Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Allocation of Spectrum in the 5 GHz Band	)	RM-8653
To Establish a Wireless Component of the	)	
National Information Infrastructure	)	

To: The Acting Secretary

PETITION FOR RULEMAKING

"NII BAND"

OF COUNSEL

David C. Nagel
Senior Vice President,
Worldwide Research and Development
APPLE COMPUTER, INC.
Three Infinite Loop, MS: 303-1DN
Cupertino, California 95014

Henry Goldberg
Mary J. Dent
GOLDBERG, GODLES, WIENER & WRIGHT

1229 Nineteenth Street, N.W.
Washington, D.C. 20036
(202) 429-4900
hgoldberg@goldberg.com

James M. Burger
Director of Government Affairs
APPLE COMPUTER, INC.
1667 K Street, N.W., Suite 410
Washington, D.C. 20006
202 466-7080
burger@apple.com

James F. Lovette
Principal Scientist,
Communications Technology
APPLE COMPUTER, INC.
One Infinite Loop, MS: 301-4J
Cupertino, California 95014
(408) 974-1418
jlovette@apple.com

May 24, 1995

TABLE OF CONTENTS

SUMMARY

This Petition for Rulemaking calls for the creation of a new band of frequencies for high capacity, unlicensed wireless data -- the "NII Band." Specifically, Apple proposes that the Commission allocate 300 MHz of spectrum in the 5 GHz range, comprised of the 5150-5300 MHz band (which has been allocated throughout most of Europe for "HIPERLAN" unlicensed wireless local area networks) and the 5725-5875 MHz band (which currently is used by unlicensed Part 15 technologies; industrial, scientific and medical ("ISM") devices; and Amateur operators).

The essential characteristics of the NII Band are:

*** Adequate bandwidth** to support high-speed applications (up to 24 Mbps or more) and large numbers of users;

* **"Part 16" operation** in protected spectrum and in conformance with an overarching set of technical rules, developed by the information industry;

* **Equal access** to the spectrum for all compliant devices and all types of communications; and

* **Longer distance** communications (10-15 km or more), creating new possibilities for unlicensed community networks.

The NII Band will be fundamentally different from any other wired, licensed-wireless, or unlicensed service. Unlike licensed-wireless services, no single entity will have an exclusive license to provide service using the spectrum. Unlike both licensed-wireless and wired services, availability will not be determined by a service provider's deployment plan or the economics of a fee-for-service offering.

Unlike traditional Part 15 operation, NII Band devices will not have to contend with unpredictable and uncontrollable interference, a host of different devices employing a variety of modulation schemes and power levels, and the continuing threat of giving way to incompatible services.

Unlike Data-PCS offerings, the NII Band will support very high-bandwidth transmissions and communications over longer distances. Unlike the proposed unlicensed bands above 40 GHz, the NII Band will support certain in-building and longer-distance communications that are not feasible using very high frequencies and will be amenable to more rapid product deployment.

The NII Band would promote the full deployment of a National Information Infrastructure ("NII"), extending the effective reach of the NII by making possible high-bandwidth access and interaction throughout a limited geographic area -- where mobility is key -- both on a peer-to-peer, *ad hoc* basis and through wireless local area networks. Moreover, it would provide for unlicensed, wireless, wide area "community networks" connecting communities, schools, and other groups underserved by existing and proposed telecommunications offerings.

The NII Band would advance a host of public policy objectives, including assuring that all segments of society have access to the "information superhighway;" extending advanced telecommunications offerings to schools, libraries, hospitals, and government agencies; and promoting the participation of small businesses, businesses owned by women or minorities, and pioneering firms in tomorrow's telecommunications marketplace.

Because the NII Band would build upon, but transcend, both the European HIPERLAN effort and existing Part 15 unlicensed use, it would increase U.S. competitiveness and create new export opportunities; provide interconnectivity between U.S. and European markets, thereby furthering the creation of a Global Information Infrastructure ("GII"); and dramatically expand the applications that can be supported by, and the market for products operating in, the 5 GHz ISM band.

These goals can be achieved while accommodating most current and proposed uses of the 5150-5300 and 5725-5875 MHz bands, including Microwave Landing Systems ("MLS") (if, contrary to current expectations, MLS is used in the United States), "Big LEO" system feeder uplinks, Amateur operators, existing Part 15 devices, and ISM products.

Accordingly, Apple requests that the Commission expedite creation of the NII Band and adopt technical rules to hasten the development and deployment of new technologies.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Allocation of Spectrum in the 5 GHz Band	)	RM-8653
To Establish a Wireless Component of the	)	
National Information Infrastructure	)	

To: The Secretary

PETITION FOR RULEMAKING

Apple Computer, Inc. ("Apple"), pursuant to Section 1.401 of the Federal Communications Commission's ("FCC" or "Commission") Rules, 47 C.F.R. Section 1.401, respectfully requests that the FCC initiate a rulemaking to create a new unlicensed wireless radio service consisting of 300 MHz in the 5 GHz range, which will promote the full deployment of a National Information Infrastructure ("NII"). This "NII Band" would extend the effective reach of the NII, making possible high-bandwidth access and interaction throughout a limited geographic area, where mobility is key, and providing as well for a wireless element of "community networks" serving a larger area.

Specifically, Apple proposes that the FCC:

* allocate for use as part of the NII Band the 5150-5300 MHz band, a shared private-government band that currently is not heavily used within the United States and has been allocated throughout most of Europe for unlicensed wireless local area networks;

* allocate for use as part of the NII Band the 5725-5875 MHz band, a shared private-government band that currently is used by unlicensed Part 15 technologies, industrial, scientific and medical ("ISM") devices, and Amateur operators; and

* adopt technical rules governing operation of unlicensed technologies in the NII Band.

The NII Band would provide capabilities that are not now possible using any other present or proposed technology: wired or wireless, licensed or unlicensed. It would support users engaged in *ad hoc*, peer-to-peer communications, those operating as part of a wireless local area network ("LAN"), and those communicating over longer distances, who lack access to adequate alternatives. It would hasten the full development of the NII and help to ensure that no segment of society will be excluded from tomorrow's information-based world. In short, an allocation of 300 MHz, within which unlicensed devices would operate pursuant to an agreed set of technical rules, will assure that all Americans have the opportunity to participate in and benefit from a fully-developed, fully-integrated information infrastructure.

The essential characteristics of the NII Band are as follows:

* **Adequate bandwidth:** The NII Band would provide sufficient spectrum resources to accommodate a wide range of high-bandwidth video, voice, and high-speed data applications, up to 24 Mbps or more, for large numbers of users.

* **"Part 16" operation:** NII Band technologies would operate in protected spectrum and in conformance with an overarching set of technical rules.

* **Open entry:** All compliant technologies would be permitted to operate within the band.

* **Equal access:** All devices and types of communications would have equal access to the spectrum resource.

* **Limited technical rules:** Technical standards would be set at the minimum level necessary to assure equal access, giving manufacturers the flexibility to design a variety of devices suited to different types of communications needs.

* **Longer distance:** Users would be able to employ directional antennas without paying a power penalty, in order to support community networking and similar applications.

The bands proposed for use as an NII Band would build upon current spectrum allocations. In particular, the lower of the two sub-bands has been allocated throughout most of Europe for HIgh PErformance Radio Local Area Networks ("HIPERLAN"), while the upper of the two is used within the United States by unlicensed Part 15 devices. As a result, dedication of these spectrum resources to the NII Band would increase U.S. competitiveness and create new export opportunities by enabling U.S. manufacturers to develop products for use in both the NII Band and as part of European HIPERLAN networks; provide interoperability between U.S. and European markets, thereby furthering the creation of a Global Information Infrastructure ("GII"); and dramatically expand the applications that can be supported by, and the market for products operating in, the 5 GHz ISM band. Moreover, as discussed below, these goals can be achieved while accommodating most current and proposed uses of the 5150-5300 and 5725-5875 MHz bands.

