$// NII/SUPERNet at 5 GHz, NPRM, ET Docket No. 96-102, FCC 96-193 //$
$15.401 Unlicensed NII/SUPERNet Devices /$

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

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

NOTICE OF PROPOSED RULE MAKING

Adopted: April 25, 1996 **Released: May 6, 1996**

Comment Date: [Sixty days after date of publication in the federal register]
Reply Comment Date: [Ninety days after date of publication in the federal register]

By the Commission: Commissioner Ness issuing a statement.

INTRODUCTION

1. By this action, we propose to amend Part 15 of our rules and to make available 350 megahertz of spectrum at 5.15 - 5.35 GHz and 5.725 - 5.875 GHz for use by a new category of unlicensed equipment, called NII/SUPERNet devices. These devices would provide short-range, high speed wireless digital communications on an unlicensed basis. We anticipate that these NII/SUPERNet devices will support the creation of new wireless local area networks ("LANs") and will facilitate wireless access to the National Information Infrastructure ("NII").[1] In order to permit significant flexibility in the design and operation of these devices, we propose that such devices be subject to the minimum technical standards necessary to prevent interference to other services and to ensure that the spectrum is used efficiently.

2. We believe that NII/SUPERNet devices may offer new opportunities for providing advanced telecommunications services to educational institutions, health care providers, libraries,

[1] 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.

businesses, and other users. These devices may thereby significantly assist in meeting the universal service goals and encouraging the provision of "advanced telecommunications capabilities to all Americans (including in particular, elementary and secondary schools and classrooms)," as set forth in the Telecommunications Act of 1996.[2] We further believe that the proposals 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. We also expect that 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.[3] This action is in response to Petitions for Rule Making submitted by the Wireless Information Networks Forum (WINForum) and Apple Computer, Inc. (Apple).

BACKGROUND

3. On May 15, 1995, WINForum filed a Petition for Rule Making requesting that we allocate spectrum and adopt service rules for the operation of new high speed Shared Unlicensed PErsonal Radio Network (SUPERNet) devices. According to WINForum, SUPERNet devices would operate on an unlicensed basis and provide short-to-medium range transmission of digital information at rates of approximately 20 million bits per second (20 Mbps) to meet the high-speed, high-bandwidth needs of multimedia computer applications. It states that SUPERNet would provide the kinds of communications capabilities currently available only with wired networks. WINForum further states that SUPERNet devices would support high-speed wireless local area networks, provide wireless access to broadband networks such as the NII and allow for *ad hoc* networking among end users. It submits that SUPERNet devices would provide the mobility, flexibility, increased data rates, and enhanced computer network facilities needed to advance education and business.[4] WINForum also notes that its SUPERNet proposal would be compatible with the High Performance Radio LAN (HIPERLAN) standard being developed by the European Telecommunications Standards Institute (ETSI).

4. WINForum specifically requests that we allocate 250 megahertz of spectrum at 5.10-5.35 GHz for SUPERNet devices. It further recommends that this spectrum be divided into approximately 10 wideband subchannels; that transmissions be limited to packetized data with protocols set by industry consensus; and, that certain minimum technical standards be imposed to help reduce the probability of interference and to facilitate frequency re-use between SUPERNet devices. WINForum also states that it believes that SUPERNet devices can share the

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

[3] For instance, as discussed below, our proposal encourages the development of devices compatible with the European HIPERLAN standard.

[4] See WINForum Petition at 4.

5.1-5.25 GHz band with Mobile Satellite Service (MSS) feeder links and government radiolocation operations on frequencies above 5.25 GHz.

5. On May 24, 1995, Apple filed a Petition for Rule Making requesting that we establish a new unlicensed wireless radio service to promote the full deployment of the NII and that we allocate 300 MHz of spectrum at 5 GHz for its operation. Apple states that its unlicensed "NII Band" proposal would make possible high-speed, wide-band wireless access to the NII and other computer networks. Apple indicates that unlicensed NII band devices could provide data transmission capabilities of 24 Mbps or higher. It further states that this new service would support *ad hoc* peer-to-peer communications, wireless local area networks, and community networks and other communications over 10 to 15 km (6.2 to 9.3 miles). Apple submits that its proposal will ensure that access to the NII is available to all segments of the population and especially to core public institutions such as schools, libraries, hospitals and government agencies.

6. Apple recommends that we allocate 300 megahertz in the 5.15-5.3 GHz and 5.725-5.875 GHz bands for the NII Band.[5] Apple also suggests that minimal technical rules govern the use of the NII Band and that NII Band devices be limited to asynchronous packet-based transmissions. Apple also proposes that the NII Band be regulated under a new "Part 16" structure. Under this approach, unlicensed devices would be treated as a recognized radio service, would operate in a protected spectrum band reflected in a Part 2 allocation, and would share allocated frequencies pursuant to an etiquette designed to ensure that all devices have fair and equitable access to the spectrum. Apple also suggests that the NII Band service include the capability for communications on the order of 10-15 km, without the need for and the delays associated with licensing. It indicates that this longer range capability would create new possibilities for unlicensed community networks. Apple also suggests that we allow the information industry to develop appropriate spectrum sharing etiquette and operating conventions. Finally, Apple states that NII Band operations will be compatible with other uses of the spectrum. It submits that acceptable sharing criteria can be developed with MSS feeder links at 5.15-5.25 GHz and industrial, scientific and medical (ISM) applications at 5.725-5.875 GHz.

7. In response to the Apple and WINForum petitions for rule making, the Commission received approximately 175 comments and 17 reply comments. Most commenters support an unlicensed broadband 5 GHz allocation; however, several incumbents 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.

8. On November 2, 1995, the National Telecommunications and Information Administration ("NTIA") submitted a letter addressing the WINForum and Apple petitions. In

[5] See Apple Petition at 1.

its letter, NTIA states 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. It recommends that we proceed with a Notice of Proposed Rule Making so that the important policy and technical issues raised by the petitions may be addressed. To protect public safety, NTIA indicates, however, that consideration of the 5.0 - 5.15 GHz band is not feasible at this time due to the need for this band to remain fully available for air traffic control operations.[6]

9. On February 29, 1996, Apple and WINForum submitted a letter to this Commission indicating that they have been working together to accommodate the different features of their proposals.[7] In light of the comments by the Federal Aviation Administration and NTIA, Apple and WINForum note that it has become apparent that the 5.1-5.15 GHz band is not available for unlicensed use. Accordingly, WINForum has modified its spectrum request to match the lower boundary of 5.15 GHz specified in Apple's petition. Apple and WINForum also support an additional allocation of spectrum above 5.3 GHz for unlicensed systems, to be shared with government radiolocation operations. In addition, both Apple and WINForum now support the concepts of very high data rate local systems and of relatively longer range, or "community network" products.

10. The frequency bands under consideration in this proceeding are currently allocated domestically 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;[8] the 5.25 - 5.35 GHz band is allocated to the radiolocation service on a primary basis for Government operations and on a secondary basis for non-Government operations;[9] the 5.650 - 5.925 GHz band is allocated on a primary basis to the radiolocation service for Government operations and on a secondary basis to the amateur service;[10] the 5.725 - 5.875 GHz band is designated for industrial, scientific and

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

[7] On March 12, 1996, Loral/QUALCOMM, Inc., the licensee of the Globalstar non-geostationary mobile satellite system, submitted an opposition to the Apple/WINForum letter. It raises concerns regarding the sharing of spectrum between unlicensed devices and satellite uplink operations.

[8] See 47 C.F.R. § 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 C.F.R. § 2.106, notes 797A, US307.

[9] See 47 C.F.R. § 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 C.F.R. § 2.106, note 713.

[10] See 47 C.F.R. § 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 C.F.R. § 2.106, notes 664 and 808.

medical ("ISM") applications and unlicensed Part 15 devices,[11] and radiocommunication services operating within this band must accept harmful interference that may be caused by ISM applications;[12] 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.[13]

11. Finally, regarding international allocations in these frequency bands, the 1995 World Radio Conference ("WRC-95") modified some of the international spectrum allocations in the 5 GHz frequency range.[14] Of primary 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").

DISCUSSION

A. Need for Additional Unlicensed Spectrum

12. Both WINForum and Apple state that a substantial allocation of spectrum at 5 GHz is needed for new wideband unlicensed wireless data systems. WINForum, in its petition, requests an initial allocation of 250 MHz for use by SUPERNet devices. It also requests that an additional 100-150 MHz of spectrum be reserved to meet future growth. Apple requests that a total of 300 MHz be allocated for its proposed NII Band. Both Apple and WINForum argue that existing allocations cannot support the wide bandwidth requirements of their proposals. In this regard, Apple states that existing allocations can satisfy some, but not all, demands for unlicensed wireless communications. Apple further indicates that traditional Part 15 devices, data personal communications services ("Data-PCS") devices,[15] NII Band devices, and devices deployed in the frequency bands above 40 GHz each will be tailored to meet different communications needs. For example, according to Apple, the Data-PCS bands will not be capable of supporting the high

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[11] On January 30, 1996, the Commission adopted a Notice of Proposed Rule Making [FCC 96-36] in ET Docket No. 96-8 which proposed to amend the rules regarding the operation of spread spectrum transmission systems in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands.

