Standards Working Group IEEE 802

Local and Metropolitan Area Network Standards Committee
Homepage at http://grouper.ieee.org/groups/802/

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Reply to: Vic Hayes, Chair, IEEE P802.11
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Magalie R. Salas, Esquire
Secretary
Federal Communications Commission
445 12th St. SW
Washington DC 20554

Re: ET Docket No. 99-231

Dear Ms. Salas:

Re: Amendment of Part 15 of the Commission's Rules for Spread Spectrum Devices, ET Docket No. 99-231

Dear Ms. Salas:

IEEE 802, the IEEE[1] 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 an ex parte letter in this proceeding expressing opposition to the proposed rule changes which would allow wider channels for Frequency Hopping Spread spectrum (FHSS) systems as described in the Notice of Proposed Rule Making (the "Notice") in this proceeding. Since that time, the membership has continued to analyze the proposed rule changes. Two working groups of the Committee (802.11 on wireless Local Area Networks and 802.15 on Wireless Personal Area Networks) held an Interim Meeting in San Rosa CA (13 - 17September 1999) and, based on additional material submitted, [2] respectfully submits these additional comments in this proceeding.

[1] 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.

[2] All papers are available at URL http://grouper.ieee.org/groups/802/11/Documents/index.html#FCC_NPRM_99-231

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 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. At the Interim Meeting 0f 802.11, there were xx members present, and this Amendment was debates. The vote to submit this documen to the FCC was 18 Yes, 0 No and 0 Abstain at the Interim meeting, xx-Yes, yy-No, zz-Abstain at the Letter Ballot among the full 802.11 Working Group. The Committee's Executive Committee voted to submit this document by a vote of xx-Yes, yy-No, zz-Abstain.

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 Commission asks for comments on Home Wireless Network's (HWN) assumption that wide band frequency hopping systems will be unable to consistently achieve substantially greater data rates than 1 MHz systems. The Committee 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 deployed 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 non-linear 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 current FH systems work because of the frequency diversity

capabilities inherent to hopping. Narrow band frequency hoppers experience delay spreads of 100 to 200 ns as flat fades. If, because of a fade, no transmission is possible at the particular frequency, the chance of being 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 by a factor x of a transmission system (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 the above reasoning we conclude that a 5 MHz wide frequency hopper employing 4 level FSK without equalization will not work in a normal environment. To reliably transfer data, 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 equalization is necessary. Apart from significantly more (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 also require linear components and a significant 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.

Based on the arguments above , it can be concluded that the Home RF Working Group claim that future wide-band 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. At the IEEE 802.11 interim meeting, the chair of the HomeRF Working Group presented opposing views that were not supported by the Committee.

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 Wide-Band Frequency Hopping Systems on Packet Data Systems*", attached in Annex 1, analyzes the effect of the wider bandwidth on interference probability, including a generalized analysis of the effect of the power level of the WBFH systems. This paper concludes that the power level reduction of proposed wide-band FH systems needs to be substantially more than the 5 to 7 dB reduction suggested in the Notice.

2. The document "*Effects of WBFH Power Reductions and Hop Rate*", attached in Annex 2, 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 are also described in detail with the same conclusion as above.

Summary

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 reconfirms comments made in the August 19, 1999 comment letter to the Commission and additionally concludes that WBFH systems with FSK modulation will suffer severe impairment due to multipath channel distortion. The Committee additionally believes that these systems would not be economically viable and would represent a threat to existing users of the band. The Committee is also forwarding two papers as described above in support of our comments in this matter.

Respectfully,

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Annex 1

Interference Potential of Wide-Band Frequency Hopping Systems on Packet Data Systems

Date: September 13, 1999

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1.0 Abstract

The effect of modifying the 47 CFR Part 15.247 frequency hopping spread spectrum rules to permit a wider bandwidth is investigated relative to the interference potential on packet data transmission systems that conform to the current rules. The rules modification would permit Wide-band Frequency Hopping (WBFH) systems with bandwidths of 3 MHz and 5 MHz in addition to systems operating under the current rules that limit the bandwidth to 1 MHz.

The probability of a WBFH transmission mutilating a wireless data packet is investigated in terms of the WBFH and victim power levels, the WBFH bandwidth, the duration of the victim packet interval and WBFH hop interval and potential victim receiver parameters. A WBFH system operating in accordance with the proposed revised rules and a potential victim wireless packet data system conforming to the current rules are considered to operate in the same area. The configuration analyzed consists of a victim packet data system operating in a centralized mode and an interfering WBFH system with transmitters evenly distributed within and around the victim system communication cell. The proportion of WBFH transmitters that create packet errors in the victim receiver is analyzed.

It is shown that increasing the frequency hopping rate increases the probability of interference to packet data systems. The wider bandwidth would, of itself, increase the interference probability, but it would also permit a higher hoping rate. The proposed rules