Apple is the largest vendor of personal computers for the American home, the second-largest vendor to the Japanese market, and the third largest vendor to businesses worldwide. Apple is the leading computer company in business communications and publishing. This market accounted for one-quarter of Apple's net sales which, in fiscal 1994, exceeded $9 billion overall.

In addition, Apple long has been the leading computer supplier to schools. According to one research firm, Apple has the number one position in the worldwide education market, with a 28% share.[1] Apple occupies an even stronger position in the K-12 education market, with a 61% share of the U.S. installed base.[2]

Apple's commitment to education goes well beyond merely supplying equipment. Apple is deeply involved in the technological, social, and cultural issues that influence educational reform globally. Apple plays a leading role in allowing educators and students to take advantage of advanced computing and telecommunications technologies as catalysts for creating a community of lifelong learners. Through its Apple Classrooms of Tomorrow ("ACOT") technology research group, Apple has learned that technological tools can be used to motivate students and foster their abilities, revolutionize the way they learn, and ease their access to the world around them.[3]

The absence of suitable spectrum resources for unlicensed wireless communications for educational and other uses led Apple to work with the Commission to develop such resources. Apple's 1991 "Data-PCS" Petition for Rulemaking defined the essential attributes of a pioneering unlicensed radio service and launched the effort that led to the FCC's recent decisions to allocate 30 MHz of spectrum for unlicensed voice and data services.

Since Apple filed its Data-PCS petition, the company also has participated in other proceedings addressing the spectrum available for, and the rules governing, unlicensed operation under Part 15 of the Commission's rules. These include, for example, the proceeding addressing the accommodation of LMS systems within the 900 MHz ISM band; the Commission's proposal to introduce licensed services into the 2.4 GHz ISM band; various proposals to modify the rules governing the operation of unlicensed spread spectrum devices; and the Commission's effort to develop suitable rules regarding the environmental effects of RF emissions. Apple also is involved in the FCC's proceeding to allocate spectrum above 40 GHz for a wide variety of uses, including a substantial band of frequencies for unlicensed operations.

On the international level, Apple has been involved substantially in the development of HIPERLAN and has chaired committees and dedicated company resources to the effort to draft suitable technical standards for this new service. Apple is also one of a small number of private sector companies who are working together in project "Hiperion," an effort funded by the European Commission that has been charged with building a demonstration system for HIPERLAN.

In all of these efforts, Apple has focused on the distinct benefits that can be derived from various unlicensed wireless technologies. Apple now seeks to build upon the important steps recently taken by the Commission to preserve and advance unlicensed operation by proposing the creation of a new, unlicensed, high-capacity NII Band.

Unlicensed uses of the radio spectrum developed on the periphery of the Commission's regulation of wireless services. Operation on an unlicensed basis is permitted in bands allocated to other uses, but is subject to two substantial constraints: unlicensed devices must not cause interference to any authorized spectrum user and they are not protected from any interference they might receive. In short, until recently, unlicensed operation was not a recognized radio service, had no spectrum allocation reflected in Part 2 of the Commission's rules, and operated solely on an "at sufferance" basis.

This has imposed serious constraints on the types of communications for which unlicensed technologies can be used effectively. In particular, data communications -- which require high reliability -- had to overcome an environment characterized by the constant threat of unpredictable and uncontrollable interference from other communicating and non-communicating devices. Moreover, unlicensed operation often has been constrained by regulatory requirements and boundaries, such as provisions requiring the use of spread spectrum modulation, designed to make unlicensed devices "invisible" to other spectrum users. Finally, 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 dedicate those bands to other, incompatible services.

When Apple filed its Data-PCS Petition for Rulemaking, it therefore described and urged the Commission to adopt a new "Part 16" paradigm, in which unlicensed

When Apple filed its Data-PCS Petition for Rulemaking, it therefore described and urged the Commission to adopt a new "Part 16" paradigm, in which unlicensed devices would be treated as a recognized radio service, would operate in a protected spectrum band reflected in a Part 2 allocation, and most importantly, would share allocated frequencies pursuant to a etiquette designed to ensure that all devices have fair and equitable access to the spectrum.

While this was a somewhat radical proposal in January of 1991, when Apple filed its Data-PCS Petition, the "Part 16" approach now has become well-accepted. During the past four years, the Commission, the Administration, and Congress each have recognized the importance of unlicensed use of the radio spectrum and, in particular, the merits of a "Part 16" approach.[4] The Commission, moreover, has implemented this approach by allocating two 10 MHz bands specifically for unlicensed asynchronous operation, in protected spectrum and pursuant to a spectrum etiquette,[5] and, more recently, by proposing to dedicate 8.5 GHz of spectrum to unlicensed operation in the bands above 40 GHz.

The NII will not be a monolithic national infrastructure that is used, controlled, or designed by any single person or organization. Rather, the NII will be a widespread, interconnected network of networks, carrying a variety of voice, data, and video communications services to and from a host of different users. Each of the many services to be provided will be characterized by different intensities and priorities of information and by a wide variety of requirements for bandwidth, accuracy, privacy, time-of-delivery, and geographic coverage.

The NII is not inherently solely a national, or wide-area, or revenue-producing network. While it will support communications on a nationwide (and even world-wide) basis, it also encompasses local connections and content, for information is created, stored, and retrieved locally, and individuals work and learn locally. Indeed, much of an individual's communications "traffic" never leaves his or her premises.

Certain core attributes of unlicensed "Part 16" operation distinguish it from any other type of communications service, whether wired or licensed-wireless. In particular, unlicensed operation offers:

* **Open entry:** Any manufacturer of a device that complies with the FCC's minimum technical standards may sell that product and anyone with such a device may use it to communicate with others. There is no licensing process that grants exclusive rights to any particular entity and no licensee or service provider who controls how or where the spectrum will be used.

*** Equal access:** No entity or device can deny others access to the spectrum or grant certain transmissions or users preferential treatment.

* **Innovation:** Due to its "open entry" characteristic and limited technical regulation, unlicensed operation promotes the evolution of technology and the development of new applications.

* **Flexibility:** Because users do not have to obtain licenses, engage in frequency coordination, or hard wire networks, they can communicate on an *ad hoc* basis or, where a more permanent network is desired, they can quickly, easily, and relatively inexpensively design, deploy and reconfigure a network suited to their individual needs. In addition, they can communicate even where wired solutions are impossible -- such as in remote areas or where asbestos in walls precludes the use of wire-based connections.

* **Independence:** Because deployment of unlicensed devices is controlled by end users rather than centralized network operators, systems can be deployed and operated to meet the users needs, rather than solely pursuant to a network controller's "needs."[6]

* **Spectrum efficiency:** Unlike private networks, unlicensed spectrum is not dedicated to any particular user, but rather is shared by all users on a dynamic, instant-by-instant, MHz-by-MHz basis. This technique, which is the invariable operating characteristic of the Internet and other data networks, provides the most flexible and efficient means of maximizing the sharing of the spectrum resource.

* **Low cost:** Unlike wired systems, unlicensed wireless systems are free from the often prohibitive costs of constructing a physical connection between locations.[7] Unlike commercial offerings (whether wireless or wired), use is not subject to often prohibitive connection or air-time charges.[8] Unlike private wireless networks, users do not incur the high costs of system design and construction, frequency coordination, and FCC licensing.

Unlicensed wireless technologies can serve public needs either that cannot be met at all with alternative technologies or that can be met with these technologies only if elaborate, costly, and intrusive regulation or extensive government rate subsidies are employed.