[12] See 47 C.F.R. § 2.106, note 806.

[13] See 47 C.F.R. § 2.106, Table of Frequency Allocations. In addition, the 5.850 - 5.925 GHz band is allocated on a secondary basis to the amateur service.

[14] See Final Acts of the World Radio Conference (WRC-95), Geneva, 1995, Geneva, 17 November 1995.

[15] Recently, the Commission allocated 30 megahertz of spectrum at 1910 - 1930 MHz and 2390 - 2400 MHz to unlicensed personal communications services ("PCS") devices. Unlicensed PCS devices are expected to be particularly useful for the transmission of high- and low-speed data between computing devices, cordless telephones, and wireless private branch exchanges. See In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services, Memorandum Opinion and Order, 9 FCC Rcd 4957 (1994). See also In the Matter of Allocation of Spectrum Below 5 GHz Transferred from Federal Government Use, First Report and Order and Second Notice of Proposed Rule Making, 10 FCC Rcd 4769 (1995).

data transfer rates required by new multimedia computer applications.

13. WINForum argues that a wireless platform such as SUPERNet is needed to support emerging advanced computing applications. WINForum submits that today's wireless networks do not support recent developments in broadband network technology and that these wireless networks must evolve to meet the higher data rate needs of emerging multimedia computer applications. According to WINForum, SUPERNet will provide the public with state-of-the-art wireless access to the full capabilities of the broadband wired network, including data, voice, graphics, teleconferencing, videoconferencing and other multimedia services. WINForum states that high-speed wireless access is necessary to realize fully the goals of the NII. It argues, for example, that wired solutions can never provide the flexibility needed in educational institutions. According to WINForum, high-speed wireless networks are the only cost-effective systems that can offer the mobility, flexibility and enhanced network capabilities needed to advance business, education and medical care. For example, WINForum states that broadband wireless networking holds significant potential to improve the quality, and reduce the costs, of medical care in the United States. In particular, it notes that the efficiency of medical staff could be improved by providing them real-time access to patient data, including X-ray and magnetic resonance ("MRI") images, video recordings, medical charts, and other records. Such real time access could facilitate group diagnoses, resulting in better and more efficient diagnosis of complex cases, without the need for the relevant medical experts to physically meet.

14. Apple states that its NII Band proposal would provide all segments of society with affordable access to the NII by extending advanced telecommunications offerings to schools, libraries, hospitals, and government agencies, as well as providing new business opportunities in the telecommunications marketplace. Apple estimates, for example, that the cost of wiring America's K-12 schools would be $30 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.

15. Apple also states that the NII Band would promote full deployment of the NII. According to Apple, the NII Band would extend the reach of the NII by providing wireless access and interaction to the NII throughout a limited geographic area where mobility is important. In addition, the NII Band would provide for unlicensed, wireless, wide area "community networks" connecting communities, schools and other groups. Apple also states that its NII Band proposal would advance a number of public policy objectives, including assuring that all segments of society have access to the "information superhighway"; extending advanced telecommunications services to schools, libraries, hospitals, and government agencies; and promoting the participation of small businesses and pioneering firms in the advanced telecommunications marketplace. Apple also indicates that since the NII Band would build upon and extend both the European HIPERLAN effort and existing Part 15 unlicensed systems, it has the potential to increase U.S. competitiveness and create new export opportunities for U.S. wireless products. Apple further states that compatibility between the NII Band and HIPERLAN would further the creation of a Global Information Infrastructure, or GII.

16. As noted above, both WINForum and Apple now propose that we allocate 150 MHz for unlicensed wireless operations at 5.15 - 5.3 GHz. Both also request that additional spectrum be allocated above 5.3 GHz on a shared basis with government radiolocation operations. WINForum, in its petition, suggests that the band 5.3 - 5.5 GHz could be used for SUPERNet devices.[16] Apple, in its petition, requests that the 5.725 - 5.875 GHz band be allocated for NII Band operations. Apple also submits that this band could be used with the 5.15-5.3 GHz band to provide for duplex operation.

17. Both WINForum and Apple state that allocating the 5.15 - 5.3 GHz band would allow compatibility with the HIPERLAN system being developed in Europe. They also state that the similarities of their proposals to the HIPERLAN standard suggest that unlicensed wireless operations can successfully share spectrum with MSS feeder links at 5.15 - 5.25 GHz. For example, WINForum notes that ETSI and the European Conference of Postal and Telecommunications Administrations (CEPT) have analyzed co-channel operation of MSS uplinks and HIPERLAN systems and have concluded that the threat of interference from HIPERLAN systems to MSS feeder links is negligible. Similarly, Apple states that because MSS systems operate on a global basis, sharing between HIPERLAN and MSS systems will have to be resolved in a manner that is mutually acceptable to users of both services and that similar accommodations can be made for sharing between the NII Band and MSS. Both WINForum and Apple also state acceptable sharing criteria can be developed with regard to government radiolocation systems in the 5.25 - 5.50 GHz band. WINForum notes that radiolocation systems in this band are typically located away from urban and industrial areas.[17] It therefore claims that SUPERNet operations would not cause detrimental interference to such systems. Apple states that existing services in the 5.725 - 5.875 GHz band are currently constrained by ISM operations.[18] It therefore argues that since NII Band operations generally will be a "more hospitable neighbor" than ISM devices, use of this band by NII Band devices will not adversely affect existing radiolocation and amateur operations.

18. Comments. Most comments were from potential users of NII/SUPERNet devices, and these parties generally support the Apple and WINForum proposals and cite the benefits of this service to education, medical care and industry. For example, the American Educational Research Association, et al. (Education Organizations) submit that schools and universities need a broadband, flexible, affordable service that is accessible by all citizens, to satisfy learning needs. They further state that the Apple and WINForum proposals would permit relatively easy and affordable installation of network equipment, without the delay and expense of wiring. The American Library Association ("ALA") states that the proposed service is important to libraries,

[16] WINForum initially proposed an allocation of 250 MHz in the 5.1 - 5.35 GHz band for SUPERNet operation. It also proposed that the 5.35 - 5.5 GHz band be reserved for possible future SUPERNet use.

[17] WINForum Petition at 15.

[18] As indicated above, all radio communications services using the 5.725 - 5.875 GHz band must accept any harmful interference from ISM devices.

schools, and other educational institutions as it will allow for networking and pooling of resources. The ALA emphasizes that access to the service should be affordable and available to all and therefore supports the proposed unlicensed operations which would be free of connection charges or other fees.

19. The National Educational Telecommunications Organization/Educational Satellite Institute states that for educational institutions, unlicensed services offer a range of services at substantially lower costs than wired and licensed-wireless networks. They argue that the proposed SUPERNet and NII Band concepts would provide users with greater flexibility and control to design and implement networks that meet their unique needs.[19] The Council of Chief State School Officers states that schools require technologies that are broadband and capable of supporting text, graphic, and interactive programs, including two-way video, and that the proposed service would provide an opportunity for such technologies to develop.[20]

20. The Center for Democracy and Technology ("CDT") believes that gateway-free access to computer networks is in the public interest because access to cyberspace, currently available only through commercial service providers, is currently too expensive for individuals, schools, and libraries.[21] It states that the proposed service would promote ubiquitous, affordable access for citizens everywhere, would increase the diversity of information sources accessible via computer, and would form a new platform for public and political discourse at a local and national level.

21. Microsoft Corporation ("Microsoft") states that a wireless broadband network is potentially the only economically practical means of disseminating multimedia data within a classroom. It submits that such unlicensed systems could provide students with at-the-desk access to the school library and to an array of multimedia services available on the Internet.[22] Microsoft also notes that wireless networks will enable physicians to immediately access digitally-transmitted X-rays, computer aided-tomography, full-motion ultra-sound imaging studies, and MRI diagnostics.[23] Microsoft states that the initial provision of spectrum at 5 GHz should be at least 300 megahertz to assure adequate spectrum for immediate applications, and that at least an additional 50 megahertz should be reserved for increased usage and high speed capacity.[24]

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[19] National Educational Telecommunications Organization/Educational Satellite Institute Comments at 2-3.

[20] Council of Chief State School Officers Comments at 2.

[21] CDT Comments at 3.

