DOCKET FILE COPY ORIGINAL

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

In the Matter of	)	
	)	
Wi-LAN, Inc.	)	DA 00-2317
	)	
Application for Certification of an Intentional Radiator Under Part 15 of The Commission's Rules, FCC ID K4BAP01	)	ET Doc. 99-231

COPY
RECEIVED
NOV 16 2000
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

OPPOSITION OF PROXIM, INC.

Proxim, Inc. ("Proxim"), by its attorneys, hereby opposes the above-captioned application for review (the "Application") filed by Wi-LAN, Inc. ("Wi-LAN") regarding the decision by the Office of Engineering and Technology ("OET"), released August 18, 2000, denying Wi-LAN's application for certification of a wideband orthogonal frequency division multiplexing ("OFDM") transmitter as a spread spectrum device under Section 15.247 of the Commission's rules (the "Denial").[1]

As set forth below, OET's Denial decision was correct, both as a matter of policy and as a matter of law. Only two technologies may operate under the FCC's spread spectrum rules: Direct Sequence Spread Spectrum ("DSSS") systems and Frequency Hopping Spread Spectrum ("FHSS") systems. The OFDM device that Wi-LAN submitted for Part 15 certification is neither a DSSS nor a FHSS system. It is not, therefore, eligible for certification under Section 15.247.

The Commission has been rigorous in application of its Part 15 technical rules, particularly with regard to equipment certification. As OET stated in the Denial, systems that are neither DSSS nor FHSS never have been permitted to operate under the

[1] See Letter from Dale Hatfield, Chief, OET, to Mitchell Lazarus, Counsel to Wi-LAN, Ref. No. 1300F (Aug. 18, 2000). Wi-LAN asked, in the alternative, for waiver of Section 15.247; that request also was denied.

No. of Copies rec'd 0
List A B C D E

spread spectrum rules. To the extent that Wi-LAN believes that Section 15.247 *should* accommodate its OFDM device, therefore, it should petition the FCC to amend that rule.

DISCUSSION

Proxim, which is the leading supplier in the United States of wireless LAN technologies operating under Part 15 on the Commission's rules, opposes the Wi-LAN Application. First, and most importantly, the Wi-LAN OFDM transmitter is not a DSSS or FHSS system eligible for certification under Section 15.247. As shown below, the Petitioner itself, in public documents, has clearly distinguished between spread spectrum systems and the OFDM device at issue in this proceeding. Second, as a policy matter, OET's decision to follow its past practice of strictly enforcing the Commission's technical rules was sound and appropriate.

I. The Wi-LAN OFDM Device Is Not A DSSS Or FHSS System.

A. Operation Under Section 15.247 Is Limited To Frequency Hopping And Direct Sequence Spread Spectrum Radiators.

Under the FCC's rules, "[o]peration under [Section 15.247] is limited to frequency hopping and direct sequence spread spectrum intentional radiators."[2] Although Wi-LAN does not suggest that its OFDM system should qualify as an FHSS system, it argues that the OFDM transmitter should be authorized under Section 15.247 because, using certain types of coding, this non-spread spectrum device can be made to simulate DSSS operation in some ways. At bottom, however, Wi-LAN cannot claim that the transmitter in question is a DSSS system.

DSSS is defined in the Commission's rules as a 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

[2] 47 C.F.R. § 15.247(a).

of the wide spreading of the transmitted signal."[3] That is, the RF signal in a DSSS system occupies a much larger bandwidth than would normally be the case, which lowers the power spectral density of the signal. A spread spectrum system's performance, in terms of minimizing interference to other signals and improving processing gain (the number of pseudo-random noise bits in the data symbol waveform), is determined in large part by attributes of the spreading code used to spread the RF carrier.

