

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

In the Matter of)	
)	
Amendment of Part 15 of the Commission's Rules)	
Regarding Spread Spectrum Devices)	ET Docket No. 99-231
)	
Wi-LAN, Inc)	DA 00-2317
Application for Certification of an Intentional)	
Radiator Under Part 15 of The Commission's)	
Rules)	

FURTHER NOTICE OF PROPOSED RULE MAKING AND ORDER

Adopted: May 10, 2001

Released: May 11, 2001

Comment Date: [75 days after publication in the Federal Register]

Reply Comment Date: [105 days after publication in the Federal Register]

By the Commission:

INTRODUCTION

1. By this action, we propose to amend Part 15 of the Commission's rules to improve spectrum sharing by unlicensed devices operating in the 2.4 GHz band (2400 - 2483.5 MHz), provide for introduction of new digital transmission technologies, and eliminate unnecessary regulations for spread spectrum systems. Specifically, this Further Notice proposes to revise the rules for frequency hopping spread spectrum systems operating in the 2.4 GHz band to reduce the amount of spectrum that must be used with certain types of operation, and to allow new digital transmission technologies to operate pursuant to the same rules as spread spectrum systems. It also proposes to eliminate the processing gain requirement for direct sequence spread spectrum systems, which will provide manufacturers with increased flexibility and regulatory certainty in the design of their products. We take these actions to facilitate the continued development and deployment of new wireless devices for businesses and consumers.

2. We also find that our Office of Engineering and Technology (OET) acted properly in denying an application for equipment certification filed by Wi-LAN, Inc. ("Wi-LAN") under the current spread spectrum rules for a system using wideband orthogonal frequency division multiplexing modulation (W-OFDM).¹ We agree with the staff's finding that this technology does not qualify for operation under the current spread spectrum rules. We will, however, grant an interim waiver to allow Wi-LAN's equipment and similar devices from other manufacturers to be certificated at reduced power levels during the pendency of this rule making. We note that the proposals we are making in this Further Notice, if

¹ FCC ID:K4BAP01

adopted, would accommodate devices such as Wi-LAN's.

BACKGROUND

3. Part 15 of the FCC's rules provides for the operation of unlicensed devices. As a general condition of operation, Part 15 devices may not cause any harmful interference to authorized services and must accept any interference that may be received.² In addition, all services and devices operating in the 915 MHz (902 - 928 MHz), 2.4 GHz, and 5.7 GHz (5725 - 5850 MHz) bands must accept any interference received from industrial, scientific and medical equipment. Section 15.247 contains rules governing the operation of spread spectrum devices in the 915 MHz, 2.4 GHz, and 5.7 GHz bands.³ Operation under these rules is limited to frequency hopping and direct sequence spread spectrum systems. In frequency hopping systems, an information signal, usually a data stream, modulates a radio frequency carrier that is hopped among a number of frequencies in concert with a receiver. In direct sequence systems, the information data stream is combined with a high speed digital spreading code that is used to modulate a radio carrier, producing a radio signal that has a bandwidth covering anywhere from 1 to 100 megahertz. Both frequency hopping and direct sequence systems are permitted to use output powers of up to 1 watt in the above bands, however, most devices use lower power for various design reasons, such as conserving battery life. Spread spectrum modulation reduces the power density of the transmitted signal at any frequency, thereby reducing the possibility of causing interference to other signals occupying the same spectrum. Similarly, at the receiver end, the power density of interfering signals is minimized, making spread spectrum systems relatively immune to interference from outside sources.

4. The original *Notice of Proposed Rule Making* ("*Notice*") in this proceeding, which was initiated in response to a request from the Home RF working group, proposed to amend the rules to allow frequency hopping spread spectrum systems operating in the 2.4 GHz band to use hopping channel bandwidths wider than 1 MHz.⁴ The *Notice* also proposed to adopt a new method for determining compliance with the requirement that direct sequence systems exhibit a minimum of 10 dB processing gain. The *First Report and Order* ("*First R&O*") in this proceeding amended the spread spectrum rules to allow frequency hopping spread spectrum transmitters in the 2.4 GHz band to use bandwidths between 1 MHz and 5 MHz at a reduced power output of up to 125 mW.⁵ Frequency hopping systems with a bandwidth of up to 1 MHz are required to use at least 75 non-overlapping hopping frequencies. Use of 75 hopping frequencies is generally not feasible for systems having a bandwidth in excess of 1 MHz because the 2.4 GHz band, which covers 2400-2483.5 MHz, provides only 83.5 megahertz of spectrum. Accordingly, the rules were amended to permit systems using a bandwidth greater than 1 MHz but less than or equal to 5 MHz to use as few as 15 non-overlapping channels provided that the total span of hopping channels be at least 75 MHz.⁶ Therefore, while a system using 5 MHz hopping channel bandwidths is permitted to use as

² 47 C.F.R. § 15.5.

³ 47 C.F.R. § 15.247

⁴ *Notice of Proposed Rule Making*, ET Docket 99-231, 14 FCC Rcd 13046 (1999).

⁵ *First Report and Order* in ET Docket 99-231, 15 FCC Rcd 16244 (2000).

