greater above or below the band edge by a factor of at least 50 dB.

(4) The above emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz. Regardless of the attenuation levels shown above, emissions outside the frequency range of operation do not need to be attenuated below the general radiated emission limits in § 15.209 of this part.

(5) Unwanted emissions must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

(6) The provisions of § 15.205 of this part apply to intentional radiators operating under this section.

(7) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

(c) The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signalling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals.

(d) Any U-NII device that operates in the 5.15-5.25 GHz band shall use a transmitting antenna that is an integral part of the device.

(e) Within the 5.15-5.25 GHz band, U-NII devices will be restricted to indoor operations to reduce any potential for harmful interference to co-channel MSS operations.

(f) U-NII devices are subject to the radio frequency radiation exposure requirements specified in § 1.1307(b), § 2.1091 and § 2.1093 of this chapter, as appropriate. All equipment

shall be considered to operate in a "general population/uncontrolled" environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

(g) The frequency stability of the carrier frequency of an intentional radiator operating under this section shall be ± 10 ppm over 10 milliseconds. The frequency stability shall be maintained over a temperature variation of -20 degrees to +50 degrees Celsius at normal supply voltage, and over a variation in the primary supply voltage of 85 percent to 115 percent of the rated supply voltage at a temperature of +20 degrees Celsius. For equipment that is capable of operating only from a battery, the frequency stability tests shall be performed using a new battery without any further requirement to vary supply voltage.

APPENDIX B: FINAL REGULATORY FLEXIBILITY ANALYSIS

As required by Section 603 of the Regulatory Flexibility Act, 5 U.S.C. § 603 ("RFA"), an Initial Regulatory Flexibility Analysis ("IRFA") was incorporated in the *Notice of Proposed Rule Making* ("NPRM"), ET Docket No. 96-102.¹⁵⁷ The Commission sought written public comment on the proposals in the *NPRM*, including the IRFA. The Commission's Final Regulatory Flexibility Analysis ("FRFA") in this Report and Order conforms to the RFA, as amended by the Contract With America Advancement Act of 1996 ("CWAAA"), Pub. L. No. 104-121, 110 Stat. 847 (1996).¹⁵⁸

I. *Need for and Objectives of the Rule:* By this action, the Commission provides 300 megahertz of spectrum for a new category of unlicensed equipment called "Unlicensed National Information Infrastructure" ("U-NII") devices. These devices are needed to provide high speed wireless digital communications on an unlicensed basis. The Commission anticipates that these U-NII devices will support the creation of new wireless LANs, campus networks, community networks, and will facilitate wireless access to the National Information Infrastructure. Additionally, the rules set forth herein will foster the development of a broad range of new devices and services that will stimulate economic development and the growth of new industries. Finally, this action will promote the ability of U.S. manufacturers to compete globally by enabling them to develop unlicensed digital communications products for the world market.

II. *Summary of Significant Issues Raised by the Public Comments in Response to the IRFA:* Five parties directly address the *IRFA*. In general, comments support the provision of U-NII devices and argue that these operations will benefit small entities. Several comments addressing the *IRFA* argue that longer range U-NII devices will be needed to permit schools and libraries to access information on the NII without having to pay expensive monthly charges, such as long distance fees, to telecommunications service providers. Further, these parties state that longer range U-NII devices will not only benefit equipment manufacturers, but also will benefit Internet service providers, small entities in rural communities, and the up to 5 million small businesses that offer products and services over the Internet.¹⁵⁹ However, regarding the manufacturers of U-NII devices, the Northern Amateur Relay Council of California, Inc. ("NARCC") argues that only established major players in the microwave radio community will have the talent and resources to bring U-NII devices to the market in a timely manner. Therefore, NARCC contends that affording small companies preferential treatment will not produce anything significant in the way of a lower cost, more innovative product.¹⁶⁰ Finally, Cylink, Inc. opposes the adoption of an interim spectrum etiquette because small entities would not have the resources to develop interim equipment and to later redesign that equipment to comply with any formally adopted spectrum etiquette.¹⁶¹

III. *Description and Estimate of the Number of Small Entities to Which the Rules Will Apply:*

¹⁵⁷ See *Notice of Proposed Rule Making*, ET Docket No. 96-102, 11 FCC Rcd 7205 (1996).