[22] Microsoft Comments at 3.

[23] Microsoft Comments at 3.

[24] Microsoft Comment at 4.

22. The Atlanta Veteran's Administration Rehab R&D Center ("Atlanta VA") believes that the proposed service would be of great help to disabled people. Atlanta VA is currently developing wearable computer technology that would provide wireless access to control devices such as crosswalk push buttons, audio access to pedestrian cross walk signal displays, voice access to elevator push buttons and controls, and wireless control of handicapped van doors, lifts, and automatic door openers.[25]

23. Compaq Computer supports Apple's and WINForum's proposals for a substantial allocation at 5 GHz for unlicensed access to the NII. Compaq argues that the 5 GHz band is well suited for an NII/SUPERNet band, which would bring the United States closer to the realization of the NII. Additionally, Compaq claims that the American economy, and its leadership position in world markets for computers and computing applications, will be strengthened by the proposed allocation.[26] Compaq states that the recently established Data-PCS service will have insufficient bandwidth capacity to accommodate the proposed operations. Compaq also adds that Data-PCS' operating protocols, which are necessary to accommodate other spectrum users, are unsuitable for the proposed multimedia computer-based applications.

24. The Information Technology Industry Council ("ITIC") supports an allocation of from 250 to 300 megahertz in the 5 GHz range for unlicensed wireless data networks. ITIC states that the proposed allocations would support applications that cannot be satisfied using other frequency bands or services and would build upon the European HIPERLAN allocation, thereby creating new opportunities for U.S. manufacturers.[27] Harris Corporation ("Harris") also supports both petitions, submitting that the harmonization of U.S. allocations with European allocations is a highly desirable objective and would benefit U.S. manufacturers. Similarly, Nortel states that broadband networks will create jobs, foster economic growth, and improve access to communications by industry and the American public.[28]

25. AT&T states that WINForum and Apple have demonstrated the public need for a 250 to 300 megahertz allocation of contiguous spectrum for high speed wireless data communications. However, AT&T opposes Apple's proposal to allocate the 5.725 - 5.875 GHz band on the basis that Part 15 spread spectrum devices could not easily share this band with existing ISM operations. Andrew Corporation ("Andrew") supports an allocation at 5.15 - 5.30 GHz for unlicensed operations, but opposes Apple's proposed upper NII Band, arguing that this is one of the few remaining spectrum locations fully available for spread spectrum and ISM operations. Andrew claims that recent Commission actions have caused the ISM and spread

[25] Atlanta VA Comments at 1-3.

[26] Compaq Comments at 3.

[27] ITIC Comments at 2.

[28] Nortel Comments at 3.

spectrum industry to focus on using the 5.8 GHz band and therefore predicts increased use of that band. Accordingly, Andrew contends that 150 megahertz at 5.15 - 5.30 GHz should be sufficient initially for NII/SUPERNet services, adding that the benefits of making available 300 megahertz of spectrum are too speculative at this time to warrant disruption of existing services at 5.8 GHz. Andrew suggests that the 5.725 - 5.875 GHz band could be considered in the future if the 5.15 - 5.30 GHz band becomes congested. The Fixed Point-to-Point Communications Section, Network Equipment Division of the Telecommunications Industry Association ("TIA") supports the concept of establishing high-speed wireless digital services, but states that many issues, like spectrum sharing, need to be addressed before spectrum is allocated for such a service.

26. Several incumbent and potential users of 5 GHz spectrum oppose the WINForum and Apple proposals. Generally, they argue that the petitioners have failed to demonstrate a need for unlicensed operations in the 5 GHz range and have not provided a sufficient analysis of the spectrum sharing potential of such operations with existing or proposed services in the band. For example, the American Radio Relay League, Inc. ("ARRL") opposes the allocation and contends that this allocation is unnecessary because it duplicates other services, such as licensed PCS (for longer range communications), microwave operations, and unlicensed PCS. In particular, ARRL opposes Apple's allocation proposal for the 5.8 GHz band, arguing that Apple has not sufficiently addressed the potential for harmful interference to amateur operations in the 5.650 - 5.925 GHz band. Further, ARRL argues that Apple provides no technical showing to support the allocation; does not address how coordination between unlicensed users and incumbents would be done; and provides no explanation of why spectrum above 40 GHz would not be better for its purposes. Additionally, ARRL notes that the proposed allocation would have to be coordinated internationally because the International Telecommunication Union has not allocated the 5.8 GHz band to the fixed and mobile services. The Southern California Repeater and Remote Base Association ("SCRRBA"), an amateur organization, also opposes the allocation and states that any commercial use will overpower the amateur operators on this band because so much equipment would be deployed that the amateurs would be driven off the band.

27. Constellation Communications ("Constellation") and Loral/QUALCOMM Partnership, L.P. ("Loral") oppose the allocation of the 5.15 - 5.25 GHz band, where feeder links for non-geostationary orbit mobile-satellite systems are planned.[29] Constellation argues that the petitions lack technical information and do not provide any convincing sharing analyses to demonstrate compatibility with feeder link operations. Constellation claims that WINForum's interference calculation is insufficient and that the actual interference to feeder links would be much more severe than is predicted by the petitioners. Constellation argues that petitioners must show that the aggregate power transmitted by all possible unlicensed operations within the low

[29] We note that Loral filed a Request for Waiver on March 7, 1996, requesting authority to construct, launch and operate a low-Earth orbit satellite system with feeder links in the 5.091 - 5.250 GHz and 6.875 - 7.055 GHz bands. In its request, Loral asks for a waiver of the U.S. Table of Frequency Allocations pending Commission action to implement the Final Acts of the WRC-95. The waiver would permit authorization of feeder links for its system consistent with the outcome of the WRC-95. The Commission has previously authorized Loral to construct, at its own risk, an MSS system with feeder links in the 5.025-5.225 GHz frequency bands, subject to the outcome of the WRC-95. See Loral/QUALCOMM Partnership, 10 F.C.C. Rcd. 3926 (Intl. Bur. 1995).

earth orbiting ("LEO") MSS receiving beam would be limited to acceptable levels. Constellation also argues that FSS operations should not be required to protect unlicensed devices from harmful interference. Loral argues that substantial spectrum has recently been allocated for unlicensed wireless data services and that the Commission should not consider further allocations for this purpose. Loral also observes that WINForum's interference calculation used system parameters for Loral's MSS system that have since changed, and that the new system design includes higher gain satellite receiving antennas which would be more susceptible to interference. Loral maintains that studies[30] showing sharing feasibility between MSS and HIPERLAN do not necessarily apply to the WINForum and Apple proposals.[31]

28. The Federal Aviation Administration ("FAA") opposes any use of the 5.00 - 5.15 GHz band for unlicensed SUPERNet devices, arguing that the Microwave Landing System ("MLS") is not being phased out in favor of the differential Global Positioning System ("GPS"). On the contrary, the FAA states that it has plans for at least 26 MLS installations, and that the Department of Defense currently has a significant number of MLS installations in operation. Further, the FAA states that the International Civil Aviation Organization recently concluded that the 5.00 - 5.15 GHz band should remain allocated for aeronautical radionavigation. Additionally, the FAA opposes the use of the 5.15 - 5.25 GHz band for NII/SUPERNet devices until spectrum sharing studies demonstrate that the devices can successfully share the band on an interference-free basis with aeronautical safety services.

29. The Federal Highway Administration ("FHWA") anticipates that the 5.850 - 5.925 GHz band will be suitable for intelligent transportation systems ("ITS") technologies associated with vehicle-to-roadside communications (e.g., automated toll collection) and supports its allocation for that purpose.[32] The FHWA notes that NTIA is considering the reallocation of the 5.850 - 5.925 GHz band from shared Government/non-Government use to exclusive non-Government use and requests that NTIA do so with a recommendation to the Commission that ITS be considered when making decisions as to future applications in this band. The FHWA notes that Apple's proposal for the 5.725 - 5.875 GHz band overlaps with ITS use of the 5.850 - 5.925 GHz band, but does not make a recommendation with regard to Apple's proposal and does not discuss whether ITS could share the 25 megahertz of overlap spectrum at 5.850 - 5.875 GHz with NII Band devices.

30. WINForum, in its reply comments, states that its proposed wireless multimedia

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[30] See infra Appendix C.

[31] See Loral's ex parte filing dated April 17, 1996.