Certain coding techniques allow technologies that are not DSSS systems to mimic DSSS system performance. For example, some types of Forward Error Correction ("FEC") technology, including that used by the Wi-LAN OFDM transmitter, allow non-DSSS systems to achieve interference tolerance similar to that of a DSSS system. For that reason, makers of these systems have, Proxim understands, applied to the FCC for certifications that would allow them to operate these systems pursuant to Section 15.247, notwithstanding the fact that they are not "spread spectrum" systems.

As noted in the OET Denial, these applications consistently have been rejected.[4] The FCC's position has been — and continues to be — that the "Part 15 rules limit spread spectrum operations to direct sequence and frequency hopping systems" without exception.[5] The reference in Wi-LAN's Application to Complementary Code Keying ("CCK") systems, apparently in an effort to suggest that OET previously has certified non-DSSS systems under Section 15.247,[6] is not to the contrary.

---

[3] 47 C.F.R. § 2.1.

[4] Wi-LAN argues that OET's reference to these prior denials was procedurally inappropriate because OET is not required, under the Freedom of Information Act, to provide Wi-LAN with the details of these applications. Wi-LAN has missed the point. It is not that OET has previously denied an application for certification of a device that is exactly like the Wi-LAN OFDM device, but rather that OET has not granted certification under the spread spectrum rules for *any* device that is not a DSSS or FHSS system. It is irrelevant, therefore, that Wi-LAN might, if given these applications, be able to show that the devices in question differ from its OFDM device in some respect.

[5] See generally Amendment of Parts 2 and 15 of the Rules with Regard to the Operation of Spread Spectrum Systems, 5 FCC Rcd 4123 (1990).

[6] See Application at 11-12.

CCK is a form of multiple-waveform signaling in which a DSSS chip pattern is impressed upon the waveforms transmitted. The DSSS spreading function dominates the transmitted spectrum, and the demodulation is carried out by correlation (de-spreading) against the reference waveforms. By contrast, OFDM transmits multiple sub-carriers and derives its robustness primarily from FEC coding. The only controversial aspect of CCK operation under Section 15.247 is that CCK uses only 8 chips/symbol, and hence achieves only 9 dB of processing gain by most metrics. Nonetheless, although weak compared to other DSSS modulations, CCK is in fact regarded as DSSS.

B. OET's Denial Confirmed The FCC's Commitment To Enforcing The Technical Rules Under Part 15.

OET's unwavering commitment to a strict interpretation of Section 15.247 was confirmed in the Denial. OET explained in the Denial that, whatever the interference characteristics of the Wi-LAN OFDM device, it was not a DSSS system as defined in the Commission's rules. A DSSS system, OET pointed out, "utilizes an occupied bandwidth much greater than the bandwidth necessary to transmit the information."[7] Wi-LAN's OFDM system, on the other hand, "does the opposite, by minimizing the occupied bandwidth necessary to send the information transmitted."[8]

Moreover, whereas a "high speed spreading code and an information data stream are used to modulate a single RF carrier" in a DSSS system, Wi-LAN's OFDM signal is "generated by separating a high speed serial data stream and sending these separate signals in parallel and concurrently on multiple sub-carriers."[9] Thus, not only are the signals carried differently on Wi-LAN's OFDM-based system, they are generated differently as well.

---

[7] Denial at 2.
[8] Id.
[9] Id.

OET was not swayed by the fact that the Wi-LAN OFDM device was able to achieve a processing gain similar to that required of DSSS systems, or that it could pass the interference test applicable to spread spectrum transmitters (the "CW jamming margin test"). OET explained in the Denial that, "[a]lthough the device may exhibit processing gain and may comply with the remainder of the requirements listed in Section 15.247, the capability to pass a CW jamming margin test or any other requirement does not change our conclusion that the [Wi-LAN] OFDM transmitter is not a DSSS system."[10] Consequently, OET denied the petition for reconsideration, concluding that "[a]rbitrarily allowing an OFDM type system to be authorized under Section 15.247 ... would not be in the public interest."[11]