Many of the networks that will form the future NII will be outgrowths of the networks we now rely on: those owned by telephone companies, cable companies, television broadcasters, satellite operators, cellular (and, soon, PCS) providers, and the like. These subsets of the NII will be built by entities who will provide services, most often for a fee, to their subscribers. These network operators generally will decide which neighborhoods to serve and which to bypass, what uses and applications to support, and what charges to impose upon users. In many cases, they will also decide what information to put on their networks. To a very significant extent, networks will be built, and services provided, only when they can be justified by anticipated advertising revenues, service fees, access charges, or other similar revenue sources.

The Administration, the Commission, the Congress, the states, and others have recognized the importance of ensuring that the NII is available to all segments of the population, in particular low-income households, those living in rural and other difficult-to-serve areas, and those with special needs. In addition, they have emphasized the need to ensure that adequate services are provided to core public institutions, including schools, libraries, hospitals, and government agencies. Moreover, even beyond basic "universal service" goals, policymakers are striving to develop ways to promote the offering of the broadest possible array of communications, information, and computing services to every individual and organization in every walk of life -- every student and teacher, every health care professional, every home maker, every tribal community, every worker, and every entrepreneur and researcher.

Yet few service franchisees or wireless network licensees have a compelling business case for extending their networks to each student's desk, to each patient's bed in a medical center, to each library carrel and table, or to each worker's bench or office; for making their infrastructures freely available for civic or community-owned and operated networks; or for laying the cables or building the wireless infrastructures needed to provide advanced services to rural and difficult-to-serve areas.

In some cases, people may be left behind, without access to the information and communication resources they need. In others, service providers may elect to extend their networks into schools and other public facilities or to provide services on a low-cost basis to public entities. In still others, regulatory requirements (including universal service contributions and "carrier of last resort" obligations) may force network extensions or low-cost services. Even when service is provided as a "gift," or in response to a regulatory mandate, however, service costs will need to be subsidized by ratepayers or taxpayers.

The public interest would be served better if access could be secured, and service provided, through low-cost, market solutions that do not depend on either corporate largess or regulatory mandates. Thus, for example, when competition can lower prices to acceptable levels or expand service offerings into previously unserved areas, competition -- rather than government requirements and cross subsidies -- can be used to advance universal service goals. Once one moves beyond a basic "universal service" package, market forces -- not government regulation -- will be even more important in determining what services are available to whom and on what terms.

Unlicensed wireless communications technologies can be an important part of such a market-based solution. Spectrum devoted to unlicensed operation serves, in the Commission's words, as a "public good" through which a variety of communications needs can be met.[9] The deployment of networks relying on unlicensed spectrum is not dependent on the centralized deployment plans of traditional service providers or on the economics of wireline and licensed-wireless networks.

In addition to advancing "universal service" goals, the creation of suitable, sufficient unlicensed bands will further other important policy objectives. As the FCC seeks to adopt, refine, and implement various policies intended to assure broad participation in the communications marketplace (most notably, its entrepreneurs-block rules for auctioned spectrum and its pioneer's preference policies), unlicensed spectrum provides a continuing opportunity for minorities, women, small businesses, and pioneering firms to develop new offerings and enter the telecommunications marketplace. Likewise, unlicensed wireless devices, such as portable computers creating wireless extensions to the Internet, can create new, flexible, immediately functional computing and communicating opportunities for the disabled, the elderly, and others with limited mobility.

The NTIA recently recognized the benefits of unlicensed wireless technologies and the important role they will play in the NII:

The critical importance of [unlicensed] wireless systems...to the future development of the National Information Infrastructure (NII) is well recognized and supported. Wireless connectivity will be essential to support ubiquitous, affordable and adaptable networking capabilities, and it will facilitate many mobile applications. Furthermore, nonlicensed wireless components of the NII will provide significant opportunities for innovators and small companies to make contributions to the overall mix of products and services available through the NII."[10]

Just as unlicensed wireless communications will form only one "lane" on the information superhighway, different types of unlicensed devices, operating in different parts of the radio spectrum and in accordance with different technical parameters, will form distinct subsets of this lane. Traditional unlicensed, Part 15 devices, Data-PCS devices, NII Band devices and devices deployed in the bands above 40 GHz each will be tailored to meet various communications needs. Together, these unlicensed technologies will provide an array of choices that will be capable of satisfying individuals' requirements for a wide variety of communications.

As discussed above, traditional Part 15 devices, particularly those that operate in the ISM bands, support many important communications needs. However, their operation is, and will continue to be, constrained by the cluttered environment within which they must operate and by the risk of regulatory changes that introduce new, incompatible, higher-status services into their operating bands. As a result, traditional "at sufferance" Part 15 operation is fundamentally different from new "Part 16" approaches, such as Data-PCS and the unlicensed bands above 40 GHz, and different still from the proposed NII Band.

The Commission's recent decisions to dedicate two 10-MHz bands for low-power, local-area unlicensed data (or, more specifically, asynchronous) communications, subject to compliance with an overarching spectrum etiquette, dramatically will broaden the range of applications that can be supported on an unlicensed basis. Most importantly, the Data-PCS allocation has created new, immediately-available spectrum for local-area data communications at speeds of up to approximately 10 Mbps, for nomadic and collaborative computing, for spontaneous networking and, where there is a nearby wireless-compatible point-of-presence for wide area networks, for "gateway" access to those networks.

Data-PCS also represents a leap forward from traditional Part 15 operation in terms of the bandwidth it will be capable of supporting. Within each of the two 10 MHz Data-PCS bands, wireless transmissions at a given locale can approximate the performance of a single Ethernet cable, *i.e.*, a data transfer rate of 10 Mbps.[11] Data-PCS connections will be valuable for applications such as collaborative classroom activities, reaching shared file servers in hospitals, and numerous nomadic activities. As data compression techniques continue to develop, they will also support some types of video teleconferencing and transfers of elaborate graphics.

While the value of the FCC's decision to launch Data-PCS cannot be overstated, Data-PCS, alone, cannot satisfy all demands for unlicensed wireless communications. In particular, the 20 MHz Data-PCS band will not be capable of supporting the ever-higher data transfer rates required by new applications and the exponential growth in the number of users relying on those applications, which ultimately will evolve.[12] Indeed, the availability of Data-PCS capabilities will raise expectations and demands for spectrum even as it demonstrates higher levels of performance.

The Commission recently issued a proposal to develop for private sector use the "mm waves" above 40 GHz.[13] The bandwidth and the potential applications contemplated by the FCC's proposal can have important benefits, and Apple fully supports the Commission's efforts in this regard.

Several factors, however, distinguish the mm wave bands from Apple's proposed NII Band.

First, as the Commission has recognized, additional technological development is needed before commercial use of the mm wave bands will be fully possible.[14] The problems associated with product development are several. Most importantly, not only must manufacturers design products capable of providing the required throughput, with the required reliability, over the required distance, they must reach a point where this can all be done at a commercially reasonable cost.[15]

Second, transmission distances for a given power in the mm wave bands are more limited than for radio signals at lower frequencies.[16] This affects the ability to use mm wave devices for relatively long-range communications. In addition, mm wave signals are more easily blocked by walls, which may limit this band's usefulness for some in-building applications. At this point, however, it is impossible to state with certainty the limits of mm wave systems, because any final assessment of which uses unlicensed mm wave systems will support depends in significant part on how the FCC resolves questions regarding allowable transmitter power, the use of directional antennas, and other open issues.