⁶ Manufacturers typically avoid operation near 2483.5 MHz in order to meet restrictions on out-of-band emissions to protect mobile satellite service operations in the upper adjacent spectrum. Therefore, frequency hopping systems that employ a bandwidth of 5 MHz generally could not use more than 15 hopping frequencies without repeating operation in the same spectrum. The requirement to hop over a minimum number of channels ensures that the transmissions are spread over a wide range of frequencies to reduce the risk of interference to other systems.

few as 15 hopping frequencies, one using 3 MHz hopping channel bandwidths must use at least 25 hopping frequencies to comply with the rules. In the *First R&O*, the Commission stated that it would address the processing gain issue in a future Report and Order.⁷

5. Thirteen parties ("Petitioners") filed a Joint Petition for Clarification or, in the Alternative, Partial Reconsideration ("Joint Petition") of the *First R&O*.⁸ The Petitioners request that the rules be clarified to allow frequency hopping systems in the 2.4 GHz band with bandwidths of 1 MHz or less to use as few as 15 hopping channels. The petitioners state that such operations should be subject to an output power limit of 125 mW and should be required to use adaptive hopping techniques to avoid operating on occupied frequencies.

6. We observe that there have been several other recent developments relevant to the spread spectrum rules. One such development is the Wi-LAN application for certification of a W-OFDM system under the spread spectrum rules as discussed further below. Another is a recent announcement by Texas Instruments that it plans to introduce a new high data rate, digital transmission system called packet binary convolutional coding ("PBCC") for operation in the 2.4 GHz band under the spread spectrum rules. While Texas Instruments claims that this technology will meet the current rules, at this juncture compliance has not been demonstrated. We are also aware that the IEEE Working Group 802.11 is in the process of developing standards for a new generation of wireless networks capable of operating at data speeds of at least 20 MB/s.⁹ There has been much debate within this standards group centered on whether certain technologies meet the FCC's spread spectrum rules.

DISCUSSION

7. The Commission's spread spectrum rules have been a tremendous success. A wide variety of devices have been introduced under these rules for business and consumer use including cordless telephones and computer local area networks. Moreover, the past few years have witnessed the development of industry standards, such as IEEE 802.11b, Bluetooth, and Home RF, that promise to greatly expand the number and variety of devices that will operate in the 2.4GHz band. We anticipate the introduction of wireless headsets and computer connections for cellular and PCS phones, wireless computer peripherals such as printers and keyboards, and a host of new wireless Internet appliances that will use this band as well as the other bands that provide for unlicensed operation.

8. Since the time the spread spectrum rules were first introduced some 15 years ago, the Commission has amended the rules several times to accommodate technology developments and promote new and innovative use of the 915 MHz, 2.4 GHz, and 5.7 GHz bands.¹⁰ Over the years, the data rates achievable by spread spectrum devices have increased from a few kilobits per second to 20 megabits per

⁷ *First Report and Order* in ET Docket 99-231, *supra* at footnote 1.

⁸ *Joint Petition For Clarification or, in the Alternative, Partial Reconsideration*, submitted on October 25, 2000, by 3Comm, Apple Computer, Cisco Systems, Dell Computer, IBM, Intel Corporation, Intersil, Lucent Technologies, Microsoft, Nokia Inc., Silicon Wave, Toshiba America Information Systems, and Texas Instruments.

⁹ The IEEE (Institute of Electrical and Electronics Engineers) is a non-profit technical professional organization. Among other activities, the organization develops operating standards for communication equipment. The IEEE 802.11 Working Group, in particular, develops standards for wireless local area networking devices.

¹⁰ *First Report and Order, GEN Docket 81-413*, 1 FCC 2nd 419 (1985), 58 RR 2nd 251 (1985).

second, and more. These high data rates were not envisioned when the rules were first drafted. In fact, the original rules were crafted in a manner to highlight the interference immunity characteristics of spread spectrum devices, even at the expense of higher speeds. It appears that our current rules may unnecessarily restrict system designs that could otherwise achieve data rates of more than 20 megabits per second.

9. The Commission initiated this proceeding to provide for the continued development of spread spectrum technology. In light of the Joint Petition and other recent technology developments, we are initiating this Further Notice to relax or eliminate rules that impede efficient use of the spectrum and introduction of new technologies. Specifically, we propose to further relax the frequency hopping spread spectrum rules as requested in the Joint Petition. We also propose to amend the rules to accommodate new digital transmission systems that have spectrum characteristics similar to spread spectrum systems. In addition, we propose to eliminate the processing gain requirement for direct sequence spread spectrum systems. Finally, in conjunction with our analysis of these proposals, we address Wi-LAN's Application for Review of OET's denial of its application for equipment certification.

10. **Frequency Hopping Spread Spectrum Systems.** Petitioners argue that frequency hopping spread spectrum systems in the 2.4 GHz band that have a bandwidth of 1 MHz or less should be permitted to use as few as 15 hops as was permitted for systems having a bandwidth greater than 1 MHz. They also argue that the requirement that the total span of hopping channels shall be 75 MHz should not be applied to systems using bandwidths of 1 MHz or less. They state that the current requirements exacerbate interference because they effectively compel multiple systems to operate to a large extent in the same spectrum. Further, they submit that the requirements effectively negate the opportunity for frequency hopping systems to use adaptive hopping techniques as allowed in Section 15.247(h) because there is only 83.5 MHz of spectrum available in the 2.4 GHz band. Accordingly, petitioners request that the Commission clarify the rules adopted in the *First R&O* to specify a minimum of 15 hopping channels for any system that uses adaptive hopping techniques as allowed under Section 15.247(h) and limits its output power to 125 mW, regardless of hopping channel bandwidth. Similar to the rules adopted in the *First R&O*, the request would require systems with 5 MHz hopping channel bandwidths to use at least 75 MHz of spectrum. However, systems with smaller bandwidths will be able to use less spectrum.