¹⁵⁸ See Subtitle II of the CWAAA is "The Small Business Regulatory Enforcement Fairness Act of 1996" ("SBREFA"), codified at 5 U.S.C. § 603.

¹⁵⁹ See *Wireless Field Test for Education Project*; *Fundamental Research Corporation*; *Crystal Wind Communications, Inc.*; and *Jean Armour Polly*.

¹⁶⁰ See *Northern Amateur Relay Council of California, Inc. Comments* at 7.

¹⁶¹ See *Cylink Reply* at 17.

The RFA generally defines the term "small business" as having the same meaning as the term "small business concern" under the Small Business Act, 15 U.S.C. §632. Based on that statutory provision, we will consider a small business concern one which: (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). The RFA SBREFA provisions also apply to nonprofit organizations and to governmental organizations. Since the Regulatory Flexibility Act amendments were not in effect until the record in this proceeding was closed, the Commission was unable to request information regarding the number of small business that might use this service and is unable at this time to determine the number of small businesses that would be affected by this action. The rules adopted in this Report and Order will apply to any entities manufacturing U-NII devices to operate in the 5 GHz range which could include computer manufacturers and unlicensed RF equipment manufacturers. Although the rules do not directly affect entities that purchase this equipment, comments contend that several million entities, including consumers, schools, libraries, and small businesses, could benefit from the use of these devices.

The rules adopted in this Report and Order will apply to entities engaged in the manufacturing of U-NII devices. The Commission has not developed a definition of small entities applicable to unlicensed device manufacturers. Therefore, the applicable definition of small entity is the definition under the Small Business Administration ("SBA") rules applicable to manufacturers of "Radio and Television Broadcasting and Communications Equipment" and "Computer Manufacturers." According to the SBA's regulations, an RF manufacturer must have 750 or fewer employees in order to qualify as a small business.¹⁶² 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.¹⁶³ Further, according to SBA regulations, a computer manufacturer must have 1,000 or fewer employees in order to qualify as a small entity.¹⁶⁴ Census Bureau data indicates that there are 716 firms that manufacture electronic computers and of those, 659 have fewer than 500 employees and qualify as small entities.¹⁶⁵ The remaining 57 firms have 500 or more employees; however, we are unable to determine how many of those have fewer than 1,000 employees and therefore also qualify as small entities under the SBA definition. The Census Bureau categories are very broad and specific figures are not available on the number of these firms that will manufacture U-NII devices; however, we acknowledge the likelihood that many of them will be small businesses.

IV. Description of Projected Reporting, Recordkeeping and Other Compliance Requirements:

The rules adopted in this Report and Order will require U-NII manufacturers to comply with the Commission's equipment certification requirements set forth in Section 15.210(b), prior to marketing, and the radio frequency hazard requirements set forth in Sections 1.1307(b), 1.1310,

¹⁶² See 13 C.F.R. § 121.201, Standard Industrial Classification (SIC) Code 3663.

¹⁶³ See U.S. Department of Commerce, *1992 Census of Transportation, Communications and Utilities* (issued May 1995), SIC category 3663.

¹⁶⁴ See 13 CFR § 121.201, (SIC) Code 3571.

¹⁶⁵ See U.S. Small Business Administration 1995 Economic Census Industry and Enterprise Report, Table 3, SIC Code 3571, (Bureau of the Census data adapted by the Office of Advocacy of the U.S. Small Business Administration).

2.1091, and 2.1093 of the rules. All equipment will be deemed to operate in an 'uncontrolled' environment. Any application for equipment certification for these devices must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request. The equipment certification requirement is necessary to ensure compliance with the Commission's rules and promote electromagnetic compatibility. Further, compliance with the radio frequency hazard requirements is necessary to protect the health of individuals using the equipment. These requirements are typically required for all unlicensed equipment. No further reporting or recordkeeping requirements will be imposed. Therefore, the only compliance costs likely to be incurred are costs necessary to ensure that prototype devices comply with our equipment certification requirements and radio frequency hazard requirements.