Third, it will be necessary to resolve some potentially complex regulatory issues before product deployment in the mm wave bands may occur. In particular, compliance testing standards and procedures and questions regarding appropriate RF safety exposure standards and susceptibility to emissions from other devices must be resolved.[17] and may require substantial refinements to existing approaches.[18]

Finally, unlike the mm wave band, the NII Band builds upon European efforts to develop HIPERLAN networks. For a host of reasons -- including, most importantly, international competitiveness and global interconnectivity -- the United States cannot afford to focus exclusively on a mm wave allocation while ignoring the distinct attributes of, and opportunities presented by, the 5 GHz band.[19]

Like Data-PCS and unlicensed networks above 40 GHz, the NII Band will support a combination of *ad hoc*, peer-to-peer communications, wireless LANs, and wireless wide-area networks ("WANs"). While it thus can be used in many of the same types of networking situations in which other unlicensed spectrum can be used, due to its comparative strengths and weaknesses, the 5 GHz NII Band will be suited to satisfying several communications needs that cannot adequately be supported in existing and proposed unlicensed bands.

In contrast to Data-PCS's 2 x 10 MHz allocation, NII Band users would have access to 300 MHz of unlicensed spectrum, with much broader latitude for sharing and usage. As a result, individual users' devices could be capable of faster access to networks and transfer of information -- for example, the 24 Mbps data rates expected for HIPERLAN, or two and one-half times the nominal capacity of Data-PCS connections -- because the total bandwidth available to use and share would be much greater.[20]

The dramatic effect of increased bandwidth perhaps can best be understood in reference to the time it would take to transmit the contents of one typical, multimedia

CD-ROM at various speeds. Using a 1200 bps modem, the transmission would take two months to complete. Using a 9600 bps modem, it would take one week. Using an ISDN 64 kbps circuit, it would take one day. Using a T1 (1.544 Mbps) circuit, it would take 1 hour.[21] NII Band users, however, even among groups at the same locale, each could accomplish such transactions, simultaneously, in a few minutes. Moreover, the copious bandwidth of the NII Band will permit microcellular frequency re-use for yet more spectrum capacity and efficiency. This capability translates not only into the ability to do conventional tasks more quickly, but also into the ability to do things not previously possible.

In much of Europe, the 5150-5300 MHz band has been allocated for HIPERLAN, a family of unlicensed wireless LAN products conforming to internationally agreed-upon standards.[22] HIPERLAN products are expected to provide a 24 Mbps connection among computing devices, including computers, servers, printers, and *ad hoc* portable networks. After several years of intense development, agreement on the HIPERLAN standard has been reached at the Committee level. Although some additional procedures are required prior to final adoption, the HIPERLAN standard could be made final as soon as early 1996. From that day forward, HIPERLAN products could, in theory, be deployed in countries that have allocated spectrum to this use, although in fact product development has barely begun.

The NII Band would build upon, but greatly extend HIPERLAN. Like HIPERLAN, the NII Band would be packet-switched in nature and would guarantee all compliant devices fair access to spectrum. By creating an NII Band within the United States, with a spectrum allocation corresponding to the European HIPERLAN allocation, the FCC would create market opportunities for U.S. manufacturers and would enable users to operate on both sides of the Atlantic Ocean using similar technologies.

The details of NII Band operating rules, however, would not be identical to the HIPERLAN standard. HIPERLAN is near the edge of practical technology at this time. Under the HIPERLAN standard, every HIPERLAN device must be capable of operating at a very high data rate (24 Mbps). However, this capability currently can be accomplished only at significant product manufacturing costs and with high power consumption. It could easily be the end of the decade before HIPERLAN will be practical for desktop computers at a reasonable cost or, for portable devices, at all.

Accordingly, while the NII Band rules should accommodate HIPERLAN-conformant devices, the NII Band must not be dedicated exclusively to HIPERLAN or restricted in any way that favors HIPERLAN operation at the expense of other technologies. Neither should the NII Band be limited to a narrow range of data rates or band subdivision that would result in some services being precluded and permit others to consume too much spectrum.

Just as there are upper limits on the bandwidths that Data-PCS devices can support (due to the size of the Data-PCS allocation), they are limited with respect to the distances over which they can communicate (due to the low maximum output power allowed Data-PCS devices).[23] As a general rule and consistent with Apple's original Petition, Data-PCS devices generally will be suited to indoor operations, through walls on a single floor, within approximately 50 meters -- perfect for many office, home, hospital, factory and school situations.[24]

In contrast, the NII Band rules will permit much larger distances for unlicensed operation outdoors. With NII Band devices, it will be possible to communicate at distances on the order of 10 to 15 km or more, depending, of course, on terrain, bandwidth, and other factors. The capability to communicate on an unlicensed, wireless basis over such distances will open up new ways of communicating. Perhaps most importantly, it will make possible an entirely new application of wireless networking: the community network. Until the NII Band becomes available, there will be no appropriate regulatory provision for unlicensed communications of this nature.

The United States is made up of population centers of all sizes -- large cities, small rural communities, farms, ranches, industrial parks, suburban housing developments, universities, resorts, and a host of other groupings -- along with vast reaches of mountains, desert and croplands. Communications infrastructures within some of these population centers are well developed and will be upgraded in the coming decade to support a full range of advanced communications services. Others, however, may never see these offerings or may lag so far behind major urban centers that the businesses and individuals living in them will fall so far behind their urban counterparts in education, health care, and competitiveness that they are placed at a permanent disadvantage.

The NII Band could be used to prevent this disparity of opportunity. Using relatively low-cost equipment, groups of users could create a high-bandwidth, community-wide network that could then, as a unit, interconnect with the broader telecommunications infrastructure. For example, a community center, university, rural school district, or Native American tribal council could employ omnidirectional antennas for low power, high bandwidth transmissions throughout an area, while their members could use antennas directed towards the source, enjoying the ability to interact because the system would operate on a two-way basis. These centers could in turn be joined together by point-to-point links and connections could be established between the community network and the broader communications infrastructure. Deployment of such networks would mean that community organizations could acquire equipment at low cost, they would not incur license or coordination fees, and would not be subject to a service provider's fees.[25]

There already are a number of community networks in operation, using a combination of wired and wireless technologies and licensed and unlicensed services. Even on their present limited scale, they have demonstrated their ability to promote participation in the democratic process, to give access to government resources, to mobilize and resolve issues through communications, to empower individuals and improve business opportunities.[26] The allocation of the NII Band will allow them to flourish.

While it is important to recognize the important applications that the NII Band will support, the value of the Band can be understood adequately only by also examining the types of users for whom such an allocation could make full participation in tomorrow's information-based society a reality. While this discussion is by no means exhaustive of the types of institutions that could use NII Band effectively, it is illustrative of the solutions this Band will make possible.

It is imperative that the United States develop individuals who are capable of sustaining and extending tomorrow's information economy. It is also imperative that we capitalize upon the opportunity to use computers and communications to improve educational opportunities and overcome the chasms that continue to divide our society. To do so, it is vital that we ensure that students across the country have access to adequate computing resources that are linked to the vast information resources that lie outside each school building.[27]

As Chairman Hundt has discussed, however, this is not yet occurring. There are more than 45 million American students in kindergarten through grade twelve, taught by 2.8 million teachers, in more than 2 million classrooms, in 110,000 American schools. Yet there are computers connected to telephone lines in only 3% of America's classrooms, and 78% of U.S. schools do not have even a single modem.[28]

The numbers are not much better when one moves into the world of higher education. Although the scene has shifted dramatically in recent months because of increased public awareness, as recently as early 1994 only approximately 1,100 of the more than 3,000 higher education institutions in the United States were connected to the Internet. The numbers are particularly distressing when one considers minority populations. For example, as recently as last year only one of the 28 colleges that are controlled by Native Americans was connected to the Internet.

The use of networking for K-12 education promises to be one of the basic tools for repairing what is, in many ways, a "broken" education system. As National Research Council ("NRC") has stated, the Internet "is a holy grail...[for] the K-12 education community, which should have greater access to it but has not been able to afford that access."[29] Through networking, schools will be able to gain access to a world of information resources that is not defined by the size of the local school budget, but rather is available across district lines, across income, even across national boundaries.

local school budget, but rather is available across district lines, across income, even across national boundaries.