11. Petitioners refer to the results of studies which they assert show that facilitating use of adaptive hopping techniques in the 2.4 GHz band would help to ameliorate interference by allowing frequency hopping systems to avoid transmitting on frequencies used by direct sequence systems that may be operating at the same location or nearby.¹¹ Petitioners state that interference avoidance is beneficial to both frequency hopping and direct sequence systems. They note that the Commission has previously determined that adaptive hopping techniques can be used to mitigate interference. For example, in the 915 MHz band (902 - 928 MHz), the rules permit frequency hopping spread spectrum systems to employ a minimum number of hopping channels with bandwidths narrow enough, in comparison to the available bandwidth, to allow the systems to adapt their hopsets to avoid other users.¹²

¹¹ Joint Petition at 3. Copies of these studies were not submitted with the Joint Petition. If Petitioners wish for the Commission to consider these studies in the context of this proceeding, they should submit copies for inclusion in the docket of this proceeding.

¹² See 47 C.F.R. § 15.247(a)(1)(i). Frequency hopping systems in the 902-928 MHz band that use hopping channels at least 250 kHz wide are permitted to use as few as 25 channels. A system operating in this fashion would be able to use as little as 6.25 MHz of the available 26 MHz, allowing it to avoid occupied portions of the spectrum.

12. We agree with comments filed by Proxim Inc. ("Proxim) and Mobilian Corporation that the relief requested by the Petitioners cannot be afforded on the basis of a clarification or reconsideration. Although the request was proposed in an *ex parte* filing shortly before the *First R&O* was adopted, we do not believe there has been an adequate notice and comment on this proposal. We note that there are a very large number of users of the 2.4 GHz spectrum, including Amateur radio operators and fixed and mobile operations, that could be effected by this rule change and may not be aware it is being considered because it was not proposed in the *Notice*.¹³ We do, however, believe that the petitioners' request has merit and therefore will consider it pursuant to this Further Notice.

13. Accordingly, we propose to amend Section 15.247 by incorporating the changes proposed in the Joint Petition. The proposed rule modification is shown in Appendix B, Section 15.247(a)(1)(iii). Specifically, we propose to allow use of as few as 15 hops, as provided by our current rules, irrespective of the bandwidth utilized, provided that the output power does not exceed 125 mW and the device uses adaptive hopping techniques, as proposed in the Joint Petition. Interested parties are invited to comment on the acceptability of this proposal. Commenters are encouraged to include technical analyses that support claims that this change will either improve or degrade sharing of this spectrum. We particularly invite comment as to whether use of adaptive hopping techniques should be mandatory and how we should determine compliance with this requirement when evaluating specific devices for purposes of equipment certification. Commenters are also encouraged to examine alternative operating parameters or conditions that may achieve the same goals. For example, the operating conditions in the Joint Petition would allow a system using 1 MHz bandwidth hopping channels to use as little as 18% of the available spectrum at 2.4 GHz to implement adaptive hopping techniques. Could the Commission realize the goals of the petitioners by requiring that adaptive hopping systems use a minimum of 25% or 50% of the band with a power reduction in relationship to amount of spectrum used? Could even fewer hops be used efficiently and effectively with a corresponding reduction in power? Those commenters who do not agree that the rule changes would be beneficial to operation in the 2.4 GHz band should provide an explanation.

14. We are not proposing to reduce the minimum number of hopping channels required for frequency hopping spread spectrum systems in the 915 MHz or 5.7 GHz bands. We note that the Commission has previously reduced the required minimum number of hopping channels in the 915 MHz band from 50 to 25.¹⁴ The Commission indicated that the modified rules would facilitate improved sharing of the band.¹⁵ With regard to the 5.7 GHz band, 125 MHz of spectrum is available to accommodate the required 75 hopping channels. Therefore, there are generally a sufficient number of frequencies available to avoid interfering with other users. We invite comment on the on whether it is appropriate to consider modifications to the minimum number of hopping channels for these bands.

¹³ See the Table of Frequency Allocations, 47 C.F.R § 2.106. The 2400-2402 MHz band is allocated to the Amateur service on a secondary basis; the 2402-2417 MHz band is allocated to the Amateur service on a primary basis; the 2417-2450MHz band is allocated on a secondary basis to the Amateur service and on a secondary basis to the federal government for the Radiolocation service; and, the 2450-2483.5 MHz band is allocated to the Fixed and Mobile services on a primary basis and to the Radiolocation service on a secondary basis. Part 15 devices may not cause any harmful interference to these services and must accept any interference that may be received. See 47 C.F.R § 15.5. In addition, all services and devices operating in the 2400-2483.5 MHz band must accept any interference received from industrial, scientific and medical equipment.

¹⁴ See *Report and Order* in ET Docket 96-8, 12 FCC Rcd 7488 (1997).

¹⁵ *Id* at paragraph 27.

15. **Digital Transmission Systems.** We observe that new digital transmission technologies have been developed that have spectrum characteristics similar to spread spectrum systems. Indeed, proponents of some of these technologies allege that their systems meet the processing gain requirement of Section 15.247(e) for direct sequence spread spectrum systems.¹⁶ The Wi-LAN device is one example. Other examples include the technology advanced by Texas Instruments and technologies considered by standards organizations such as IEEE 802.11. However, the current rules only provide for specific types of spread spectrum technology and do not provide latitude to permit other types of technologies that have similar spectrum characteristics.¹⁷ This situation not only has the potential to block the introduction of new and perhaps beneficial technologies, but also can create confusion as to whether a particular device may meet the rules and thereby can discourage investment and potentially lead to inequities in competition among equipment manufacturers. In comments responding to Wi-LAN's Application for Review, Intersil Corporation ("Intersil") contends that the Commission should draft an alternate set of rules to authorize digitally modulated equipment operating in the 2.4 GHz band.¹⁸ Intersil states that the rules could specify a suitable power level and power spectral density that would ensure that the devices not cause harmful interference to other users in the band.