[32] FHWA Comments at 1 and its attached "Overview of Spectrum Needs in the 5850 - 5925 [MHz] Band by the ITS Program." In order to reduce the cost and complexity of the in-vehicle ITS communications equipment at the consumer level (it is likely that this equipment will eventually be standard on all vehicles), the FHWA considers it essential that all ITS services be provided by a single transmitter in the same frequency band. The FHWA states that the 5.850 - 5.925 GHz band is the lowest frequency band where 75 megahertz of continuous spectrum may be available in the near term. The FHWA asserts that ITS could share the band with existing services.

service cannot be provided by licensed services because: 1) licensed services cannot dedicate the bandwidth necessary to offer such services on a widespread basis; 2) unlicensed devices are less constrained by economics and can be deployed anywhere at any time; and 3) only unlicensed devices will provide virtually unlimited access without recurring costs.[33] WINForum reiterates its belief that unlicensed Data-PCS does not have the spectrum to support the proposed data rates of the SUPERNet. Additionally, WINForum states that existing Part 15 bands cannot be used because conventional Part 15 devices would not comply with a necessary spectrum etiquette and therefore would be incompatible with SUPERNet devices. WINForum contends that though the Commission's pending proposal to provide spectrum above 40 GHz for computer communications will be necessary to meet future needs, current radio technology is not sufficiently advanced to permit SUPERNet operations at millimeter wave frequencies. In its reply comments, Apple states that the inter-service sharing issue should be addressed as part of the rule making process. Apple does not propose that any existing or planned user be relocated from the 5 GHz band, nor does it propose that NII Band technologies receive preferential treatment over any existing user or type of usage.

31. Proposal. We recognize that recent developments in a number of different digital technologies have greatly increased the need for business, industry, and consumers to transfer large amounts of data from one network or system to another. Specifically, innovative technological developments now permit the digitization and compression of large amounts of voice, video, imaging, and data information, which can be transmitted as "data packets" from one place to another. Also, computers now have faster central processing units and substantially increased memory capabilities, which have further increased the demand for devices that can more quickly transfer larger amounts of data. Further, digital equipment is now 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 beginning to be used in combination and interaction with other such networks.

32. We believe that these dramatic developments in digital technology have stimulated a need for the availability of spectrum to be used for wireless interconnection within and among these networks. We agree with WINForum that the spectrum currently allocated for existing wireless services and devices is not adequate to meet the demands of today's broadband network data transmission services. Generally, the available bandwidth in the current allocations is not sufficiently wide to permit existing wireless services to take advantage of new technologies currently available on wired networks. For example, services developed for Data-PCS devices were not designed to handle broadband multimedia computer applications, and the spectrum available to those services would quickly be congested by any significant usage for such applications. Therefore, we tentatively conclude that, to serve this need, sufficient spectrum in the 5 GHz band should be made available to provide for a number of operations in each

[33] WINForum Reply at 15.

geographical area to meet the growing demand for new high speed data services.[34]

33. We believe that providing additional spectrum for unlicensed operation would benefit a vast number of users, including educational, medical, business, and industrial users. For example, allowing unlicensed devices 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. We also agree with the commenting parties who suggest wireless networks could help improve the quality and reduce the cost of medical care. These systems could allow medical staff to obtain on-the-spot patient data, X-rays, and medical charts. Diagnosis by a group of medical experts could be more rapidly and readily obtained, resulting in better and more efficient diagnosis, without the need for the relevant experts to be physically present at a common location. These types of applications may be especially useful to Americans who live in rural, insular, high cost or remote areas.

34. Additionally, because we believe that elements of both Apple's NII Band proposal and WINForum's SUPERNet proposal have merit, we propose that devices operating in this unlicensed spectrum be called NII/SUPERNet devices after the proposals. While we recognize that the proposals present some difficulties which need to be resolved in this proceeding, such as spectrum sharing between incumbents and new users and the propagation of 5 GHz signals within buildings, we believe that the 5 GHz range is the appropriate spectrum for these proposed operations. That is, spectrum below this range is too congested, and higher frequencies would both increase the cost of equipment and would have even more limited propagation characteristics than 5 GHz. Additionally, we believe, based on the comments, that sharing could be feasible, particularly if we limit appropriately the authorized power for the unlicensed devices. Accordingly, we propose to make available 200 megahertz of spectrum at 5.15 - 5.35 GHz and 150 megahertz of spectrum at 5.725 - 5.875 GHz for unlicensed NII/SUPERNet devices. We seek comment on whether 350 MHz of spectrum is necessary to provide this service in the 5 GHz range. We believe that access to this spectrum by unlicensed wireless LANs and multimedia devices is warranted by the growing demand for such operations by business, industry, medical and educational institutions, and consumers.

35. We agree with NTIA and the FAA that air safety services must be protected from harmful interference and therefore are not proposing to allow NII/SUPERNet devices access to the 5.10 - 5.15 GHz band. However, we are persuaded at this time that NII/SUPERNet devices could operate above 5.15 GHz without causing interference to aeronautical radionavigation if we adopt appropriate out-of-band emission and power limits. Additionally, we believe that the NII/SUPERNet devices can successfully share spectrum with the MSS feeder links which are expected to operate in the 5.15 - 5.25 GHz band. As WINForum notes, the issue of HIPERLAN

[34] Although the petitions and comments request an allocation of spectrum for unlicensed NII/SUPERNet devices, we note that unlicensed Part 15 operations typically are not allocated spectrum, but are permitted to operate in certain bands.

and MSS feeder link sharing has been addressed in Europe, thus it appears feasible that similar operations such as NII/SUPERNet devices should also be able to share spectrum with MSS feeder links.[35] We also believe that the 5.725 - 5.875 GHz band is appropriate spectrum for NII/SUPERNet operations and that with appropriate technical constraints these devices can share with existing amateur, unlicensed and ISM operations, as well as with FSS uplinks in the 5.850-5.875 GHz band. Regarding FHWA's interest in the 5.850 - 5.925 GHz band, we note that at this time the spectrum requirements for Intelligent Transportation Systems (ITS) and their possible impact on other services are not clear. Accordingly, this issue is beyond the scope of this proceeding and will be addressed in future rule makings as appropriate. As recommended by NTIA and others, we agree that additional studies of spectrum sharing between the proposed unlicensed operations and existing and other proposed operations in the 5.15 - 5.35 GHz and 5.725 - 5.875 GHz bands would be useful and request that interested parties address this matter in their comments.

B. Technical Standards

36. In their petitions, WINForum and Apple suggest that we adopt only the minimum technical standards needed to prevent harmful interference and that we provide a basic spectrum sharing protocol, or etiquette, to promote sharing among unlicensed devices. Both petitioners also indicate that such an etiquette should be developed by industry through a consensus process. They further suggest that the sharing protocol should permit unlicensed devices to operate on a shared basis, permit different operational characteristics to meet varying user requirements, and not restrict the purposes for which the proposed spectrum can be used. They state that this approach would foster flexibility in the types and designs of unlicensed devices that could use this band.[36]

37. In its petition, WINForum proposes that SUPERNet devices operate at low power to limit interference and to promote spectrum sharing. Although WINForum does not propose a specific power limit or communications range in its petition, its interference analysis included in Appendix B to its petition uses a maximum transmitter power of -10 dBW and a communications range on the order of 50 meters.[37] Apple suggests that we also permit higher power to enable unlicensed devices to cover distances of 10 to 15 kilometers (6.2-9.3 miles) or more, for its proposed community networks.[38] Specifically, Apple suggests that transmitters should be permitted to operate with up to 1 watt of power and should be permitted to use both

[35] See CEPT Recommendation T/R 22-06 (Madrid 1992); see also Proposed Modification of CEPT Recommendation T/R 22-06; see also Appendix C.

[36] WINForum Comments at 19-21 and Apple Comments at 28.

[37] WINForum Petition at App. B at 3.

[38] Apple Petition at 18. In their joint letter of February 29, 1996, Apple and WINForum agree that the concepts of very high data rate local systems and of relatively longer range community network products are both necessary and desirable.

omnidirectional and directional antennas without EIRP limits.[39] Finally, WINForum suggests that out-of-band emissions limits be established to promote spectrum sharing with adjacent spectrum users.[40]

38. With regard to a spectrum sharing protocol, WINForum states that unlicensed devices in this band should be subject to protocol standards similar in concept to the unlicensed Data-PCS sharing protocol. Apple states that any industry developed standards should be minimal and should allow a variety of communications options.[41] Apple argues that these rules should be flexible enough to encourage innovation and technological evolution, but not so broad as to permit a mix of incompatible users with mutually exclusive operating characteristics. Both petitioners request that NII/SUPERNet operations be limited to packet based transmissions.