Currently, however, network access is stymied by costs and logistics. According to information submitted to the Department of Education, after insufficient funds and the associated lack of equipment, the most significant barrier to schools' acquisition of advanced telecommunications capabilities is "too few access points in building."[30] Even many schools with substantial computing resources still find it necessary to move classes to "the computer lab" where networking is possible, thus diluting many of the benefits that computers could provide to enrich the flow of classroom activities. As a result, computer competence and computer use often become ends in themselves, instead of aids to other instructional goals.

One of the core problems facing schools is, then, the "last link" problem -- creating a connection from the point of entry of an infrastructure connection, to the computers themselves. Wireless technologies -- particularly unlicensed wireless technologies, including the NII Band -- are uniquely suited to solving this problem.

The Commission took the first major step in making this solution a reality when it created the Data-PCS band. As discussed above, Data-PCS devices will provide low cost, flexible means for last link connections supporting applications involving data rates of up to 10 Mbps. Increasingly, however, educators will require higher-bandwidth networking. As the NRC reported, "To achieve many of the benefits anticipated by educators will require access to the high-end networking that would make possible better video and multimedia exchanges. This implies higher bandwidth, reliable service, and so on. More sophisticated systems and higher bandwidth enable better graphical interfaces and functionalities."[31]

The NRC report continues by urging, among other things, access to current information sources, collaborations among students and teachers, a more active (as opposed to passive) acquisition of information and learning, reinforcement of basic learning skills, expansion of interests in sciences, and the "ability to build a bridge from school to home...". These networking features and their combined richness of information content will be best implemented in the NII Band, where signals can readily pass from one part of a school to another,[32] where bandwidth-intensive uses can be accommodated, and where, in many locales, the longer distances possible with directional antennas will help knit the home-school fabric.

Libraries long have served as a vital and opportunity-laden public resource. Over the years, they have evolved from repositories of books, to sources of diverse media including CD ROM data bases, video tapes, audio books, and music and drama recordings. In addition, increasingly they have become interconnected with other information resources, although, in the past, this has principally involved a physical connection, such as a dedicated telephone line.

As the form in which information is retained and distributed changes, however, libraries themselves know they must change if they are to continue to serve their core functions. New ways of exchanging information can make the long waits associated with inter-library loans of printed matter a thing of the past. Communications resources can provide access to on-line card catalogues, centralized scholarly databases, and a host of other resources to local users. In addition, they can make it possible for libraries to share their resources with individuals in other communities. Just as schools can provide students with access to the world's information resources, libraries can act as a gateway between entire communities and these resources, ensuring that every individual has a way to connect into and benefit from the information economy.

Currently, however, libraries are ill-equipped to serve this important role. There are about 15,000 public libraries (in addition to numerous corporate and private libraries) in the United States. But as of the middle of 1994, libraries with Internet access were numbered only in the hundreds, or fewer than 10%.[33] In light of funding constraints, it is unlikely that libraries will be able to expand significantly their offerings in the areas of computing and communications unless low cost, easily implemented alternatives are available to them.

The High-Performance Computing Act of 1991 recognized the importance of ensuring that libraries are connected to the nation's information infrastructure. Similarly, it is possible that Congress will pass legislation guaranteeing libraries at least limited access to the Information Superhighway. Yet while Congress can take some steps to promote access by public institutions such as libraries, as discussed above, private solutions, rather than government mandates, will need to be relied upon to a very significant extent in achieving this objective.

The NII Band can be an integral part of such a solution. Libraries are already starting to experiment with community and inter-library wireless networks as a means of achieving increased interconnectivity. Yet because there are as yet no adequate spectrum resources for unlicensed, wideband, wireless communications, there is no clear path for widespread deployment of such networks. The NII Band could provide this path and permit the deployment of unlicensed networks connecting libraries within a city, across a university campus, or especially, in rural America. As a noted expert stated:

"[M]any communities, rural and urban, want network access, especially for their children now. While many have never heard of the "Super Highway,"...many others hope this will be the "yellow brick road" out of isolation: lack of education, remoteness, being out of contact; out of vulnerability: increasing capacity to handle shocks and contingencies through contact with distant places and reciprocal relationships; out of powerlessness: ability to access resources, obtain legal redress and negotiate new possibilities."[34]

The NII Band could be used not only to connect buildings within or across library systems, but also to connect users within the library to information resources -- whether the library's own or, via the Internet or another network, those housed elsewhere. For example, researchers and others could use computers with NII Band communications capabilities (through a wireless access point) to search the library system's electronic card catalog and collection of electronically-stored books, maps, and other reference sources, organize the results, compare those results with the results of other researchers at other institutions, and compile a consolidated, nationwide reference resource on a particular topic. Similarly, those who do not themselves have a computer and an Internet connection could use library computers and wireless connections to access government documents or communicate with colleagues or friends from the carrel or desk at which they are working.

Like the role played by the Carnegie Foundation more than a half-century ago, the federal government must "invest" in libraries by dedicating unlicensed wireless spectrum. This one-time in-kind investment will create a public resource that will inure to the benefit of generations to come, and play a critical role in preventing the creation of a society of information "haves" and "have nots."

The success of the NII Band depends upon the adoption of a set of operating requirements to govern unlicensed use of the frequencies.[35] These requirements should be minimal and should establish standards at the lowest possible level in order to allow a wide variety of wireless communication options (much as the present Section 15.247 of the Commission's rules defines modulation techniques and power limits, but little else). The operating requirements also must be explicit enough at higher levels as to be consistent with the way digital information is communicated effectively.

While the development of a specific set of operating requirements for the NII Band will require a great deal of work and the input of a large number of interested parties, the following describes the essential attributes that would be mandated, as well as some general recommendations on the manner in which the requirements should be developed.

The rules governing the NII Band must assure that all devices retain an equitable right to access and share the spectrum resource. In particular, they must prohibit any rules for operation which are based upon (or display the preclusive behavior of) a circuit-switched network,[36] as well as any requirement (or exceptional priority) for centralized "gatekeepers."

An essential quality of the NII Band is that, like the Internet and virtually all other data networks, it must be used only for packet-switched (or "connectionless")

information transport. Moreover, each packet's "right" to access the spectrum must be equitable at all times. Any operating rules that incorporate a hierarchy among packets that permits certain types of packets to monopolize a transmission path by excluding other packets would, in essence, transform packet-based connections into traditional connection-based communications.

Similarly, any requirement (or "super-priority") for networks employing a centralized control mechanism that can deny other users access to the spectrum resource contradicts the essential nature of unlicensed operation. Some unlicensed networks (such as some wireless LANs), of course, will employ a central control function. Other users must be free, however, to communicate without obtaining the approval of, or deferring to, any type of hegemonic controller.

In designing its proposal for the NII Band, Apple has sought to identify a suitable amount of spectrum that will minimize the possibility of spectrum overcrowding. Even with a suitable allocation, however, there may be circumstances in which overcrowding occurs. In such cases, it is imperative that all communications share this burden equally (through delays in transmission times), rather than permitting some types of applications to monopolize the network at others' expense.

The fact that a particular type of traffic (*e.g.*, some voice circuits) may require a guaranteed service quality does not mean that this traffic is more "worthy" than other types of traffic. There is, quite simply, no correlation between the mode of transmission and the value of the content of the "message." For example, information critical to patient care could be contained in a voice conversation between physicians (a voice circuit), in medical records (a data circuit), or in x-ray images (either a data or video circuit). Any effort to create a hierarchy among users based upon the transmission type is fundamentally misguided and should be rejected.