16. We agree that the rules should be modified to permit the operation of alternative digital technologies that have spectrum characteristics similar to spread spectrum systems. We do not believe that it is necessary to adopt a separate rule section for digitally modulated radios as Intersil suggests. Instead, it appears that alternative digital technologies can be accommodated with appropriate modifications to the existing spread spectrum rules in Section 15.247. Specifically, we propose to amend Section 15.247 to provide for use of spread spectrum or digital technologies. This proposed change would apply for operations in the current spread spectrum bands at 915 MHz, 2.4 GHz and 5.7 GHz. Digital technologies would be required to meet the same technical requirements as spread spectrum systems, as modified in this proceeding. We believe that this proposal will allow more and more diverse products to utilize those bands and thereby increase consumer choice. It would provide the flexibility and certainty needed to promote the introduction of new, non-interfering products into the band, without the need for frequent rule changes to address each specific new technology that may be developed.

17. The rules for Part 15 spread spectrum systems limit maximum peak output power to 1 watt. In addition, the rules for direct sequence systems limit peak power spectral density conducted to the antenna to 8 dBm in any 3 kHz band during any time interval of continuous operation. This peak power density limit is intended to control interference by ensuring that the transmitted energy in a direct sequence system is not concentrated in any one portion of the emission bandwidth. In considering the appropriate power limits for digital modulation systems, it appears that the spectrum characteristics of these systems are very similar to the characteristics of direct sequence spread spectrum systems. Accordingly, it appears that digital systems may exhibit no more potential to cause interference to other devices than direct sequence systems. With this in mind, we invite comment on whether digitally modulated systems should be allowed to operate at the same power levels as direct sequence spread spectrum systems, namely 1 watt maximum output power with power spectral density not exceeding 8 dBm in any 3 kHz band. However, we also invite comment as to whether the flexibility we are allowing for digitally modulated systems warrants a reduction in permitted power levels to reduce the likelihood of any adverse impact on other systems operating in this spectrum, similar to the reduced power levels adopted for wide-band frequency

¹⁶ 47 C.F.R. § 15.247(e).

¹⁷ See 47 C.F.R. § 15.247(a).

¹⁸ *Reply Comments of Intersil Corporation*, in DA 00-2317, November 30, 2000.

hopping systems.¹⁹ If we find it necessary to reduce the allowed power for digitally modulated systems, should we make any changes in the power level adjustments for point-to-point operation in Section 15.247(b)(3)?²⁰

18. The proposals made herein would more closely align the Section 15.247 rules with the U-NII rules. We seek comment on whether the same result would be achieved by amending the U-NII rules to include the 915 MHz and 2.4 GHz bands. The upper limit of the 5.725 - 5.825 GHz U-NII band would also need to be expanded to 5.850 GHz in order to realign the standards with those presently permitted under Section 15.247. We specifically invite comment on any detrimental impact this could have on manufacturers.

19. **Direct Sequence Processing Gain.** The rules currently require direct sequence systems to have a processing gain of at least 10 dB.²¹ Processing gain may be determined using the "CW (continuous wave) jamming margin test" by stepping a signal generator in 50 kHz increments across the system passband. The jamming level required to produce the recommended Bit Error Rate (BER) and the system output power are recorded at each point. The "jammer to signal" ratio is then calculated from these measurements. Processing gain is calculated as: $G_p = (S/N)_o + M_j + L_{sys}$, where G_p =processing gain of the system, $(S/N)_o$ = signal to noise ratio required for the chosen BER, M_j = jammer to signal ratio, and L_{sys} = system losses (not more than 2 dB.)

20. In the *Notice*, the Commission observed that the CW jamming margin test may not measure the true processing gain for certain types of direct sequence spread spectrum systems where a portion of the information signal is embedded in the spreading code. The Commission proposed to instead require use of a Gaussian noise signal in the jamming margin test. It stated that a Gaussian interferer is likely to give a more accurate measure of processing gain because it is more closely related to the noise a system would encounter in a real-world environment.²²

21. In response to the *Notice*, commenters identified a number of questions that would need to be answered before the Commission could allow the use of a Gaussian interferer in the jamming margin test set-up. Particularly, commenters questioned how the Gaussian noise interferer should be generated, what bandwidth should be used, and how will the test be performed.²³ Similarly, in its comments in the matter of Wi-LAN's Application for Review, Intersil contends that the diversity of opinion within the industry as to the definition of processing gain makes it difficult to develop a test to measure the parameter. Intersil also states that, while the Gaussian noise test may be easier to implement, it may not give a true indication of whether the system actually has 10 dB of processing gain.²⁴ Home Wireless Networks suggests that the processing gain requirement is no longer necessary and that the Commission should only address the emissions characteristics of such devices.

¹⁹ See *First R&O* at paragraph 15.

²⁰ See 47 C.F.R. § 15.247(b)(3).

²¹ See 47 C.F.R §15.247(e).

²² See *Notice* at paragraphs 13-14.

²³ See, generally, Lucent Technologies, Inc. comments; Aironet Wireless Communications, Inc. comments; Proxim, Inc. and Micrilor, Inc. reply comments.