Skills of an application examiner, radio technician or engineer will be needed to meet the requirements. If a device is not categorically excluded, the manufacturer of the device must make a determination of whether the device will comply with the RF radiation limits. This study can be done by calculation or measurement, depending upon the situation. In many cases the studies can be done by a radio technician or engineer. Certification applications are usually done by application examiners.

V. Significant Alternatives and Steps Taken By Agency to Minimize Significant Economic Impact on a Substantial Number of Small Entities Consistent with Stated Objectives:

Based on comments received in response to the NPRM, the Commission considered several significant alternatives. For example, although the *NPRM* proposed to make 350 megahertz available for U-NII devices, parties with incumbent or future operations request that less spectrum be made available in order to protect their interests. Specifically, parties with mobile satellite service ("MSS") interests argues that U-NII devices should not be permitted in the 5.15-5.25 GHz band because of potential use of this band by MSS feeder links.¹⁶⁶ Further, amateur radio parties oppose U-NII operations in the 5.725-5.875 GHz band because of amateur operations in this spectrum.¹⁶⁷ Resound Corporation ("Resound") and the Federal Highway Administration ("FHWA") oppose U-NII operations in the 5.850-5.875 GHz band because of future plans to use this spectrum.¹⁶⁸ After considering these alternatives, the Commission concluded that 300 megahertz of U-NII spectrum at 5.15-5.35 GHz and 5.725-5.825 GHz is appropriate for these devices to operate without interfering with incumbent and potential operations. This reduction from the proposed U-NII spectrum is necessary to protect Part 15 hearing assistance devices, potential intelligent transportation system operations, and amateur operations in the 5.825-5.875 GHz band from interference. This action should not have a negative impact on small U-NII businesses and will protect incumbent and proposed spectrum users which may be small businesses.

Additionally, various parties recommend different technical standards for U-NII devices. For example, some U-NII proponents support increasing the proposed power limit and permitting unrestricted antenna gain for U-NII devices in order to accomplish longer range

¹⁶⁶ See e.g., Loral/Qualcomm Licensee, Inc. Comments at 4.

¹⁶⁷ See e.g., Amateur Radio Relay League, Inc. Comments at 5.

¹⁶⁸ See Resound Comments at 7 and FHWA Comments at 2.

communications.¹⁶⁹ However, AT&T and point-to-point microwave parties oppose longer range use of U-NII devices and support short range, low power operations.¹⁷⁰ The Commission has determined that U-NII devices should be governed by minimal technical rules which permit maximum flexibility in the way these devices are implemented. Specifically, the Commission has concluded that an increase in the power limits proposed in the *NPRM* is supported by new material in the record in this proceeding, but does not believe unrestricted antenna gain should be permitted due to interference concerns. The Commission has determined that the public interest is best serviced by increasing the maximum peak power limit as follows: 50 mW peak transmitter output power with up to 6 dBi antenna gain (equates to 200 mW EIRP) permitted in the 5.15-5.25 GHz band; 250 mW peak transmitter output power with up to 6 dBi antenna gain (equates to 1 W EIRP) permitted in the 5.25-5.35 GHz band; and 1 W peak transmitter output power with up to 6 dBi antenna gain (equates to 4 W EIRP) permitted in the 5.725-5.825 GHz band. In addition, to permit manufacturers flexibility in designing U-NII equipment, the Commission will permit the use of higher directional antenna gain provided there is a corresponding reduction in transmitter output power of one dB for every dB that the directional antenna gain exceeds 6 dBi. Also, U-NII use of the 5.15-5.25 GHz band is restricted to indoor operations only. Further, this action adopts a power spectral density ("PSD") requirement for U-NII devices that would require that the maximum power be spread across of bandwidth of at least 20 megahertz. This PSD requirement will ensure that U-NII devices spread its signal energy evenly across the band and encourages the use of this spectrum by wideband high data rate applications, but permits non-wideband operations at reduced powers. These increased power limits will permit U-NII equipment manufacturers, many of which may be small businesses, more flexibility to develop products to meet market demands.