By providing for equal access, the Commission would not in any way preclude applications that deliver what appears (to the user) to be real-time voice, video or similarly time-dependent material. Creative developers and users have found ways to use the Internet (a packet-based network), for example, to convey and deliver live music performances and high-quality video without monopolizing the available communications bandwidth. There are continuing developments of Internet protocols, including those intended to convey ATM cells. Even though a "wireless ATM" has not been fully researched, it remains a possibility that should not be precluded; the capacity of the NII Band allocation may be the agent for full development of wireless ATM and other innovations.

There may, of course, be some types of communications for which the risk of delay inherent in true "packet-based" unlicensed operation will be unacceptable. These requirements, however, can be met using wired networks or a licensed, homogeneous wireless service (where quality of service can be guaranteed). Indeed, because overcrowding will most often occur in precisely the same densely-populated environments in which advanced wired networks will be deployed promptly, wired service will generally be an option reasonably available to these users.

The point is that the value of the NII Band could be undermined, unless steps are taken to prevent its saturation by telephony, entertainment-video, or other connection-based services, before technologies are invented to better accommodate mixtures of packet- and circuit-switched. The NII Band is not intended to be a substitute for other wireless and wired offerings. Rather, it is intended to be a complement to those offerings and its integrity should not be compromised to achieve objectives that are not needed in light of the capabilities of other types of networks.

For the reasons discussed in the preceding section, it is imperative that the Commission play an active role in developing a set of broad objectives designed to assure that the NII Band actually will be used for the purposes that justify its creation. These objectives should be flexible enough to encourage innovation and technological evolution, but not so broad as to allow a variegated mix of incompatible users with mutually exclusive technical, operating, and quality of service characteristics and requirements. This only would duplicate on a larger scale the problems presently associated with traditional Part 15 unlicensed operation.

The FCC need not, however, take the lead in defining on a "micro" level the technical rules governing the NII Band. Instead, it should rely substantially on the expertise of a working group composed of industry experts, such as the Internet Architecture Board ("IAB") and its Internet Engineering Task Force ("IETF"), along with wireless data industry members.

A possible starting point for NII Band rules could be that any transport and service functionality that is consistent with, and successfully conveyed by, today's Internet, should be provided for in the NII Band rules. The converse should also prevail. As the Internet and other elements of the NII develop, the NII Band rules could be evolved as well to keep pace.

As discussed above, it is particularly appropriate to allocate the 5150-5300 MHz band to the NII Band, since this band already has been allocated in most of Europe for HIPERLAN. U.S. users and manufacturers, therefore, will benefit from the opportunities for interoperability, roaming, and increased exports that will flow from an NII Band allocation. Moreover, such an allocation will respond to the desires of our trading partners for a HIPERLAN-type allocation within the United States, which likely will be expressed in international fora including, at WRC-95.[37]

The 5725-5875 MHz also is singularly appropriate as a component of the NII Band. It represents a large contiguous allocation that is not currently heavily used. Moreover, its allocation as part of the NII Band will mesh with -- rather than displace -- most or all existing and planned uses. Thus, by upgrading this band from traditional Part 15 to protected "Part 16" use, the Commission essentially will be able to create a 150 MHz resource capable of supporting the broad range of high-bandwidth services described above.[38]

Finally, these two NII Band segments make an attractive frequency-duplex pair. While computer networks do not often have the luxury of separate fore and back wiring, future developments (including the use of control channels) could open new opportunities for approaching even more closely the "guaranteed" quality of service of circuit-switched networks without sacrificing the equality that is so essential to the NII Band's success.

The 5150-5300 MHz Band is a shared government/non-government band that is not currently heavily used. The frequency range 5000-5250 MHz is allocated to the aeronautical radionavigation service and to the aeronautical mobile-satellite service on a primary basis.[39] In addition, it is allocated to the fixed-satellite service for earth station uplinks when these services are used in conjunction with the aeronautical radionavigation and/or aeronautical mobile service.[40] Finally, a portion of this band (5150-5216 MHz) is also allocated for downlink feeder link transmissions used in conjunction with certain radiodetermination-satellite systems.[41]

The frequency range 5250-5350 is allocated to the radiolocation service on a primary basis for government operations and on a secondary basis for non-government operations; radiolocation stations installed on spacecraft may also be employed for the earth exploration-satellite and space research services on a secondary basis.[42] The band below 5000 MHz is allocated to the radio astronomy service on a primary basis and to space research (passive) operations on a secondary basis.[43]

The 5000-5250 MHz band was intended to be used principally for the operation of an international Microwave Landing Systems ("MLS") and, under the international allocation, the requirements of this system take precedence over other uses of the band.[44] In 1994, however, the United States canceled further development of its MLS system, preferring to concentrate instead on the use of the Global Positioning Satellite ("GPS") system for the next-generation aeronautical navigation system.[45] This decision likely will free up the 5150-5250 MHz band. Even if the United States ultimately decides to use MLS, sharing issues likely can be resolved because European nations also propose to employ MLS and, as a result, MLS-HIPERLAN compatibility will need to be addressed.

In addition, one licensee of a "Big LEO" mobile satellite system, Loral/Qualcomm Partnership, L.P. ("LQP"), has proposed to operate its system feeder (or gateway) uplinks in the 5025-5225 MHz band,[46] and two other MSS applicants have also urged the FCC to make this band available for MSS feeder links.[47]

This use of the band, however, would require a modification to the existing allocation at the upcoming WRC-95. If such use is authorized at WRC-95 and adopted by the Commission, the proposed NII Band could accommodate a limited number of U.S. MSS feeder link stations, such as has been proposed by LQP.

While the NII Band will not replicate exactly the HIPERLAN standard, as discussed above, the two bands will share many elements and will likely have similar sharing characteristics *vis-a-vis* other services, including MSS feeder links. The question of sharing between HIPERLAN and MSS feeder links was considered at the Conference Preparatory Meeting for WRC-95 and WRC-97, which concluded that HIPERLAN could share spectrum with MSS feeder uplinks, although a "quiet zone" around gateway uplink sites likely would be required[48] -- not unlike the approach that will be used to protect radioastronomy locations from unwanted interference from unlicensed Data-PCS devices.

In light of the work that has already been done in this area, and because MSS systems will operate on a global basis and, therefore, sharing between HIPERLAN systems and MSS feeder uplinks will have to be resolved in a mutually acceptable manner, Apple is confident that an acceptable sharing scenario can be developed within the United States. To promote the development of such a sharing approach, Apple urges the Commission to take into consideration an NII Band allocation in developing and promoting the needs of MSS systems at WRC-95 and support efforts to maximize opportunities for operation of both MSS feeder links and NII Band devices within this band.

With respect to radiolocation services being provided in the 5250-5300 MHz band, there is insufficient information publicly available for Apple to determine the extent to which this band is being used and the exact nature of operations in the band. However, Apple believes that the technical rules governing the NII Band can be designed in a manner that will promote sharing opportunities and is hopeful that NII Band technologies could share spectrum with existing and planned users of this band. Moreover, radiolocation services occupy only 50 MHz of the 300 MHz NII Band, which may create further opportunities for successful sharing.

The 5725-5875 MHz band is allocated for use by U.S. military radiolocation services on a primary basis and for use by non-government Amateur operations on a secondary basis.[49] In addition, the band is used for ISM equipment and by Part 15 equipment.[50] The 5850-5875 MHz portion of the band is also allocated to fixed-satellite uplinks on a primary basis, although this use is limited to international inter-continental systems and is subject to case-by case electromagnetic compatibility analysis.[51] The 5830-5850 MHz portion of the band is also allocated for amateur-satellite service downlinks on a secondary basis.[52]

Operations throughout the 5725-5875 MHz band are constrained by the presence of ISM devices and the requirement that radiocommunications services using this band must accept any harmful interference caused by these devices.[53] Because NII Band technologies generally will be a more hospitable "neighbor" than ISM devices (which currently are not subject to power limitations or emission restrictions), the NII Band allocation likely will not adversely affect existing radiolocation or Amateur operations.