²⁴ See *Reply Comments of Intersil Corporation* in DA 00-2317, November 30, 2000, at 5.

22. The processing gain requirement was adopted more than ten years ago as a means to ensure that manufacturers would not take advantage of the higher power levels afforded spread spectrum devices by designing systems with wide bandwidths where much of the energy transmitted is not needed for communication. As the spread spectrum industry has matured it is not clear that this requirement continues to be necessary. Manufacturers have an incentive to design their systems to include processing gain in order for their devices to operate properly when located near other radio frequency devices. In addition, it has become increasingly difficult to determine the true processing gain of certain direct sequence spread spectrum systems. The comments filed in response to the Notice suggest there is no agreement on a reliable method of measuring processing gain. We observe that uncertainties about the processing gain requirement can be a significant impediment to the introduction of new technologies. In light of these factors, we are now proposing to eliminate the processing gain requirement for direct sequence spread spectrum systems. We invite comment on this proposal.

23. **Wi-LAN Application for Review.** On February 17, 2000, Wi-LAN filed an application for equipment certification for its Wideband Orthogonal Frequency Division Multiplexing (W-OFDM) transmitter under the rules for direct sequence spread spectrum systems. The Commission's Office of Engineering and Technology ("OET") denied that application on the basis that Wi-LAN's W-OFDM device did not meet the definition of a direct sequence spread spectrum system as set forth in Section 2.1 of the rules.²⁵ Section 2.1 of our rules defines a spread spectrum system as, "[A]n information bearing communications system in which . . . the bandwidth is deliberately widened by means of a spreading function over that which would be needed to transmit the information alone."²⁶ As stated above, Section 2.1 provides for only two specific types of spread spectrum systems: direct sequence and frequency hopping. Section 2.1 defines a direct sequence systems as, "[A] spread spectrum system in which the carrier has been modulated by a high speed spreading code and an information data stream. The high speed code sequence dominates the "modulating function" and is the direct cause of the wide spreading of the transmitted signal." OET found that the Wi-LAN device does not meet this definition because it, among other things, does not use a high speed spreading code to modulate a single radiofrequency (RF) carrier and, further, the spreading function that is used does not dominate the modulation function. It therefore denied Wi-LAN's application for certification on the basis that the W-OFDM device could not be authorized as a direct sequence spread spectrum system. Subsequently, OET denied Wi-LAN's Petition for Reconsideration of that decision for the same reasons.²⁷

24. Wi-LAN has filed an Application for Review of the staff action.²⁸ In this filing, Wi-LAN argues that its device meets all the technical requirements explicitly stated in the rules for direct sequence spread spectrum systems and should be granted certification. Wi-LAN states that its W-OFDM system accomplishes the spreading function required by the spread spectrum definition through the addition of forward error correction codes and the use of an Inverse Fast Fourier Transform (IFFT) sequence. It contends that this transform function is closely analogous to the high speed spreading code used in other

²⁵ See letter from Joe Dichoso to Wi-LAN, Inc. regarding application for FCC ID: K4BAP01, May 12, 2000. See also, 47 C.F.R. § 2.1.

²⁶ 47 C.F.R. §2.1(c).

²⁷ Letter from Dale N. Hatfield, Chief of the Office of Engineering and Technology, to Mitchell Lazarus, August 18, 2000.

²⁸ *Application for Review*, September 20, 2000. The Commission gave public notice of receipt of the *Application for Review*. See DA 00-2317, October 17, 2000.

direct sequence systems. Wi-LAN argues that this transform function widens the occupied bandwidth from 6.875 MHz to 25 MHz, or a factor of 3.6, over that needed for the digital information alone, and that this meets the spreading requirement in the rules. It does not provide data on the processing gain of its system. Wi-LAN further contends that OET's assertion that it has turned down similar requests from others is not supported by any specific references, and in any event may not be used for denial of certification for a device that meets the letter and intent of the rules. In an Opposition to the Application for Review, Proxim does not raise substantive objections to the propriety of the technology proposed, but argues that Wi-LAN's technology is not permitted under the current rules and must be addressed through rule making. In comments and replies, Cisco Systems, Inc., Metricom, Inc., and Intersil support Wi-LAN's application.

25. Initially, we find that OET acted properly in denying Wi-LAN's application for certification. In this regard, we agree with OET that Wi-LAN's W-OFDM device does not meet the definition of a direct sequence spread spectrum system as set forth in Section 2.1 of the rules. As OET observes, this device does not use a high speed data code to accomplish wide spreading of the transmitted signal. Rather, it adds forward error correction data to widen the bandwidth, and it does so by only a relatively modest amount, *i.e.*, 12.5 MHz or a factor of 1.8, over that necessary to transmit the information alone. The additional spreading to 25 MHz is a product of the modulation process that does not add to the system's processing gain. This does not comport with the requirements that the high speed code sequence dominate the modulating function or that it is the direct cause of the wide spreading of the transmitted signal. Wi-LAN's argument that the Commission has previously accepted transforms as spreading functions when it certified the Fast Walsh transform used in 11 Mbps Complementary Code Keying (CCK) systems is incorrect. The approval of that system was based on the fact that, while it did incorporate a transform, it also used a high speed spreading code and therefore could be characterized as a direct sequence spread spectrum systems. We reiterate that, as indicated above, operation under the Part 15 spectrum rules is limited to frequency hopping and direct sequence systems. The Wi-LAN system is neither of these types but rather is a digital modulation system, as discussed above, that resembles a spread spectrum system only in its spectrum characteristics.