C. Wi-LAN's OFDM Device Is Not A DSSS System.

As a technical matter, OET's conclusion is correct: Wi-LAN's OFDM device is not a DSSS system. Indeed, Wi-LAN has conceded as much on its own website which — until very recently — drew a clear distinction between spread spectrum technologies and OFDM devices.[12] In its description of OFDM, Wi-LAN has noted that "[t]here are basically three RF technology options for approaching th[e] challenge [of increasing the speed of wireless networking]: narrow band microwave, spread spectrum, and OFDM."[13] Wi-LAN then distinguished OFDM devices from narrow band and spread spectrum technologies, concluding that the "difficulties in narrow band and spread

---

[10] Id. Indeed, it was irrelevant to OET whether the OFDM device could pass the CW jamming margin test or whether it met any of the remaining technical requirements under Section 15.247. Those other technical requirements, OET explained, are only applicable if the system in question is first determined to be a spread spectrum system.

[11] Id.

[12] "What is OFDM?" at http://www.wi-lan.com/ofdm/first.html (Oct. 26, 2000). A copy of Wi-LAN's web page from that date is attached to this pleading because, in the interim, Wi-LAN has changed its website to blur the distinctions that it formerly recognized between spread spectrum technologies and OFDM systems.

[13] Id.

spectrum are overcome by OFDM."[14] Thus, Wi-LAN appeared to agree, only a few weeks ago, with OET's conclusion that OFDM is not DSSS.

Nonetheless, in its Application, Wi-LAN has attempted to finesse the issue. Rather than claim that its OFDM device is a true DSSS technology, Wi-LAN asserts that its OFDM device "satisfies the definition of" a direct sequence spread spectrum system because its "transform sequence is closely analogous to the 'chip' sequence used in conventional direct sequence systems."[15] As set forth above, however, "closely analogous" to DSSS never has been the applicable standard for certification under Section 15.247.

II. Strict Enforcement Of The Commission's Certification Standards Is Sound And Appropriate As Matter Of Policy.

The rigorous approach taken by OET in the Denial is consistent with FCC precedent and sound as a matter of policy. Since 1985, when it first authorized the operation of unlicensed spread spectrum systems under Part 15, the FCC consistently has required strict compliance with the technical standards of Section 15.247.

When it has been shown that the technical requirements of the rule have become outdated or are that they are in need of change to accommodate new technologies, the FCC has made such changes in a rulemaking proceeding involving the participation of all interested parties.[16] That is the path that Wi-LAN should have followed in this case if it could make a convincing showing that its OFDM device warrants authorization under Section 15.247-like standards.

The Commission should not abandon this rulemaking approach and begin authorizing non-spread spectrum devices under the current rule. The spread spectrum rules have been carefully tailored to permit efficient operation of unlicensed wireless

---

[14] Id.
[15] Application at 10-11.
[16] See, e.g., Amendment of Parts 2 and 15 of the Commission's Rules Regarding Spread Spectrum Transmitters, 12 FCC Rcd 7488, 7507 (1997) (updating DSSS definition).

technologies in an essentially unregulated environment. The necessary antecedent for successful unlicensed operation, however, is careful regulatory control over the types of equipment that will be permitted to use the band. Indeed, it is at the equipment certification stage that the Commission has its best, and perhaps only, opportunity to ensure rule compliance in the unlicensed bands.

For that reason, the Commission should not proceed by waiver — or by loose application of existing rules — when a party presents it with a new technology that can, the party argues, be operated efficiently in accordance with the spread spectrum rules. In those cases, as OET did in this case, the Commission should deny the application and advise the party to seek an amendment to the rule. The Commission and interested parties, including small businesses, then will have a fair opportunity to evaluate the proposed change.

CONCLUSION

For the reasons stated herein, the Commission should deny and dismiss the application for review filed by Wi-LAN, Inc.

Respectfully submitted,

PROXIM, INC.