39. WINForum proposes that SUPERNet devices be permitted to operate under either a centralized control scheme or a distributed control scheme.[42] Apple argues that the rules should prohibit any operations that are based solely on a circuit-switched network or require centralized control. Apple argues that the rules should provide all devices equitable rights to access and share spectrum without any hierarchy among users regardless of transmission type.[43]

40. WINForum also requests that the proposed allocation be subject to minimal channelization requirements, and both petitioners suggest that some compatibility in frequency assignment and channelization be afforded between NII/SUPERNet devices and the HIPERLAN system. Specifically, WINForum suggests that the allocation be divided into approximately 10 broadband subchannels, each capable of supporting a data rate of 20 Mbps or more. Apple did not make a specific recommendation with regard to a channeling plan, but states that while data rates of over 20 Mbps should be permissible, similar to the HIPERLAN system, the band should not be limited to a narrow range of data rates or band subdivisions.[44] Apple states that the actual data transfer rates for the proposed unlicensed devices will depend on the technical rules governing operation, the design of the particular device and the radio environment.

41. Comments. The commenting parties generally agree that NII/SUPERNet operations should be subject to the minimum technical standards necessary to prevent harmful interference,

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[39] Apple Comments at 23.

[40] WINForum Petition at 19.

[41] Apple Petition at 25.

[42] In a centralized control scheme, one network node controls which of the other nodes is allowed to transmit at any given time. In a distributed control scheme, all nodes of the network simultaneously contend for access to the channel upon completion of each transmission.

[43] Apple Petition at 25-27.

[44] Apple Petition at 15-17.

such as limits on maximum power and out-of-band emissions. They also generally support use of a basic spectrum etiquette to promote sharing among unlicensed operations. The commenting parties further agree with the petitioners that the basic spectrum sharing rules governing the operation of NII/SUPERNet devices should be established by industry consensus. A number of parties also support the adoption of standards that provide some degree of compatibility with HIPERLAN. In general, most commenters support a flexible channelization approach that would allow the operation of both wideband and narrowband channels. Finally, while a number of parties support permitting higher power community network operation, others argue that such higher power operations would increase the potential for interference to other services.

42. AT&T, in its comments, states that technical standards for NII/SUPERNet devices should be the minimum needed to prevent interference and that spectrum protocols should be developed through industry consensus. AT&T also agrees with WINForum that a broadband channelization plan would optimize the usefulness of the spectrum and prevent scattered narrowband operations from interfering with the intended use of this spectrum for wideband, high speed digital services.[45] The Part 15 Coalition, however, states that while extremely high data rates may be needed for some of the proposed unlicensed operations, they should not be generically required.[46] It states that both narrowband and broadband transmissions should be permitted in order to assure the provision of a wide variety of services, technologies and applications. Tetherless Access Ltd. argues that WINForum's proposal to establish a channelization scheme is exclusionary and would prevent new technologies that may use bandwidth in different ways.[47] Nortel supports a spectrum sharing protocol (analogous to the sharing plan for unlicensed PCS spectrum) that would be developed through industry consensus.[48] Andrew and others encourage the Commission to adopt technical standards consistent with those of the European HIPERLAN system and argue that inconsistent policies could lead to higher costs and additional delays.[49]

43. Several parties support the petitioners' proposal that NII/SUPERNet devices be permitted to provide longer range community network service. Duncan, Weinberg, Miller & Pembroke argue that 10-15 km (6.2-9.3 miles) links would be useful to local governments with offices scattered across a community and that other currently available long range alternatives are too expensive or impractical for local government use. Daniel L. Green submits that long range NII/SUPERNet devices would provide new possibilities for the creation of unlicensed community networks and affordable data communications for residential, educational, business,

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[45] AT&T Comments at 8-9.

[46] Part 15 Coalition Comments at 8.

[47] Tetherless Comments at 4.

[48] See n. 15, supra.

[49] Andrew Comments at 8.

community and rural entities. Metricom also supports Apple's longer range communications proposal. Microsoft comments that the rules for power and antenna gain should be flexible enough to permit both higher power operations that allow one device to fully serve a single neighborhood or campus and lower power operations for wireless LANs.

44. ARRL, AT&T, Digital Microwave Corp. ("DMC"), Harris and others oppose the long range community network aspect of Apple's NII Band proposal, claiming that links longer than 1 km (.62 miles) in length would have the potential to cause harmful interference.[50] ARRL argues that community networks could be provided by existing Part 94 services and should not form the basis for a new unregulated service. AT&T states that Apple's proposed long-range network could interfere with MSS feeder links. Harris points out that the Commission typically limits short distance microwave operations to spectrum above 10 GHz. The Southern California Repeater and Remote Base Association (SCRRBA) opposes NII/SUPERNet paths longer than 500 meters (546.8 yards) and recommends power limitations similar to those applied to the unlicensed PCS operations at 2.39 - 2.40 GHz.[51]

45. Apple replies that its opponents' interference concerns are overstated because users of longer links will not be mutually exclusive with one another or with other spectrum users. Apple argues that both short and long distance NII/SUPERNet band devices will operate at low power and pursuant to technical rules, such as listen-before-talk, designed to promote spectrum sharing and equal access to the spectrum. In its reply comments, WINForum states that it supports the use of highly directional receive antennas for longer range communications. It also states that an etiquette governing the conditions of access to the spectrum is necessary and reiterates that this etiquette should limit interference caused by the devices and should ensure the spectrum is used efficiently. WINForum argues, however, that interoperability should not be required because it would limit innovation. WINForum further states that any differences between its petition and Apple's should be resolved through industry consensus.

46. Proposal. If we make unlicensed spectrum available for NII/SUPERNet devices, we believe that the rules should provide the maximum technical flexibility in the design and operation of these devices. At the same time the rules must ensure that these devices do not cause harmful interference to the incumbent and proposed operations in these or adjacent bands. We agree with the petitioners that minimal standards would provide opportunity for the greatest variety of unlicensed devices that may use these bands and would enable the maximum flexibility in the types of services that may be provided. We are proposing below the minimal technical regulations we believe are necessary to accomplish these goals.[52] These rules specify power limits, out-of-band emission limits, and a basic "listen-before-talk" protocol standard. We are

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[50] DMC Comments at 2 and Harris Comments at 3.

[51] SCRRBA Comments at 15, see also 47 C.F.R. §§ 15.319(c)-(e).

[52] See infra Appendix A (Proposed Rules).

encouraging the industry to develop any further protocol standards or etiquette it believes necessary.

47. Specifically, we are proposing to limit the peak EIRP for NII/SUPERNet devices to -10 dBW (0.1 watt). We believe this power level should provide typical communications distances of 50 to 100 meters (54.7 to 109.4 yards) and will meet most of the high speed communications needs envisioned by the petitioners. We note that the low power (0.1 watt) NII/SUPERNet devices we propose would operate at a higher power (approximately 21 dB EIRP higher) than existing non-spread spectrum Part 15 intentional radiators permitted in the 5.725 - 5.875 GHz band.[53] We are not, however, proposing to accommodate the higher power, longer range communications links sought by the petitioners at this time. We are concerned that permitting such higher power operations would pose unacceptable interference risks to other services, such as fixed satellite service in the 5.10-5.35 GHz band, and would greatly limit the number of unlicensed operations within a local area.

48. Nevertheless, we find merit in the concept of longer range community networks and seek comment on whether to permit such higher power operation at up to 1 watt of transmitter output power within the 5.725-5.875 GHz band. Are there any rule changes desirable for these or other licensed allocations, to broaden eligibility or expand flexibility or otherwise eliminate regulatory barriers that may now prevent that spectrum from being used in community networks? We note that antenna gain is an important factor in both the distance covered and the interference potential of the system. We request comment on whether antenna gain should be limited and, if so, to what level.[54] We believe that accommodating such higher power unlicensed operation in this portion of the spectrum may be appropriate since this band is already available for similar higher power Part 15 spread spectrum operations.[55] We also note that there may be a considerable difference between the interference potential of existing spread spectrum transmitters and the modulation systems contemplated by Apple. We seek comment on the similarities or differences in interference potential of these two types of devices. We believe that providing for longer range operations may promote the development of community networks that would provide users with affordable access to a broad range of data communications services. We also request comment, however, on whether such community network operation would be better accommodated on a licensed basis either in this band, as discussed below, or in other bands presently available for licensed use. For example, could such uses be implemented by PCS licensees in the 2 GHz range or by providers soon to be licensed at 28 GHz, 38 GHz and above 40 GHz? What would be the regulatory implications, if any, of such a long-range network if it were connected to the public switched telephone network? If we were to permit these higher

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[53] See 47 C.F.R. § 15.249.

[54] We note that Apple proposes not to limit antenna gain. See Apple Submission titled Implementing the NII Band: Suggested Technical Rules.

[55] See Spread Spectrum Transmitters, Notice of Proposed Rule Making, ET Docket No. 96-8, 11 FCC Rcd 3068, 61 Fed. Reg. 15206 (April 5, 1996).

power community networks in the upper band, is sharing with the proposed lower power devices feasible?