26. Notwithstanding our finding that Wi-LAN's W-OFDM system is not a spread spectrum system as defined in our rules, we find that it will serve the public interest to allow grant of equipment certification now for this system and similar systems that operate in the 2.4-2.483 GHz band if they meet the existing rules for direct sequence spread spectrum systems in Sections 15.247(a), (b), (c), and (d), conditioned on their compliance with any final rules that may be adopted in this proceeding.²⁹ Accordingly, the Commission will waive, on an interim basis, the restriction of Section 15.247(a) that limits operation pursuant to the remaining portions of Section 15.247 to frequency hopping and direct sequence spread spectrum systems.³⁰ We find that there is good cause to waive the cited rule during the pendency of this proceeding because such devices have generally the same emission mask as currently authorized devices and thus will not undermine the existing rules. Digital modulation systems closely resemble spread spectrum systems in terms of their spectrum occupancy characteristics, and therefore are not likely to pose any increased risk of interference over that posed by spread spectrum systems. We believe that compliance with the rules listed above, which address spectrum occupancy, power, out-of-band emissions, and antennas, will ensure that digital modulation systems operating in the 2.4 GHz band will operate with the same spectrum occupancy characteristics as spread spectrum systems. We also observe that such systems

²⁹ See 47 C.F.R. §§15.257(a), (b), (c), and (d).

³⁰ 47 C.F.R. §1.3 grants the Commission authority to waive any provision of its rules provided good cause is demonstrated. See also *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969).

appear to offer capabilities in terms of broadband data transmission capacity that are likely to make them more desirable than traditional spread spectrum systems for many users. Allowing authorization of digital modulation systems now will avoid the delays otherwise imposed by our rulemaking process and thereby substantially speed the process for implementation of these new system designs. In this regard, our decision to waive the restrictions which prevent authorization of such systems reflects our view that it is appropriate and desirable to take steps wherever possible to facilitate the timely and efficient introduction of new technologies and equipment, and particularly those that will support the development and deployment of broadband infrastructure without threat to incumbent operations and devices. For the reasons indicated above, we believe that authorization of Wi-LAN's device and other digital modulation systems prior to our adoption of final rules will not result harm to other radio operations. Consistent with Wi-LAN's application for equipment certification, we will require that any devices granted prior to the adoption of new rules pursuant to the provisions of this paragraph comply with a maximum peak output power limit of 100 mW. In addition, any devices so conditionally authorized will have to comply with whatever rules we ultimately adopt for digital modulation systems in the 2.4 MHz band. Accordingly, we are instructing OET to re-examine the Wi-LAN application for certification of its W-OFDM system for its compliance with the above listed portions of Section 15.247 of the rules and the power limits indicated above. OET shall also accept applications for equipment certification under Section 15.247 for other devices using digital modulation techniques if the equipment complies with the provisions stated above. Such applications submitted pursuant to the above provisions need not be accompanied by a formal waiver request, but should state that they fall within the terms of this Order as to the waiver. Any such applications will be subjected to the conditions set forth herein, including that operation is conditioned on compliance with any final rules that may be adopted in this proceeding.

PROCEDURAL MATTERS

A. Regulatory Flexibility Act

27. As required by Section 603 of the Regulatory Flexibility Act, 5 U.S.C. § 603, 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 A. 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 Further Notice, but they must have a separate and distinct heading designating them as responses to the IRFA. The Secretary shall send a copy of this Further Notice, including the IRFA, to the Chief Counsel for Advocacy of the Small Business Administration in accordance with Section 603(a) of the Regulatory Flexibility Act, 5 U.S.C. § 603(a).

B. *Ex Parte* Rules -- Permit-But-Disclose Proceedings

28. This is a permit-but-disclose notice and comment rule making proceeding. *Ex parte* presentations are permitted, except during any Sunshine Agenda period, provided they are disclosed as provided in the Commission's rules. *See generally* 47 C.F.R. §§ 1.1200(a), 1.1203, and 1.1206.

C. Authority

29. This action is taken pursuant to Sections 4(i), 301, 302, 303(e), 303(f), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 301, 302, 303(e), 303(f), and 303(r).

D. Comment Dates

30. Pursuant to Sections 1.415 and 1.419 of the Commission's rules, 47 C.F.R. §§ 1.415, 1.419, interested parties may file comments on or before [75 days after publication in the Federal Register], and reply comments on or before [105 days after publication in the Federal Register]. Comments may be filed using the Commission's Electronic Comment Filing System (ECFS) or by filing paper copies. See Electronic Filing of Documents in Rulemaking Proceedings, 63 Fed. Reg. 24,121 (1998).

31. Comments filed through the ECFS can be sent as an electronic file via the Internet to <<http://www.fcc.gov/e-file/ecfs.html>>. Generally, only one copy of an electronic submission must be filed. If multiple docket or rulemaking numbers appear in the caption of this proceeding, however, commenters must transmit one electronic copy of the comments to each docket or rulemaking number referenced in the caption. In completing the transmittal screen, commenters should include their full name, Postal Service mailing address, and the applicable docket or rulemaking number. Parties may also submit an electronic comment by Internet e-mail. To get filing instructions for e-mail comments, commenters should send an e-mail to ecfs@fcc.gov, and should include the following words in the body of the message, "get form <your e-mail address>." A sample form and directions will be sent in reply.