By: /s/ Henry Goldberg
Henry Goldberg
W. Kenneth Ferree

GOLDBERG, GODLES, WIENER
& WRIGHT
1229 Nineteenth Street, N.W.
Washington, DC 20036
(202) 429-4900

November 16, 2000

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing Opposition of Proxim, Inc., was sent by first-class mail, postage prepaid, this 16th day of November, 2000, to the following:

Mitchell Lazarus
Fletcher, Heald & Hildreth, P.L.C.
1300 North 17th Street, 11th Floor
Arlington, VA 22209

Counsel for Wi-LAN, Inc.

/s/ Deborah Wiggins
Deborah Wiggins

What is OFDM?

Exploring OFDM:

The Future of High-Speed Wireless Communications:

Wi-LAN is the future of high-speed wireless data communications, and its competitive advantage in this field is based primarily on its control of its patented Wide-band Orthogonal Frequency Division Multiplexing (W-OFDM).

Multi-carrier modulation, in particular OFDM, has been successfully applied to a wide variety of digital communications applications over the past several years. Wi-LAN was able to improve on a good thing, making OFDM technology able to have higher bandwidth, better noise tolerance, and more security. It's these improvements that Wi-LAN patented as W-OFDM.

In June 1999, after six years of research and development, Wi-LAN announced the release of I WiLL, a wireless Access Point that uses Wi-LAN's W-OFDM technology to achieve a peak data rate of 30 Mbps in 20 MHz of bandwidth. Through W-OFDM, I.WiLL was able to demonstrate the industry's most efficient use of bandwidth.

Wi-LAN licensed its patented W-OFDM technology to Philips Semiconductors in September 1999. Both companies are currently collaborating on developing proprietary W-OFDM integrated circuits based on I.WiLL. Through this collaboration, Wi-LAN and Philips Semiconductors look to lower the cost of the customer premise equipment, and will collaborate on building integrated circuits around the IEEE 802.11a standard.

Wide-band Orthogonal Frequency Division Multiplexing (W-OFDM):

Orthogonal Frequency Division Multiplexing (OFDM) is a modulation method that, like all wireless transmission schemes, encodes data onto a radio frequency (RF) signal. Conventional single carrier transmission schemes like AM/FM (amplitude or frequency modulation) send only one signal at a time using one radio frequency. OFDM sends multiple high-speed signals concurrently on different frequencies. This results in very efficient use of bandwidth, and provides robust communications in the presence of noise, intentional or unintentional interference, and reflected signals that degrade radio communications.

The Challenge and the Options:

The on-going challenge for the industry is to increase the speed of wireless data/Internet networking.

There are basically three RF technology options for approaching this challenge: narrow band microwave, spread spectrum, and OFDM. In narrow band, the power to transmit the data is increased to overcome the noise. This improves the performance of the transmission, but interferes with other signals that are being sent by other users of the band, causing data errors for others. Narrow band systems are also sensitive to multipath interference, in which your own signal is reflected off another object and arrives late at the destination, scrambling the original signal. This requires on-going tuning and adjustment using specific hardware which means an increased system cost.

Narrow Band Equalizer Chart

With processor power increasing as a function of time, OFDM returns better performance than narrow band systems. What was not practical in the early 1990's has become practical, even superior as time marches on...

By definition, spread spectrum technology uses much more bandwidth than is absolutely required to send signals, but this allows it to overcome noise and multipath problems. Unfortunately, as the amount of data increases, so does the bandwidth requirement. The best systems to date deliver 11 Mbps and use 22MHz of spectrum. That translates to less than 44 Mbps maximum if one used the entire 2.4 GHz license-exempt band. Wi-LAN believes the best possible speed achievable is approximately 15 Mbps in 22 MHz, which means that spread spectrum technology is approaching its limits in speed.

OFDM technology breaks one high-speed data signal into tens or hundreds of lower speed signals, which are all transmitted in parallel. This creates a system highly tolerant to noise and multipath and, at the same time, is very efficient in its use of bandwidth. Noise and multipath immunity allow for wide-area, multipoint coverage, and the efficient use of bandwidth allows for many more high-speed channels within a frequency band. Therefore, the main difficulties in narrow band and spread spectrum are overcome by OFDM.