The technical rules governing the NII Band will be sufficiently broad to accommodate most, if not all, Part 15 devices deployed in, or currently planned for, this band. The NII Band operating rules will be even more flexible than the Data-PCS etiquette and, therefore, will not require segregation from most or all devices designed in accordance with Sections 15.247 or 15.249 of the Commission's rules. Moreover, Apple anticipates that Part 15 manufacturers will welcome the significant opportunities presented by the NII Band, even if, in a limited number of cases, slight adjustments in products are required. Finally, Part 15 manufacturers will have the opportunity to participate in the development of the NII Band technical rules and, therefore, will have an opportunity to assure that these rules appropriately accommodate existing and planned products.

With respect to ISM use of the band, the NII Band allocation could share spectrum with currently-deployed ISM devices. The question recently has been raised, however, about whether future ISM devices should comply with more restricted emission masks or other protections to assure that their use does not make it impossible or impracticable for the spectrum also to be used for communications purposes.[54] This question merits further consideration, in the context of the NII Band as well as other bands shared by Part 15 and ISM devices.

For the reasons stated herein, Apple requests that the Commission promptly issue a Notice of Proposed Rulemaking proposing the creation of an NII Band and the adoption of technical rules as outlined by Apple. The Commission should proceed expeditiously in order to assure that any decision at WRC-95 regarding MSS feeder links in the 5 GHz band appropriately protects future NII Band operation.

Expeditious action also is required to maximize the opportunities for developing the technical rules and business plans for the 5 GHz and above 40 GHz unlicensed bands harmoniously and in a manner that capitalizes upon each band's unique capabilities. Finally, due to the time it necessarily takes to design, develop, test, and deploy new communications products, it is imperative that the Commission move forward quickly if NII Band products are to take their appropriate place within the overall NII and provide benefits to U.S. consumers, manufacturers, educators, and others in a timely manner.

Respectfully submitted,

APPLE COMPUTER, INC.

/s/ David C. Nagel

David C. Nagel

Senior Vice President,

Worldwide Research and Development

APPLE COMPUTER, INC.

Three Infinite Loop, MS: 303-1DN

Cupertino, California 95014

James F. Lovette

Principal Scientist,

Communications Technology

APPLE COMPUTER, INC.

One Infinite Loop, MS: 301-4J

Cupertino, California 95014

Cupertino, California 95014

(408) 974-1418

jlovette@apple.com

OF COUNSEL

Henry Goldberg

Mary J. Dent

GOLDBERG, GODLES, WIENER & WRIGHT

1229 Nineteenth Street, N.W.

Washington, D.C. 20036

(202) 429-4900

hgoldberg@goldberg.com

James M. Burger

Director of Government Affairs

APPLE COMPUTER, INC.

1667 K Street, N.W., Suite 410

Washington, D.C. 20006

(202) 466-7080

burger@apple.com

May 24, 1995

---

[1] Apple Computer, Inc. 1994 Annual Report (citing statistics of Dataquest).

[2] Id. (citing statistics of Quality Education Data., Inc., "Technology in Public Schools, 1994-95.").

[3] For additional information regarding Apple's role in developing educational applications for computing and communications technologies, see Statement of Cheryl Vedoe, Vice President and General Manager, Education Division, Apple Computer, Inc., before the U.S. Senate Committee on Commerce, Science, and Transportation Hearing on Education and Telecommunications Infrastructure and S. 1822 (May 25, 1994).

[4] See, e.g., First Report and Order and Second Notice of Proposed Rulemaking, ET Docket No. 94-32, 77 Rad. Reg. 2d 314, [[paragraph]] 32 (1995) (Part 15 devices "provide a variety of consumer and business oriented services" that "have the potential to benefit virtually every person and business in the nation, as well as to promote American competitiveness abroad"); Letter to Reed Hundt, Chairman, FCC from Larry Irving, Assistant Secretary, U.S. Dept. of Commerce, ET Docket No. 94-32, ET Docket No. 94-124, PR Docket No. 93-61 (Dec. 12, 1994) ("[s]ome new technologies and applications...may require higher status and greater interference protection in some bands and for certain applications [than traditional Part 15 operation]," and the Commission "should consider designating spectrum for some nonlicensed uses or establishing a new nonlicensed radio service and associated allocations" to "facilitate particular applications that may require a more protected environment"); "Budget Reconciliation Act," House Report No. 103-111 at 253 (describing scope of FCC's auction authority and stating that competitive bidding would not be permitted to be used for unlicensed spectrum).

[5] While the Commission's Data-PCS decisions did not adopt the Part 16 designation, they incorporate the essential attributes of a Part 16 service.

[6] Even the most optimistic forecasts for the NII anticipate a decade or more of slow and uneven growth before high-data-rate infrastructure becomes accessible ubiquitously. With unlicensed spectrum, users can link themselves to the information resources upon which they rely where other advanced broadband connections have not yet been deployed, where they will never be deployed, or where they are unsuited to the communications needs of the user.

[7] For example, some estimates of the cost of hard-wiring classrooms run as high as $250,000 per school. Based upon this estimate, it would cost nearly $30 billion dollars to connect each of America's 118,000 K-12 schools to the NII.

[8] Until recently, the typical fee for attachment to the Internet at 56 kbps in many parts of the country has been approximately $15,000 a year. While competition will drive these rates down, high-speed connections in much of the country will likely remain at high levels for the foreseeable future.

[9] See Notice of Proposed Rulemaking, ET Docket No. 94-124, 9 FCC Rcd 7078, [[paragraph]] 14 (1994) ("some services that would be provided in unlicensed bands may not be optimally provided in licensed bands because they have the characteristics of a public good.").

[10] Letter to Chairman Reed Hundt from Assistant Secretary Larry Irving, *supra* n.4, at 1.

[11] The 10 Mbps data transfer must support not only actual communications traffic, but also requisite network overhead. Moreover, it must be shared by all users in a given location -- whether a small number seeking to transmit at a high rate, a large number generating lighter loads, or a mix of the two.

[12] The FCC's Data-PCS allocation can be likened to one step in the development of the Internet. The original ARPANET connected major research centers nationwide, commonly with leased circuits that conveyed 56 Kbps. It was almost immediately swamped with traffic. Successor NSFNET backbones eventually carried DS-1 rates (1.544 Mbps), and newer networks then developed to support speeds of 45 Mbps, and then of 155 Mbps. Now, high speed connections are becoming widely available, making it possible for businesses, interest groups, schoolchildren (and even adults) readily to establish their own "home page" presence on the World Wide Web.

[13] Notice of Proposed Rulemaking, *supra* n.9.

[14] See, e.g. id. at [[paragraph]][[paragraph]] 1, 4 (until recently, the technology to operate in bands above 40 GHz has been prohibitively expensive and, to date, millimeter wave technology has been limited to military and scientific applications); see also Comments of Hewlett-Packard Co., ET Docket No. 94-124, at 2 (filed Jan. 30, 1995) (mm wave technology has advanced to a point where commercial applications may be feasible, but the actual development of products capable of operating in these bands will not (and can not) occur until regulators provide the protection and stability required to justify the substantial product development expenditures required).

[15] Metricom argued that the development of technologies for the unlicensed mm wave bands could be especially difficult due to the Commission's proposed allocation of the 59-64 GHz band -- a band with poor propagation characteristics -- for unlicensed services. Comments of Metricom, Inc., ET Docket No. 94-124, at 3 (filed Jan. 30, 1995).

[16] See, e.g. Notice of Proposed Rulemaking, *supra* n.9, at [[paragraph]] 8.

[17] See id. at [[paragraph]][[paragraph]] 35-36, 37-40, 41-42.