49. Regarding out-of-band emission limits, we are proposing to require that all emissions occurring from NII/SUPERNet devices outside of the 5.15-5.35 GHz and 5.725-5.875 GHz bands be attenuated by at least 50 dB or to the radiated emission limits set forth in Section 15.209,[56] whichever is the lesser attenuation. In addition, we propose that any emissions occurring in the restricted bands[57] comply with the radiated emission limits set forth in Section 15.209. We believe that these out-of-band emission limits will provide sufficient protection against harmful interference to adjacent band and harmonically related radio operations. Additionally, we propose to amend Section 15.205 to delete the listing of 5.15 - 5.25 GHz as a restricted band.[58] Further, to ensure that the emissions from digital circuitry employed with the NII/SUPERNet equipment do not cause harmful interference to lower frequency radio operations, we propose to require that any such emissions below 1000 MHz comply with the general field strength limits set forth in Section 15.209. For any NII/SUPERNet devices that use an AC power line, we propose to require such devices to comply also with the conducted limits set forth in Section 15.207.[59]

50. The out-of-band emission rules we are proposing are similar to those rules currently applied to spread spectrum devices operating under Section 15.247 of our rules.[60] We have not received any indication that there are any technical or economic difficulties in achieving compliance with these limits. Comments are requested on these issues. However, commenting parties should note that any discussion proposing relaxation of these limits should also address the potential for increased interference to other radio services.

51. We are not at this time proposing a channeling plan as requested by WINForum. At this time, we believe that a specific channel plan would unnecessarily limit the flexibility of equipment designers to develop devices and systems that will meet a wide variety of user needs. However, to ensure that the spectrum is used efficiently and that users of NII/SUPERNet devices can access the spectrum, we solicit comment on whether we should establish a maximum channel bandwidth for such equipment and/or limit the amount of spectrum that can be used by any one device at any given time. For example, should we establish a maximum channel bandwidth of

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[56] See 47 C.F.R. § 15.209.

[57] See 47 CFR Section 15.205.

[58] Only spurious Part 15 emissions are permitted in restricted bands. 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 First Report and Order, GEN. Docket No. 87-389, 4 FCC Rcd. 3493 (1989).

[59] See 47 CFR Section 15.207.

[60] See 47 CFR Section 15.247.

25 MHz for NII/SUPERNet devices? Further, should such devices be limited to using no more than two or three channels at any given time? Such approaches would provide flexibility in the types of services that could be offered and at the same time ensure that one or a few devices do not use a disproportionate amount of the spectrum.

52. With regard to a spectrum sharing protocol, we believe that some basic sharing protocol is necessary to ensure that this spectrum is used by unlicensed devices in a manner that permits these devices to share with one another. We encourage industry to develop appropriate etiquette protocols through a cooperative consensus process. 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. Once consensus on an etiquette is reached, we will consider those protocols in this or a further rule making proceeding. We recognize, however, it may take industry some time to develop such an etiquette. In order to expedite the development and introduction of NII/SUPERNet devices, we propose to adopt a basic "listen-before-talk" standard similar to that established for unlicensed Data-PCS devices.[61] This standard would serve on an interim basis until an etiquette is developed by industry. Specifically, as set forth in Appendix A, we propose to require unlicensed devices: to monitor the frequencies they will occupy to determine if the frequencies are unused and available; to limit the maximum time unlicensed devices may transmit to 10 milliseconds; and to require unlicensed devices to wait after ceasing transmission 50 microseconds before beginning to monitor again. We request comment on whether these interim standards would be appropriate and invite interested parties to submit alternatives.

53. We also request comment on whether we should specify a minimum modulation efficiency requirement for NII/SUPERNet devices to avoid inefficient use of this spectrum and help minimize the likelihood that a "tragedy of the commons"[62] would occur. Specifically, we solicit comment on a minimum modulation efficiency of 1 bps/Hz or higher. We note that 1 bps/Hz will provide a throughput of 25 Mbits/sec in a 25 MHz channel consistent with that requested in the petitions and comparable to the HIPERLAN system and has several precedents in our rules.[63] On the other hand, we note that technological advances would permit specification of a higher efficiency standard with little impact on equipment costs and availability. We solicit comment on what requirement would be both efficient and feasible.

54. In the Location Monitoring Service ("LMS") proceeding, we established sharing criteria for unlicensed Part 15 devices and licensed services in the 902-928 MHz band.

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[61] See 47 CFR Section 15.321(b)-(f).

[62] See generally Hardin, The Tragedy of the Commons, 162 Science 1243 (1968); Pierce, State Regulation of Natural Gas in a Federally Deregulated Market: The Tragedy of the Commons Revisited, 73 Cornell L.Rev. 15 (1987); Stewart, Environmental Regulation and International Competitiveness, 102 Yale L.J. 2039 (1993); Epstein, The Moral and Practical Dilemmas of an Underground Economy, 103 Yale L.J. 2157 (1994).

[63] See 47 C.F.R. § 21.122(a)(1) and 47 C.F.R. § 94.94.

Consistent with our decisions in that proceeding, we propose to establish clear technical operating parameters under which users of unlicensed NII/SUPERNet devices may operate without risk of being considered sources of harmful interference.[64] We are proposing that NII/SUPERNet devices not be deemed to cause interference to licensed services, provided that they operate in accordance with our technical rules and they are located indoors or employ an outdoor antenna that is mounted 15 meters (16.4 yards) or less above the ground. NII/SUPERNet devices with outdoor antennas higher than 15 meters would be required to cease operation or make some accommodation, such as limiting power, to eliminate any harmful interference caused to a licensed operation. We believe that this approach will promote effective use of the spectrum by both licensed and unlicensed services. We believe that the relatively low power of NII/SUPERNet devices and low antenna height proposed for outdoor operations will minimize the potential for these devices to interfere with other services. Finally, consistent with Part 15 operation, we also propose that NII/SUPERNet devices must accept any interference caused by licensed services. We request comment on this approach. We specifically request comment on whether an antenna height of 15 meters is the appropriate benchmark with regard to outdoor installations or whether additional power (EIRP) limits may be appropriate for outdoor use.[65] We note an ITU study concluded that there was a greater potential for interference to HIPERLAN operations from MSS feeder links than vice versa. We note that the ITU study assumed most of the HIPERLAN use would be indoors. We request comment and further analysis on the impact of varying amounts of outdoor NII/SUPERNet use. We also request further comment and analysis on whether the ITU study could be applied validly to predict the potential of the proposed NII/SUPERNet devices to cause harmful interference to the MSS.

C. Alternative Regulatory Structure

55. We believe that the unlicensed regulatory structure we are proposing for NII/SUPERNet operations will promote effective use of the 5 GHz spectrum. As indicated above, we believe that low power, unlicensed operation will allow for a great variety of new educational, medical, business, and consumer applications. Further, we note that due to the incumbent use of this spectrum, particularly by high powered Government radar operations, this spectrum may be of very limited use to licensed services. Nonetheless, we note that economic theory suggests that inefficient use of a resource is likely to occur where users perceive no individual economic benefit from their own investment in efficient use of that resource. This is sometimes called the "tragedy of the commons." With regard to unlicensed operation, this might translate to a situation where users have little or no incentive to make socially beneficial investments in technology or to use the spectrum in a more efficient manner if they do not derive a direct benefit from such investments. We believe that the limited range and low power aspects of unlicensed operation generally avoid or minimize the likelihood that a "tragedy of the

[64] See Report and Order, Amendment of Part 90 of the Commission's Rules to Adopt Regulations for Location Monitoring Service, PR Docket No. 93-61, 10 FCC Rcd 4695 (1995).

[65] See n.35, supra; see also ITU Radiocommunication Study Groups, Task Group 4/5, Document 4A/66-E, February 10, 1995 (Appendix C).

commons" will occur. For example, because of the limited transmission range of unlicensed operations, the parties affected by interference, who have an incentive to consider whether to invest in more spectrum efficient technology, are likely to be related, i.e., within the same business or organization, or close neighbors, rather than a large community of users. In these situations, the affected parties are likely to work together to arrive at solutions that will provide individual users a direct benefit.

56. Nevertheless, if we were to change our current proposal in order to provide for higher power community network operations in the 5.725 - 5.875 GHz band, with the attendant longer range and greater interference potential of these operations, it might be appropriate to license this portion of the spectrum and, in the case of mutually-exclusive applications, use competitive bidding to award such licenses.[66] We note that such point-to-point operations are similar to existing licensed fixed operations and request comment on whether licensing may lead to more efficient use of the spectrum. Under such an approach, service providers could be licensed for specific portions of the 5.725-5.875 GHz band, such as 25 MHz channels, and specific geographic service areas, such as Basic Trading Areas ("BTAs") or Major Trading Areas ("MTAs"). We request comment on whether market forces under a licensing scheme would significantly increase spectrum efficiency, how licensing would impact longer range community networks envisioned by the petitioners, and on any additional considerations or rules that might be desirable to ensure that licensed and unlicensed operations could both operate in the same spectrum.