OFDM Data Rates Chart

Wi-LAN's systems are capable today of the data rates as shown in the chart. **OFDM** today provides better than 6 times the spectral efficiency of the direct sequence spread spectrum system.

The Solution is W-OFDM:

W-OFDM (Wi-LAN U.S. patent number 5,282,222) is a variation of OFDM that further improves its characteristics. The signal reception is corrected for distortions, allowing greater transmission speeds. W-OFDM also further processes the signal to maximize the range.

While OFDM has long been acknowledged as a very efficient technology, it has proven difficult to implement until now. Recent advances in digital signal processors now permit OFDM systems to be cost-effectively constructed, creating renewed interest in OFDM. The digital audio and terrestrial digital video broadcasting standards are based on OFDM. In 1998, the 802.11a task group of IEEE (Institute of Electrical and Electronics Engineers) Standards Committee elected to use OFDM in its high-speed (6 to 54 Mbps) extension to the 802.11 wireless LAN standard.

This decision was followed by the approval of the IEEE 802.11a standard in September 1999 by the IEEE Standards Board. The IEEE is the standards body for development and dissemination of voluntary, consensus-based industry standards involving leading-edge electro-technology. As well, the European Telecommunications Standards Institute (ETSI) is considering W-OFDM for the ETSI BRAN standard. These standards are evidence that the patented technology Wi-LAN has been developing since 1991 is the direction of high-speed wireless data communications. With the RF spectrum becoming increasingly crowded, OFDM is a promising solution, allowing more efficient use of radio frequency.

The Advantages of OFDM:

1. Spectral efficiency, meaning more bps/Hz than conventional transmission schemes.
2. Spectral efficiency is further enhanced as the spectrum can be made to look like a rectangular window, meaning all frequencies are utilized similarly.
3. OFDM is less sensitive to timing errors. A timing error is simply translated to a phase offset in the frequency domain.

The Advantages of W-OFDM:

1. Great performance against multipath, through a simple division by the channel frequency response.
2. Enhanced equalization of radio distortions, through a division by the channel frequency response that includes the radio distortion.
3. Easy inclusion and optimal exploitation of forward error correcting codes, like Reed-Solomon, ensuring the integrity of transmitted data. This includes the ability to recover the symbols, even if some carriers are totally absent.
4. More amenable to erasures of errors in the forward error corrector which could improve the bit error rate performance by over an order of magnitude. The positions of the errors can easily be determined from the estimated channel frequency response.
5. The whitening process reduces the peak to average ratio, which reduces the linearity requirement of the power amplifiers.
6. Less sensitive to carrier offset.
7. The group delay of the frequency response can be used to deliver an estimate of the propagation time between the transmitter and receiver, which in turn is an estimate of the separation between the two.

Wi-LAN holds fundamental patents on W-OFDM and is pioneering the development of large-scale, high data rate W-OFDM systems. The efficiency and noise tolerance of W-OFDM allow the best of both spread-spectrum and narrow band systems to be united. This combination, and our established data networking protocols, further extend the capabilities of W-OFDM into *realm of practical multipoint networks.*

W-OFDM allows low power, multipoint RF networks to be implemented that minimize their interference with adjacent networks. W-OFDM is also insensitive to noise and multipath interference, so ongoing tuning, adjustments and maintenance requirements are reduced. W-OFDM effectively permits several independent channels to operate within the same band,

allowing multipoint networks and point-to-point backbone systems to be overlaid on one another in the same frequency band.

Less disruption of adjacent users and insensitivity to external noise means that high-speed multipoint data networks can be simply and rapidly deployed. Once installed, these systems are tolerant to changes in the RF environment, limiting maintenance requirements, and the systems can be easily expanded to meet the users changing needs. Operation in an unlicensed band also avoids costly licensing procedures, and allows the use of widely available equipment, which further improves the lifetime economics of a project.

For More Information: info@wi-lan.com