32. Parties who choose to file by paper 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 copies must be filed. If more than one docket or rulemaking number appear in the caption of this proceeding, commenters must submit two additional copies for each additional docket or rulemaking number. All filings must be sent to the Commission's Secretary, Magalie Roman Salas, Office of Secretary, Federal Communications Commission, 445 12th Street, SW, Washington, DC 20554. Comments and reply comments will be available for public inspection during regular business in the FCC Reference Center (Room CY-A257), 445 12th Street, SW, Washington, DC 20554.

ORDERING CLAUSES

33. IT IS ORDERED that, pursuant to Sections 4(i), 301, 302, 303(e), 303(f), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 301, 302, 303(e), 303(f), and 303(r), this Further Notice of Proposed Rule Making is hereby ADOPTED.

34. IT IS FURTHER ORDERED that, pursuant to Sections 4(i), 301, 302, 303(e), 303(f), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 301, 302, 303(e), 303(f), and 303(r), the Application for Review filed by Wi-LAN, Inc. on September 20, 2000 is hereby DENIED.

35. IT IS FURTHER ORDERED that, pursuant to Sections 4(i), 301, 302, 303(e), 303(f), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 301, 302, 303(e), 303(f), and 303(r), OET shall process applications for certification of digital modulation systems that operate in the 2400 - 2483.5 MHz band for compliance with the proposals in this Further Notice of Proposed Rule Making.

36. IT IS FURTHER ORDERED that the Commission's Consumer Information Bureau, Reference Information Center, SHALL SEND a copy of this Further Notice of Proposed Rule Making, including the Initial Regulatory Flexibility Act, to the Chief, Counsel for Advocacy of the Small Business Administration.

37. For further information concerning this Further Notice, contact Neal L. McNeil, Office of

Engineering & Technology, (202) 418-2408, TTY (202) 418-2989, email nmcneil@fcc.gov.

FEDERAL COMMUNICATIONS COMMISSION

Magalie Roman Salas
Secretary

APPENDIX A

Initial Regulatory Flexibility Analysis

As required by Section 603 of the Regulatory Flexibility Act,³¹ the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) of the expected significant economic impact on small entities by the policies and rules proposed in this Further Notice of Proposed Rule Making and Order (Further Notice). Written public comments are requested on the IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines for comments on the Further Notice of Proposed Rule Making provided above in paragraph 27.

A. Need for and Objectives of the Proposed Rules

This Further Notice proposes changes that remove unnecessary regulatory barriers to the introduction of new wireless devices using spread spectrum and other digital technologies. The proposals will also improve sharing of the spectrum by wireless devices operating in the 2.4 GHz band (2400 - 2483.5 MHz). Specifically, the Further Notice proposes to relax the frequency hopping spread spectrum rules in Section 15.247 in accordance with a Joint Petition for Clarification, or in the Alternative, Partial Reconsideration filed by thirteen parties.³² The proposed changes would permit all frequency hopping systems in the 2.4 GHz band to use as few as fifteen hopping channels instead of the seventy-five hopping channels some systems are now required to use. Systems using the minimum number of channels will be required to employ adaptive hopping techniques in order to avoid transmitting on occupied frequencies.

The Further Notice seeks comments regarding alternative operating parameters or conditions for frequency hopping systems that may achieve the same goals. For example, the operating conditions in the Joint Petition would allow a system using 1 MHz bandwidth hopping channels to use as little as 18% of the available spectrum at 2.4 GHz to implement adaptive hopping techniques. The Further Notices asks whether the Commission could realize the goals of the petitioners by requiring that adaptive hopping systems use a minimum of 25% or 50% of the band with a power reduction in relationship to amount of spectrum used.

The Further Notice also proposes to modify the rules for non-frequency hopping spread spectrum systems in the 915 MHz (902 - 928 MHz), 2.4 GHz, and 5.7 GHz (5725 - 5850 MHz) bands to accommodate developing systems that use digital modulation techniques. Systems using digital modulation techniques would be required to meet the same technical requirements as spread spectrum systems, as modified in this proceeding. The Commission believes that this proposal will allow more and more diverse products to utilize those bands and thereby increase consumer choice. It would also provide the flexibility and certainty needed to promote the introduction of new, non-interfering products into the band, without the need for frequent rule changes to address each specific new technology that may be developed. This proposal would more closely align the Section 15.247 spread spectrum rules with the

³¹ 5 U.S.C. § 603.

³² See *Joint Petition for Clarification or, in the Alternative, Partial Reconsideration* filed October 25, 2000 in ET Docket 99-231 on behalf of 3Comm, Apple Computer, Cisco Systems, Dell Computer, IBM, Intel Corporation, Intersil, Lucent Technologies, Microsoft, Nokia Inc., Silicon Wave, Toshiba America Information Systems, and Texas Instruments.

Section 15.407 U-NII rules. Therefore, we seek comment on whether the same result would be achieved by amending the U-NII rules to include the 915 MHz and 2.4 GHz bands.

Finally, the Further Notice proposes to eliminate the processing gain requirement for direct sequence spread spectrum systems. The processing gain requirement was adopted more than ten years ago as a means to ensure that manufacturers would not take advantage of the higher power levels afforded spread spectrum devices by designing systems with wide bandwidths where much of the energy transmitted is not needed for communication. As the spread spectrum industry has matured it is not clear that this requirement continues to be necessary. Manufacturers have an incentive to design their systems to include processing gain in order for their devices to operate properly when located near other radio frequency devices.

B. Legal Basis

The proposed action is taken pursuant to Sections 4(i), 301, 302, 303(e), 303(f), and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. Sections 154(i), 301, 302, 303(e), 303(f), and 303(r).