D. New Part 16 Regulations

57. In its petition, Apple requests that we create a new "Part 16" of our rules to govern unlicensed NII Band operations.[67] It urges that we adopt a new Part 16 paradigm in which unlicensed devices are treated as a recognized radio service, operate in protected spectrum reflected in a Part 2 allocation and share allocated frequencies pursuant to an etiquette designed to ensure that all devices have fair and equitable access to the spectrum. Apple argues that its Part 16 concept is now well accepted, and states that while the Commission's Data-PCS decisions do not include a Part 16 designation, they incorporate the essential attributes of a Part 16 service.

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[66] See 47 U.S.C. § 309(j)(2)(A). Section 309(j)(2)(A) of the Communications Act of 1934, as amended , permits competitive bidding to be used "[i]f mutually exclusive applications are accepted for filing for any initial license or construction permit which will involve a use of the electromagnetic spectrum described in paragraph (2), then the Commission shall have authority, subject to paragraph (10), to grant such license or permit to a qualified applicant through the use of a system of competitive bidding that meets the requirements of this subsection." Additionally, "[u]se of the electromagnetic spectrum is described in this paragraph if the Commission determines that-

> (A) the principal use of such spectrum will involve, or is reasonably likely to involve, the licensee receiving compensation from subscribers in return for which the licensee--
> (i) enables those subscribers to receive communications signals that are transmitted utilizing frequencies on which the licensee is licensed to operate; or
> (ii) enables those subscribers to transmit directly communications signals utilizing frequencies on which the licensee is licensed to operate...."

[67] Apple Comments at 5.

Apple argues the unprotected status of Part 15 operations has constrained the types of communications for which unlicensed technologies could be used. It claims that because unlicensed technologies rest on the "bottom rung of the spectrum ladder," their continued existence in particular bands often has been threatened by proposals to allocate those bands to other, incompatible services.

58. Comments. Apple's proposal is supported by a number of parties who argue that a new Part 16 of the rules would provide these proposed unlicensed devices additional rights to the spectrum while maintaining their unlicensed status. Nortel and the Part 15 Coalition support Apple's proposal to apply a Part 16 regulatory regime to the proposed unlicensed band to protect NII/SUPERNet devices from incursions by other services.[68]

59. ARRL, however, opposes the establishment of a Part 16, arguing that there is no legal authority provided in the Communications Act of 1934, as amended, for creating such a regulatory regime. ARRL argues that the Communications Act of 1934 permits an allocation of spectrum for unlicensed devices only with respect to radio control and citizen's radio service facilities. It further argues that, as a matter of equity and fairness to licensed users, unlicensed devices should not be entitled to both the protected status afforded licensed services and the advantages inherent in unlicensed operations such as frequency agility, bandwidth variability, lack of eligibility requirements and flexibility of use.[69]

60. Proposal. We tentatively conclude that the technical and operational flexibility afforded under Part 15, along with our proposed conditions under which unlicensed NII/SUPERNet devices may operate without risk of being considered sources of harmful interference, is the appropriate structure for regulating these devices. Consistent with our actions for unlicensed Data-PCS and LMS, supra, we believe that Part 15 will provide the operating certainty requested by Apple. Accordingly, we propose to codify the regulations governing NII/SUPERNet devices under Part 15 of our rules. We request comment on this approach and any alternatives. In particular, what higher status is desired than that currently afforded Data-PCS at 1910 - 1930 MHz and 2390 - 2400 MHz, which are regulated under Part 15? If a higher status is requested, is existing Commission authority sufficient to grant it or is additional statutory authority from Congress required?

E. Other Matters

61. ISM Regulations. Apple raises the issue of whether ISM devices operating in the 5.725-5.875 GHz band should be required to comply with more restricted emission limits or other requirements. Apple argues that more stringent regulation of ISM devices is needed to ensure

[68] Nortel Comments at 5; Part 15 Coalition Comments at 6.

[69] ARRL Comments at 4-5.

that such equipment does not preclude NII/SUPERNet or other uses of this spectrum.[70] However, Andrew opposes additional restrictions on ISM operations because it anticipates an increase in the implementation of ISM operations in the 5.725-5.875 GHz band. It is not clear that sharing between unlicensed NII/SUPERNet devices and ISM operations would require modification of the ISM regulations to make them more restrictive. We tentatively believe that such restrictions would be an unjustified burden on the ISM user community. Accordingly, we are not proposing any additional restrictions on ISM operations at this time. We solicit comments on this issue.

62. International Allocations. Finally, as a ministerial matter, we will update, at the Report and Order stage of this proceeding, the International Table of Frequency Allocations, 47 C.F.R. § 2.106, and its associated footnotes with regard to the spectrum bands under consideration in this rule making, in order to reflect decisions made at WRC-95. As the International Table is provided for informational purposes only, these changes to the rules do not require public comment. Domestic implementation of any of the international rules will be addressed in a future rule making proceeding, or, as appropriate, in connection with specific requests for authorizations.[71]

PROCEDURAL INFORMATION

63. Regulatory Flexibility Analysis. As required by Section 603 of the Regulatory Flexibility Act, the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the expected impact on small entities of the proposals suggested in this document. The IRFA is set forth in Appendix B. Written public comments are requested on the IRFA. These comments must be filed in accordance with the same filing deadlines as comments on the rest of the NPRM, but they must have a separate and distinct heading designating them as responses to the Initial Regulatory Flexibility Analysis. The Secretary shall send a copy of this NPRM, including the Initial Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration in accordance with paragraph 603(a) of the Regulatory Flexibility Act. Pub. L. No. 96-354, 94 Stat. 1164, 5 U.S.C. Section 601 et seq. (1980).

64. Ex Parte Presentation. This is a non-restricted notice and comment rule making proceeding. Ex parte presentations are permitted, provided they are disclosed as provided in Commission rules. See generally 47 C.F.R. Sections 1.1202, 1.1203, and 1.1206(a).

65. Authority. 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).

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[70] Apple Petition at 33.

[71] See n.29, supra.

66. Comment. Pursuant to applicable procedures set forth in Sections 1.415 and 1.419 of the Commission's Rules, interested parties may file comments on or before **[Sixty days after the date of publication in the Federal Register]**, and reply comments on or before **[Ninety days after the date of publication in the Federal Register**]. All relevant and timely comments will be considered by the Commission before final action is taken in this proceeding. To file formally in this proceeding, participants must file an original and four copies of all comments, reply comments, and supporting comments. If participants want each Commissioner to receive a personal copy of their comments, an original plus nine comments must be filed. Comments and reply comments should be sent to Office of the Secretary, Federal Communications Commission, Washington, DC 20554. Comments and reply comments will be available for public inspection during regular business hours in the FCC Reference Center (Room 239) of the Federal Communications Commission, 1919 M Street, N.W., Washington, DC 20554. Additionally, informal comments may be filed over the Internet to 96-102@fcc.gov.

67. Additional Information. For further information concerning this rule making proceeding contact Tom Derenge at (202) 418-2451, internet: tderenge@fccgov, or Fred Thomas at (202) 418-2449, internet: fthomas@fcc.gov, Office of Engineering and Technology, Federal Communications Commission, Washington, DC 20554.

FEDERAL COMMUNICATIONS COMMISSION

William F. Caton
Acting Secretary

Appendix A: Proposed Rules

Part 15 of title 47 of the Code of Federal Regulations is proposed to be amended as follows:

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 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	16.42-423	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-	2483.5-2500	17.7-21.4
8.37625-8.38675	156.52525	2655-2900	22.01-23.12
8.41425-8.41475	156.7-156.9	3260-3267	23.6-24.0
12.29-12.293	162.0125-167.17	3332-3339	31.2-31.8
12.51975-12.52025	167.72-173.2	3345.8-3358	36.43-36.5
12.57675-12.57725	240-285	3600-4400	([2])
13.36-13.41	322-335.4		

[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 NII/SUPERNet Devices

§ 15.401 Scope.

This subpart sets out the regulations for unlicensed National Information Infrastructure SUPERNet (NII/SUPERNet) devices operating in the 5.15 - 5.35 GHz and 5.725 - 5.875 GHz bands.

§ 15.403 Definitions.

(a) *Emission bandwidth*. For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Compliance with the emissions limits is based on the use of measurement instrumentation employing a peak detector function with an

instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

(b) *NII/SUPERNet devices [Unlicensed]*. Intentional radiators operating in the frequency bands 5.15 - 5.35 GHz and 5.725 - 5.875 GHz that provide a wide array of wideband, high data rate mobile and fixed communications services to individuals, businesses, and institutions.