Further, the Commission considered several alternatives from the comments regarding a spectrum etiquette for U-NII devices. Although some parties support the proposed interim "listen-before-talk" ("LBT") spectrum etiquette until industry can develop a formal spectrum etiquette,¹⁷¹ others oppose the interim etiquette because it would limit the flexibility of U-NII devices to use different technologies.¹⁷² Further, several U-NII proponents support the adoption of an industry developed spectrum etiquette to govern unlicensed use of this spectrum.¹⁷³ Metricom, however, suggests that rather than adopting a complex spectrum etiquette, U-NII devices should be required to use spread spectrum techniques.¹⁷⁴ The Commission has now concluded that the proposed LBT spectrum etiquette could delay deployment of U-NII devices and hinder innovation in the development of these devices. Rather, the Commission has concluded that simple technical rules, such as PSD limits and out-of-band emission requirements, should be sufficient to ensure spectrum sharing between incumbent operations and new U-NII devices. The Commission declined to adopt a spectrum etiquette, any channelization plan, or a minimum modulation efficiency requirement because such requirements may preclude certain technologies or some of

¹⁶⁹ See e.g., Apple Computer, Inc. Comments at 8.

¹⁷⁰ See e.g., AT&T Comments at 3; Pacific Telesis Group Comments at 4; and Telecommunications Industry Association, Fixed Point-to-Point Communications Section Comments at 4.

¹⁷¹ See e.g., Consumer Electronics Manufacturers' Association Comments at 4.

¹⁷² See e.g., Hewlett-Packard Comments at 3.

¹⁷³ See e.g., WINForum comments at 21.

¹⁷⁴ See Metricom Reply at 10.

the many different concepts envisioned by U-NII proponents. We believe this action will benefit small entities by permitting these entities to develop innovative equipment to meet market demands without having to follow protocols governing use of the spectrum.

Finally, the *NPRM* proposed to establish parameters in the rules ("safe harbor"), under which U-NII devices complying with these parameters could operate without being considered sources of harmful interference. Incumbent parties oppose "safe harbor" rules or any action that would provide unlicensed devices addition spectrum rights.¹⁷⁵ However, U-NII proponents request that these devices be protected either by "safe harbor" rules or by providing a primary allocation status for the unlicensed operations.¹⁷⁶ After considering the alternatives, the Commission concluded that "safe harbor" rules are not necessary at this time to provide assurances to assurance to U-NII operators that their communications will not be prohibited. Rather, the Commission invited MSS parties to monitor the emissions from U-NII devices in the 5.15-5.25 GHz band and if emissions approach the 10 dBW/MHz level to request that we reassess the use of this band through future rule making.¹⁷⁷ At that time the Commission could determine if future U-NII devices should be required to operate at different technical standards. This approach will provide both MSS feeder link and U-NII operations with an appropriate level of protection and assurance for the continuation of their operations. While, the Commission is confident that an interference situation will not arise, this approach will permit it to develop regulatory solutions that will adequately protect the investments of both services, if such a situation were to develop.

Report to Congress: The Commission shall send a copy of this Final Regulatory Flexibility Analysis, along with this Report and Order, in a report to Congress pursuant to the Small Business Regulatory Enforcement Fairness Act of 1996, 5 U.S.C. § 801 (a)(1)(A). A copy of this FRFA will also be published in the Federal Register.

¹⁷⁵ See e.g., Loral/Qualcomm Licensee, Inc. Comments at 15; Metricom Reply at 7; and San Bernardino Microwave Society Reply at 3.

¹⁷⁶ See e.g., Apple Computer Comments at 27, WINForum Reply at 23, and Consumer Electronics Manufacturers' Association Comments at 7.

¹⁷⁷ We also note that it may also be appropriate to reassess the technical parameters governing U-NII devices in light of second generation MSS systems. For example, second generation MSS systems may be more sensitive and therefore more susceptible to interference from U-NII devices. On the other hand, if European HIPERLAN systems proliferate and operate at more power than U-NII devices, second generation MSS systems may be required to more robust and immune to interference from such devices.