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

The RFA directs agencies to provide a description of, and, where feasible, an estimate of the number of small entities that may be affected by the proposed rules, if adopted.³³ The Regulatory Flexibility Act defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small business concern" under section 3 of the Small Business Act.³⁴ A small business concern in its field of operation; and (3) satisfies any additional criteria established by the SBA.³⁵

The Commission has not developed a definition of small entities applicable to unlicensed communications devices manufacturers. Therefore, we will utilize the SBA definition applicable to manufacturers of Radio and Television Broadcasting and Communications Equipment. According to the SBA regulations, unlicensed transmitter manufacturers must have 750 or fewer employees in order to qualify as a small business concern.³⁶ Census Bureau data indicates that there are 858 U.S. companies that manufacture radio and television broadcasting and communications equipment, and that 778 of these firms have fewer than 750 employees and would be classified as small entities.³⁷ We do not believe this action would have a negative impact on small entities that manufacture unlicensed spread spectrum devices. Indeed, we believe the actions should benefit small entities because it should make available increased business opportunities to small entities. We request comment on these assessments.

³³ 5 U.S.C. § 603(b)(3).

³⁴ *Id.* § 601(3).

³⁵ *Id.* § 632.

³⁶ See 13 C.F.R. § 121.201, NAICS Code 334220 (SIC Code 3663). Although SBA now uses the NAICS classifications, instead of SIC, the size standard remains the same.

³⁷ See U.S. Dept. of Commerce, *1992 Census of Transportation, Communications and Utilities* (issued May 1995), SIC category 3663 (NAICS Code 334220).

D. Description of Projected Reporting, Recordkeeping and Other Compliance Requirements

Part 15 transmitters are already required to be authorized under the Commission's certification procedure as a prerequisite to marketing and importation. *See* 47 C.F.R. §§ 15.101, 15.201, 15.305, and 15.405. Additionally, manufacturers of direct sequence spread spectrum systems must submit a determination of system processing gain to the Commission in order to obtain product certification.

The proposed regulations will add permissible methods of operation for frequency hopping spread spectrum systems. No new reporting or recordkeeping requirements are proposed for the manufacturers of frequency hopping spread spectrum devices. However, the rules proposed in the Further Notice would eliminate the requirement that manufacturers of direct sequence systems submit evidence of compliance with a minimum processing gain. Therefore, the proposed rules reduce the reporting and recordkeeping burdens placed on all manufacturers, including small entities. None of the proposals would require alteration of any existing products.

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

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

At this time, the Commission does not believe the proposals contained in this Further Notice will have a significant economic impact on small entities. The Further Notice does not propose new device design standards. Instead, it relaxes the rules with respect to the types of devices which are allowed to operate pursuant to the spread spectrum regulations. There is no burden of compliance with the proposed changes. Manufacturers may continue to produce devices which comply with the former rules and, if desired, design devices to comply with the new regulations. The proposed rules will apply equally to large and small entities. Therefore, there is no inequitable impact on small entities. Finally, this Further Notice does not recommend a deadline for implementation. We believe that the proposals are relatively simple and do not require a transition period to implement. An entity desiring to take advantage of the relaxed regulations may do so at any time.

For the reasons stated above, unless our views are altered by comments, we find that the proposed rule changes contained in this Further Notice will not present a significant economic burden to small entities. Therefore it is not necessary at this time to propose alternative rules. Notwithstanding our finding, we request comment on alternatives that might minimize the amount of adverse economic impact, if any, on small entities.

F. Federal Rules that May Duplicate, Overlap, or Conflict With the Proposed Rule

None.

APPENDIX B

Proposed Rule Changes

Authority: 47 U.S.C. 154, 302, 303, 304, 307, and 544A.

We propose to amend Title 47 of the Code of Federal Regulations, Part 15, as follows:

Section 15.247 is proposed to be amended by revising paragraphs (a), (a)(1)(ii), (a)(1)(iii), (c), and (d); re-designating paragraphs (b)(3) and (b)(4) as (b)(4) and (b)(5), respectively; adding a new paragraph (b)(3); deleting paragraph (e); revising paragraph (f); and re-designating paragraphs (f), (g), and (h) as paragraphs (e), (f), and (g), respectively.

Section 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(a) Operation under the provisions of this section is limited to frequency hopping and direct sequence spread spectrum systems and digitally modulated intentional radiators that comply with the following provisions:

(1) * * *

(i) * * *

(ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

(iii) Frequency hopping systems in the 2400 - 2483.5 MHz band shall use at least 75 non-overlapping channels, except that as few as 15 non-overlapping channels may be used for systems that intelligently modify their hopsets in accordance with Section 15.247(g). Hopsets modified in this manner must be re-determined at least once every 30 seconds. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

(2) Systems using direct sequence spread spectrum and digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands.

(b) * * *

(1) for frequency hopping systems in the 2400 -2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 Watt. For all other frequency hopping systems in the 2400 - 2483.5 band: 0.125 Watt

(2) * * *

(3) For systems using digital modulation in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5780 MHz bands: 1 Watt.

(4) Except as shown below, if transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the above stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(4)(i) and (b)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(5) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. *See* § 1.1307(b)(1) of this Chapter.

(c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

(d) For direct sequence spread spectrum and digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

(e) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and direct sequence or digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The direct sequence or the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall comply with the power density requirements of paragraph (d) of this section.

(f) Frequency hopping systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a

continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(g) The incorporation of intelligence within a frequency hopping system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.