IEEE P802.11
Wireless LANs

Alantro FCC Correspondence

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This document consists of copies of two correspondences involving the proposal to IEEE 802.11 from Alantro Communications and the FCC.

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Ray LaForge
Equipment Authorization Division
Federal Communications Commission
7435 Oakland Mills Drive
Columbia, MD 21046

Reference: *Alantro Request for Interpretation of Section 15.247*

Dear Mr. LaForge:

This is a request for an interpretation of Section 15.247 of the Commission's Rules, dealing with the processing gain of a direct sequence spread spectrum device. The processing gain can be treated as the sum of three elements: the coding, the rate/spreading gain due to reduction of data rate relative to uncoded modulation, and the waveform spreading gain which spreads the transmitted power to fill the bandwidth. We request an interpretation that that the CW jamming margin method of Section 15.247(e)(2) is a valid measurement of the total of these three elements.

Alantro Communications, Inc., is a dynamic new hardware company building products in the high performance digital communications and coding areas. Recently, we have been developing a solution for high-speed wireless local area networks (LANs). As part of our efforts, we have been actively participating in the emerging high-speed physical layer standard under consideration by the auspices of the IEEE 802.11.

The IEEE 802.11 adopted a standard, in the fall of 1997, incorporating a spread spectrum signal based on an 11 bit "Barker" sequence. This standard is known as the "Direct Sequence" or DS standard. The DS standard operates at a maximum data rate of 2Mbps and several companies make products intended to inter-operate with this standard.

The recent activities of the IEEE 802.11 have been directed towards the definition of a compatible extension of the existing standard that will result in a data transmission rate in excess of 10Mbps. There are a number of proposals currently under consideration by the IEEE 802.11, including a proposal from Alantro Communications [5]. (Note—Attachments [3-5] are enclosed with the mailed copy of this letter, and will be supplied upon request in electronic (.pdf) format.)

Under certain scientific interpretations [1][4], none of the proposals currently under active consideration by IEEE 802.11 for a 10 Mbps rate could be considered "spread spectrum" because none of them achieve a processing gain of 10 dB through spectrum spreading coding. Nonetheless, the intent of the FCC regulations, that the signals transmitted will have limited means to create interference, and that certified devices can correctly operate in the presence of given levels of interference, are achievable under these proposals.

For example, the interference immunity of a signal can be improved through the use of modern error control coding techniques. This is partially explained by John Proakis in [2] (page 707-708):

> *"...the jamming margin achieved...depends on the [spreading gain/rate] gain and the coding gain."*

Thus, the rate/spreading gain of a spread spectrum signal does not benefit from the effect of error control coding; moreover, waveform spreading provides additional benefits because it reduces the likelihood of interference to other users.

We understand that in a recent FCC ruling, a 2.4 GHz spread spectrum product from Aironet, operating at 11Mbps, has been shown to pass the CW jamming margin test and has therefore been approved. This product incorporates a bi-orthogonal modulation technique (MOK) implemented by Harris Corporation in its "PRISM" chip set.

The Alantro design uses a binary convolutional code (BCC) rather than MOK, with significantly larger "free distance." We are confident that the Alantro design will meet or exceed all FCC regulations required to operate in the desired band. In fact, we believe that the Alantro solution can be viewed as a significant improvement, in terms of noise and interference immunity to the Harris solution.

From a transmission point of view, the power spectral densities of the two approaches are indistinguishable. In both cases, at the primary rate, an 11MHz QPSK modulation is coding with a rate ½ code. This results in a primary information rate of 11Mbps in both cases.

The difference between the two approaches is observed at the receiver and concerns noise and interference tolerance. The difference is exhibited in the coding gain of the two systems. In additive white Gaussian noise (AWGN), the Alantro BCC solution exhibits an improvement in excess of 3dB over MOK. This implies significant improvement in both noise *and* interference immunity.

As noted above, we understand that the Harris product was approved based upon the CW jamming margin test. We are confident that the Alantro BCC solution will pass this test with improved margin. We will of course submit appropriate measurements when we seek an Equipment Authorization for our product. Moreover, based on theoretical analysis and the requested interpretation of processing gain, our product will satisfy the 10 dB processing gain requirement of Section 15.247(e), and in fact will achieve 12.7 dB of processing gain at an 11 Mbps rate. In contrast, according to our analysis, the Harris MOK solution achieves an "ideal" processing gain of only 9.6dB. In fact, to achieve the 5.5 fold data rate improvement (relative to the existing 2Mbps 802.11DS standard) requires a signal to noise ratio improvement of +5.1dB for MOK [3][4], while the Alantro BCC requires only +2dB, [4][5].

Consequently, as noted above, the processing gain can be treated as the sum of three elements: the coding gain, the rate/spreading gain, and the waveform spreading gain. We request an interpretation that that the CW jamming margin method of Section 15.247(e)(2) is a valid measurement of the total of these three elements.

You may contact me by phone or in writing to the address provided above, by facsimile, or by e-mail mailto:heegard@alantro.com. You can also contact our consultant, Jeff Krauss by phone at (301) 309-3703.

Yours Truly,

Chris Heegard
CEO, Alantro Communications

cc with attachments: G. Czumak
Enc: References [3]-[5]

References

[1] James L. Massey "Towards an Information Theory of Spread-Spectrum Systems," *Code Division Multiple Access Communications* (Eds. S. G. Glisic and P. A. Leppanen), Kluwer Academic Publishers, 1995.

[2] John G. Proakis, *Digital Communications*, Third Edition, McGraw Hill, 1995.

[3] Chris Heegard, "Modulation and Coding for Wireless Local Area Networks," Alantro Communications, IEEE 802.11- 98/ 24, January 1998.

[4] Matthew B. Shoemake and Chris Heegard, "The Definition of Spreading and Coding and Their Relation to Processing Gain," Alantro Communications, IEEE 802.11- 98/ 85, March 1998.

[5] Matthew B. Shoemake and Chris Heegard, "Proposal for High Data Rate 2.4 GHz PHY With Variable Rate Binary Convolutional Coding on QPSK," Alantro Communications, IEEE 802.11- 98/ 82, March 1998.

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April 30, 1998

Chris Heegard
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Dear Chris:

It is my opinion that the FCC has adopted a policy that it will grant an Equipment Authorization to any direct sequence spread spectrum device that satisfies the CW jamming margin test of Section 15.247(e)(2) of the FCC Rules.

This opinion is based on a review of the Equipment Authorization files of the Lucent WaveLAN device (FCC ID# IMRWLPC24) and the Aironet product (FCC ID# LOZ102035) that employs the Harris chip set with less than 10 to 1 spreading, as well as telephone conversations with Charlie Cobbs of the FCC's Equipment Authorization Division.

Based on these sources, it appears that the FCC policy is that any direct sequence spread spectrum device that passes the CW jamming margin test is acceptable, even if it does not employ traditional methods of spread spectrum technology.

Please let me know if you have any further questions.

Sincerely,

Jeffrey Krauss