[18] See, e.g., Comments of Metricom, Inc., *supra* n.15, at 4 (the development of technical rules for the mm wave bands will be especially difficult due to the number of "unknowns" about operations in the bands).

[19] By considering allocations and operating rules for the 5 GHz NII Band at the same time it considers allocations and operating rules for the mm wave bands, the Commission and industry will be able to write standards that take advantage of each band's unique capabilities and limitations.

[20] The actual data transfer rates experienced by any individual user that could be supported by a 300 MHz NII Band will depend on the technical rules governing operation, the design of particular devices, and the radio environment. The example of 24 Mbps is based upon efforts by the HIPERLAN community to address multipath propagation conditions and their conclusion that, with sufficient signal processing and other measures, an indoor data communications path could deliver upwards of 24 Mbps raw data rate. At this juncture, such performance has not been demonstrated using market-ready hardware, but experiments and simulations have been successful.

[21] "Making Government Work: Electronic Delivery of Federal Services," OTA-TCT-578, at 40 (Sept. 1993). One CD can contain 5 billion bits, the equivalent of an encyclopedia.

[22] Many European countries have allocated the entire 150 MHz band, although some have allocated only 100 MHz.

[23] Data-PCS devices are allowed a power output proportional to their bandwidth. See 47 C.F.R. [[section]][[section]]15.319(c)-(e). Peak transmit power is limited to 100 microwatts multiplied by the square root of the emission bandwidth in hertz. For example, a 1 MHz signal would be allowed 100 mW, and a 10 MHz signal 316 mW output.

[24] As discussed above, it is not yet clear the distances over which mm wave band devices will be capable of communicating. Traditional Part 15 devices, as a general rule, are distance limited due to the restriction on the use of highly directional antennas. See 47 C.F.R. [[section]]15.247 and [[section]]15.203. Certain manufacturers have increased communications distances by incorporating relatively high-cost technologies, and others have obtained waivers or were grandfathered under prior regulations that did not limit antenna gain. While these solutions may be viable for some users, their price may place them beyond the reach of other users, including, in particular, low income individuals, government agencies, and schools and libraries.

[25] Low cost, mass-market unlicensed 5 GHz data links should cost in same range as, and be as readily installed by consumers as, the recently-introduced 18" satellite TV receivers. The cost of commercial microwave links runs to the tens or hundreds of thousands of dollars, albeit that these latter devices are orders of magnitude more robust.

[26] NTIA has funded some of these community network extensions; several national-level foundations including the Marino Institute, the Benton Foundation, the Rockefeller Foundation, to name but a few, support deployment; and the National Public Telecomputing Network promotes the establishment of "Free-Nets" around the country (with such networks now operating in more than 100 communities). Many states, including Maryland, North Carolina, and Iowa, have aggressive networking projects, while private non-profit organizations such as the Community Networking Institute based in Kearney, Nebraska leverage modest local assets into powerful public resources.

[27] See, e.g., Presentation of Chairman Reed E. Hundt before the 1994 National Urban League Conference (July 26, 1994) (discussing the benefits computers provide in improving learning capacity, educational performance, and self esteem, and discussing opportunities for using the communications revolution to revolutionize education).

[28] Sources for these figures include the Department of Education, "Advanced Telecommunications in U.S. Public Schools, K-12," FCES 95-731, February, 1995; Office of Technology Assessment, Congress of the United States, "Teachers and Technology--Making the Connection," OTA-EHR-616 (Apr. 1995); U.S. Department of Education, "Connecting K-12 Schools to the NII: A Preliminary Assessment of Technology Models and their Associated Costs," Working Paper, Russell I. Rothstein (Aug. 4, 1994). While different estimates do not agree precisely, they do not disagree in material substance.

[29] "Realizing the Information Future: The Internet and Beyond." National Research Council, National Academy Press, Washington: 1994 at 11-12.

[30] Department of Education, "Advanced Telecommunications in U.S. Public Schools, K-12," FCES 95-731, at 21 (Feb. 1995.).

[31] Id. at 126.

[32] The mm waves will not pass so readily through walls as will the 5 GHz NII Band signals.

[33] "Realizing the Information Future," *supra* n.29, at 139.

[34] Dr. Janet K. Poley, President of A*DEC, a consortium of land grant colleges and universities developing learning opportunities using technology, University of Nebraska-Lincoln, in "Ties That Bind: Rural Issues of Converging Communities." Proceedings of the [Ties That Bind] Conference sponsored by Apple Computer and the Morino Institute, May 2-5, 1995.

[35] It has become common to refer to any set of channel access rules as an "etiquette." The term originally was applied to rules or procedures whereby dissimilar communications devices could defer to one another without any exchange of information, with a goal of minimizing interference. The term does not itself imply

interoperation or signal-handling compatibility, and it would be premature to describe the NII Band rules as an "etiquette."

[36] In packet-based transmissions, information is divided into discreet small pieces, or "packets," each of which is sent whenever a "channel" is free, using whatever route is available at that time. Thus, transmitting devices occupy a "channel" only for the very brief time it takes to send an individual packet. In contrast, on conventional telephony and other circuit-switched networks, once a circuit is established a user can stay connected indefinitely -- in essence, circuits become the "property" of the first user in line, for as long as they want them. This can deprive other, later-starting circuit-dependent operations of access and can preclude any access at all for, or interrupt the transmission of, packets of data. The result is an inevitable inequity whenever the two functions are forced to share spectrum: connection-based circuits guaranteeing a high quality of service will consume the bandwidth they need, and packet data must accept whatever bandwidth, if any, is left over.

The WINForum organization spent many person-years attempting to create an "etiquette" pursuant to which isochronous (voice-like) and asynchronous (packet data-like) transmissions could share the unlicensed PCS band. Ultimately, WINForum proposed, and the Commission adopted, completely separate frequency bands, with totally different channel access and usage rules, for the two functions.

[37] Questions concerning the HIPERLAN band are likely to arise at WRC-95 in light of the proposed use of an overlapping band for MSS feeder links.

[38] As noted previously, the "5800 MHz " band has slightly different frequency boundaries for operation under Sections 15.247 and 15.249. The allocation for Section 15.247 should be expanded to match that of Section 15.249, as well as the NII Band allocation.

[39] 47 C.F.R. [[section]] 2.106 and n. 733.

[40] Id. n.797.

[41] Id nn.797A and US307.

[42] Id. and n.713; for certain additional restrictions on operation within this band, see nn.US110 and G59.

[43] 47 C.F.R. [[section]] 2.106.

[44] Id. n.796.

[45] See, e.g., "FAA Cancels MLS in Favor of GPS," Aviation Week and Space Technology, Vol. 140, No. 24, at 33.

[46] Application of Loral/Qualcomm Partnership, L.P., Order and Authorization, DA 95-128, [[paragraph]] 15 (released Jan. 31, 1995).

[47] E.g., Memorandum Opinion and Order, ET Docket No. 92-28, FCC 95-70, [[paragraph]] 14 (Mar. 20, 1995).

[48] Conference Preparatory Meeting for WRC-95 and WRC-97, Document CPM95/118-E, at (Apr. 4, 1995) ("[i]t has been concluded that sharing between non-GSO/MSS feeder links and HIPERLANs is feasible in the uplink direction provided feeder link earth stations are separated on the order of 3 to 10 km from indoor HIPERLANs and 16 to 50 km for outdoor HIPERLANs.... This distance can be further reduced by taking into account local shielding.").

[49] 47 C.F.R. [[section]] 2.106 and n.G2.

[50] 47 C.F.R. [[section]] 2.106.

[51] Id. and n.US245.

[52] 47 C.F.R. [[section]] 2.106 and n.808.

[53] Id. n.806.

[54] Letter to Mr. Richard Smith, Chief, Office of Engineering and Technology, FCC, from Richard D. Parlow, Associate Administrator, NTIA (dated Apr. 12, 1995).