
**IEEE P802.11
Wireless LANs**

**Proposal for a second letter for filing in the proceedings of FCC
OET Docket No. 99-231**

Date: September 14, 1999

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Summary

Attached is a proposal for a second letter for filing in the proceedings of the FCC in NPRM, OET Docket 99-231. This letter provides additional substantive material to support the statements in the first letter filed on August 19, 1999.

The text has been made by the experts mentioned above, based on submissions and discussions held in meetings of the ad-hoc regulatory group on Monday September 13, 1999.

The intention is to discuss the text on the Wednesday, September 15, 1999 meetings of the ad-hoc regulatory group with the aim to recommend an 802.11 and 802.0 combined e-mail ballot.

Sept 13, 1999

Magalie R. Salas, Esquire
Secretary
Federal Communications Commission
445 12th St. SW
Washington DC 20554

Re: ET Docket No. 99-231

Dear Ms. Salas:

IEEE 802, the LAN/MAN Standards Committee ("the Committee"), is writing in regard to ET Docket No. 99-231: Amendment of Part 15 of the Commission's Rules for Spread Spectrum Devices. On August 19, 1999, the Committee submitted comments in this proceeding expressing opposition to the proposed rules changes which would allow wider channels for FHSS systems as described in the Notice of Proposed Rule Making (the "Notice") in this proceeding. Since that time, the membership has continued to analyse the proposed rule changes. The Committee respectfully submits these additional comments in this proceeding.

The Institute of Electrical and Electronics Engineers, Inc. (IEEE) is a USA-based international professional organization with more than 325,000 members representing a broad segment of the computer and communications industries. IEEE 802.11, a chartered Working Group under the Committee, has developed a standard for Wireless Local Area Networking (WLAN) in the 2400-2483.5 MHz band ("the 2450 MHz band"). The number of individuals and corresponding company sponsorships in the IEEE 802.11 Working Group evidences the strong interest in wireless local area networking. The Working Group currently has over 200 members employed by 86 companies

Regarding the issue of Rule changes to increase the channel width of FHSS radio channel width, the Committee has already commented on a number of points in the correspondence of August 19, 1999. These comments are summarized below:

- a. The use of heavily overlapped channels for Wide Band Frequency Hopping (WBFH) systems will result in significantly increased interference among systems employing this method of channel selection.
- b. Increasing hop rate for WBFH systems will not reduce the interference threat to other users of the band. In fact, this measure will actually increase interference with other users. We note that there is no regulatory prohibition against the use of systems which have higher hopping frequencies, but we are of the opinion that the Commission should not make higher hop rates mandatory.
- c. In addition, we find that the proposed reductions in transmitted RF power for WBFH systems are not adequate to ensure that existing systems do not suffer increased interference.
- d. We further note that the resulting increase in interference described above will hinder market acceptance of high speed wireless networking product which operate in the 2.45 GHz ISM band.

The Committee would like to make the following additional comments relating to proposed changes in FHSS operating rules:

- a. Direct Sequence Spread Spectrum (DSSS) systems were able to achieve higher throughput without requiring a change in the Commission's Rules. More importantly, higher data rates were achieved with no change in the Power Spectral Density (PSD) of the DSSS waveform. Therefore, there is little or no impact in terms of increased interference with other users of the band.
- b. In the Notice, the FCC asks for comments on HWN's assumption that wide band frequency hopping systems will be unable to consistently achieve substantially greater data rates than 1 MHz systems. This comment by IEEE P802.11 supports HWN's view in this matter. The adverse effects of multipath on WBFH system throughput are described in detail in the following paragraphs.

Currently employed frequency hopping systems complying with Part 15 employ 2 or 4 level FSK modulation (1 or 2 Mbit/s) and have a 20 dB bandwidth of 1 MHz. The benefits of these systems are that they can be manufactured at relatively low cost because they have nonlinear signal processing components, while they maintain a reasonable performance in a multipath environment. The narrow band FH systems work satisfactorily in environments where the delay spread is in the range of 100-200 nanoseconds which are characteristic of large retail stores and manufacturing facilities.

The FH systems work because of the frequency diversity capabilities inherent to hopping. Narrow band frequency hoppers experience this level of delay spread as flat fades. If, because of a fade no transmission is possible at the particular frequency, the chance to be in a fade again at the next hop (next 1 MHz frequency channel) is small. By widening the bandwidth of the frequency hopper to 3 or 5 MHz, the hopper has to deal with in band multipath distortion instead of flat frequency fading. At the next hop (frequency) the chance that no transmission is possible because of multipath remains high.

There is a linear relationship between the intersymbol interference caused by multipath and the symbol length; widening the bandwidth of a transmission system with a factor x (without changing the modulation method) makes the system x times more susceptible to multipath. For a 5 MHz wide frequency hopping system employing 2 or 4 level FSK this means that the system can only tolerate delay spread spreads of up to 20-40 nanoseconds. These delay spreads are characteristic of ordinary rooms. Further, in low cost implementations, this amount of in band distortion can be introduced by the transmit and receive filters, thus reducing tolerance to multipath to almost zero. Such systems would not be viable from a user point of view.

From above reasoning we conclude that a 5 MHz wide frequency hopper employing 4 level FSK will not work in a normal environment. To get data through the frequency hopper has to fall back to a narrower bandwidth with a lower data rate.

Of course, a wide band FH system can be designed to be more robust against delay spread. If the same modulation method is maintained, then a form of equalisation is necessary. Apart from the higher amount of (signal) processing, which increases component cost, equalization also requires linear processing in both transmitter and receiver increasing the cost of (linear) components.

Other modulation methods that are more robust against multipath can be employed in wide band FH systems. These methods however require linear components and a high amount of signal processing.

To bring the delay spread robustness for a wide band frequency hopper to the level required for normal operation, there is a cost (nothing is free). The required components (linear power amplifiers, linear receive functions (AGC), DSP components) bring the cost to the level of currently employed direct sequence systems or higher. Direct sequence systems are running at 11 Mbit/s and with adequate robustness against delay spread effects. The costs of this type of equipment are decreasing rapidly (refer to the Apple's Airport product announcement in August this year).

Based on above arguments, it can be concluded that the HomeRF Working Group claim that future wideband FH services can be implemented at lower cost and with greater multipath robustness than can current DS systems operating at comparable speeds does not hold and is misleading.

IEEE 802.11 also submits additional studies in support of the statements made in the earlier letter of August 19, 1999.

- 1.) The document "*Interference Potential of WideBand Frequency Hopping Systems on Packet Data Systems*" includes an analysis of the effect of the power level of the WBFH systems.
- 2.) The document "Effects of WBFH Power Reductions and Hop Rate" presents analysis results showing that increasing hop rate increases the collision rate with both DSSS and conventional narrowband FHSS systems. The effects of proposed power reductions is also described in detail.

In summary, the Committee opposes the changes to the operating rules for FHSS systems as described in the Commission's Notice of Proposed Rule Making in this proceeding. The Committee reiterates comments made in the August 19, 1999 letter to the Commission and additionally concludes that WBFH system will suffer severe impairment due to multipath channel distortion. The Committee is also forwarding two papers as described above in support of our earlier comments in this matter.

Respectfully,

Submission

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