(c) *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.

(d) *Spectrum window*. An amount of spectrum equal to the intended emission bandwidth in which operation is desired.

(e) *Thermal noise power*. The noise power in watts defined by the formula N=kTB where N is the noise power in watts, k is Boltzmann's constant, T is the absolute temperature in degrees Kelvin (e.g., 295^{o} K) and B is the emission bandwidth of the device in hertz.

§ 15.405 Cross reference.

(a) The provisions of subparts A, B, and C of this part apply to unlicensed NII/SUPERNet devices, except where specific provisions are contained in subpart E.

(b) The requirements of subpart E apply only to the radio transmitter contained in the NII/SUPERNet device. Other aspects of the operation of a NII/SUPERNet device may be subject to requirements contained elsewhere in this chapter. In particular, a NII/SUPERNet 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) Under all conditions of modulation, the maximum peak EIRP from an intentional radiator operating under this section shall not exceed -10 dBW. Additionally, power spectral density shall not exceed 0.03 milliwatts in any 3 kHz bandwidth, as measured with a spectrum analyzer having a resolution bandwidth of 3 kHz.

(b) Emissions radiated outside of the frequency band of operation shall be attenuated by at least 50 dB below the level of the fundamental emission or to the general radiated emission limits in Section 15.209 of this part, whichever is the lesser attenuation. Equipment manufacturers should note that the provisions of Section 15.205 apply to intentional radiators operating under this section.

(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 transmission of control or signalling information or use of repetitive codes used by certain digital technologies to complete frame or burst intervals.

(d) The device must comply with IEEE C96.1-1991 (ANSI/IEEE C95.1-1992), "Safety

Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz." Measurement methods are specified in ... (from Section 15.319(i)).

(e) The frequency stability of the carrier frequency of an intentional radiator operating under this section shall be ± 10 ppm over 10 milliseconds or the interval between access monitoring, whichever is shorter. 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.

§ 15.409 Harmful interference.

(a) NII/SUPERNet devices will not be deemed to cause interference to licensed services provided the devices operate in accordance with the output power, out-of-band emissions limits and spectrum etiquette requirements of this subpart and provided the devices are located indoors or employ an outdoor antenna that is mounted no more than 15 meters above the ground.

(b) NII/SUPERNet devices with outdoor antennas higher than 15 meters would be required to cease operation or make some accommodation to eliminate any harmful interference caused to a licensed operation.

(c) NII/SUPERNet devices must accept any interference caused by licensed services.

§ 15.411 Spectrum etiquette.

(a) The intentional radiator must incorporate a mechanism for monitoring the spectrum that its transmission is intended to occupy. The following criteria must be met:

(1) Immediately prior to initiating a transmission, devices must monitor the spectrum window they intend to use for at least 50 microseconds.

(2) The monitoring threshold must not be more than 32 dB above the thermal noise power for a bandwidth equivalent to the emission bandwidth of the device.

(3) If no signal above the threshold level is detected, a transmission burst may commence in the monitored spectrum window. Once a transmission burst has started, an individual device or a group of cooperating devices is not required to monitor the spectrum window provided the intraburst gap timing requirement specified below is not exceeded.

(4) After completion of a transmission, an individual device or cooperating group of devices must cease transmission and wait a deference time randomly chosen from a uniform random distribution ranging from 50 to 750 microseconds, after which time an attempt to access the band again may be initiated. For each occasion that an access attempt fails after the initial inter-burst interval, the range of the deference time chosen shall double until an upper limit of 12 milliseconds is reached. The deference time remains at the upper limit of 12 milliseconds until an access attempt is successful. The deference time is re-initialized after each successful access attempt.

(5) The monitoring system bandwidth must be equal to or greater than the emission bandwidth of the intended transmission and shall have a maximum reaction time less than 50xSQRT(12.5/emission bandwidth in MHz) microseconds for signals at the applicable threshold level but shall not be required to be less than 50 microseconds. If a signal is detected that is 6 dB or more above the threshold level, the maximum reaction time shall be 35xSQRT(12.5/emission bandwidth in MHz) microseconds but shall not be required to be less than 35 microseconds.

(6) The monitoring system shall use the same antenna used for transmission, or an antenna that yields equivalent reception at that location.

(7) Devices that have a power output lower than the maximum permitted under the rules may increase their detection threshold by one decibel for each one decibel that the transmitter power is below the maximum permitted.

(b) The transmission burst duration from one device or group of devices acting cooperatively shall be no greater than 10 milliseconds. Any intraburst gap between cooperating devices shall not exceed 25 microseconds.

(c) All systems of less than 25 MHz emission bandwidth shall start searching for an available spectrum window within 30 MHz of the band edge at 5150, 5350, 5725, or 5875 MHz while systems of more than 25 MHz emission bandwidth will first occupy the center half of the band. Devices with an emission bandwidth of less than 10 MHz may not occupy the center half of the band if other spectrum is available.

APPENDIX B: INITIAL REGULATORY FLEXIBILITY ANALYSIS

Pursuant to Regulatory Flexibility Act of 1980, the Commission finds as follows:

A. Reason For Action: We find that there is a need for additional unlicensed spectrum for intentional radiators. This rule making proceeding is initiated to obtain comment regarding proposals to make spectrum in the 5 GHz band available for such purposes and to amend the Part 15 rules to add the technical requirements necessary to permit sharing between new unlicensed devices and incumbent operations.

B. Objective: The objective of this proposal is to provide adequate unlicensed spectrum for wideband applications, and to provide for the technical rules necessary for spectrum sharing and efficiency.

C. Legal Basis: The proposed action is authorized by 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). These provisions authorize the Commission to make such rules and regulations as may be necessary to encourage more effective use of radio as is in the public interest.

D. Description, Potential Impact, and Number of Small Entities Affected: This proposal may provide new opportunities for radio manufacturers and suppliers of radio equipment, some of which may be small businesses, to develop and sell new equipment. We are unable to quantify other potential effects on small entities. We invite specific comments on this point by interested parties.

E. Reporting, Record Keeping, and Other Compliance Requirements: None.

F. Federal Rules That Overlap, Duplicate, or Conflict With This Rule: None.

G. Significant Alternatives: If promulgated, this proposal will provide additional unlicensed spectrum. We are unaware of other alternatives which could provide sufficient spectrum in the immediate future. We solicit comment on this point.

APPENDIX C: CONCLUSIONS OF ANALYSIS OF SHARING BETWEEN NGSO MSS UPLINK AND HIPERLANS

International Telecommunications Union Radiocommunication Study Groups, Document 4A/66-E, page 158, 10 February 1995.

Part 2 - Analysis of Sharing Between NGSO MSS Uplink and HIPERLANs

1. **Introduction**

The feasibility of spectrum sharing between NGSO MSS feeder systems and HIPERLAN systems which may operate in the mobile service in the 5 GHz range has been investigated by TG 4/5. A further study has been made using typical parameters for the HIPERLANs provided by TG 8/3 to TG 4/5 and two characteristic NGSO mobile satellite systems: the LEO-D system which operates at relatively low altitudes and uses wideband modulation (CDMA) and the LEO-F system which uses high altitude satellites and more conventional narrow-band modulation.

2. **Conclusions**

The following conclusions have been reached based on calculations, data and assumptions annexed to this document:

i) MSS satellites of either system would not be affected by the deployment of HIPERLANs, even in very large numbers - e.g. 50 million nodes over the area seen by a satellite would not affect the reception of MSS feeder signals at MSS satellites.

ii) HIPERLANs could be affected by the ground stations of either MSS system notably in the immediate vicinity of the ground station sites. Typically the required separation distances will be of the order of 3 to 10 km for indoor usage and 16 to 50 km for outdoor usage. Roughly 99% or more of all HIPERLAN usage is projected to be indoors. For outdoor HIPERLAN usage, consideration of terrain profiles and/or local shielding will reduce these distances considerably, this depends on local factors. Since HIPERLAN systems are likely to be unlicensed, HIPERLAN users may be advised of any appropriate siting considerations in order to minimize the risk of interference.

Therefore, considering:

a) that HIPERLANs may be widely deployed but are likely to be concentrated in larger centres of population;

b) that MSS ground stations will be deployed in limited numbers;

c) that MSS ground stations will be sited away from industrialized and urban areas;

d) that only 1% of HIPERLAN usage is expected to be outdoors.

It is concluded that sharing is feasible between HIPERLANs and NGSO MSS feeder-link Earth stations, provided the distances of the order mentioned above are maintained between

the HIPERLAN systems and the NGSO MSS feeder-link Earth stations.