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: 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.

This letter provides further information in support of our opposition to the rules changes for FHSS systems. The Committee's new direct sequence standard[2] is cited as proof that innovative high rate systems do not require a rule change and we provide information in support of the Home Wireless Networks HWN[3] claim that wide bandwidth FHSS systems will not support high data rates at low cost. Further two papers are supplied which support our earlier

[1] The Institute of Electrical and Electronics Engineers, Inc. (IEEE) is an international professional organization, based in the US, with more than 325,000 members representing a broad segment of the computer, communications, and power and energy industries.
[2] See IEEE Std 802.11b: Supplement to STANDARD [for] Information Technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements-Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher speed Physical Layer (PHY) extension in the 2.4 GHz band.

submission and show that, a) the proposed reduction in transmit power is inadequate to compensate for the increased interference, and b) that increased hopping rates will increase interference to other users.

Introduction

Two working groups of the Committee, 802.11 on Wireless Local Area Networks ("WG WLAN") and 802.15 on Wireless Personal Area Networks ("WG WPAN") held an Interim Meeting in San Rosa, CA, 13 – 17 September 1999, and, based on additional material submitted, [4] respectfully submit these additional comments in this proceeding.

The vote of the WG WLAN to submit this letter to the FCC was 18 Yes, 0 No and 0 Abstain. WG WPAN unanimously passed a motion to support WLAN. At the Letter Ballot among the full WG WLAN the decision was approved by 68 Yes, 3 No, 3 Abstain votes. The Committee's Executive Committee voted to submit this document by a vote of 11 Yes, 1 No and 2 Abstain.

Regarding the issue of Rule changes to increase the channel width of the FHSS radio channel, 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,

[3] See paragraph 7 of the NPRM

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 products that operate in the 2.45 GHz ISM band.

No change of rules is required to make innovative high rate designs

The Committee has shown with the development of one its newest standard[5] that higher data rates (11 Mbit/s) can be achieved using the current rules for Direct Sequence Spread Spectrum (DSSS) without requiring a change in the Commission's Rules. More importantly, these 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.

High band width FH systems will not increase data rates at low cost

Support for HWN's argument

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

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

[5] see IEEE Std 802.11b: Supplement to STANDARD [for] Information Technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements-Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher speed Physical Layer (PHY) extension in the 2.4 GHz band.

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 ("NBFH") work satisfactorily in environments where the delay spread is in the range of 100-200 ns. The current NBFH 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 spreads of up to 20-40 ns. However, studies indicate that a significant portion (40%) of homes[6] have delay spreads of 70 ns or worse. Multipath conditions are typically

[6] See Joint Technical Committee of Committee T1 R1P1.4 and TIA TR46.3.3/TR45.4.4 on Wireless Access, "Draft Final Report on RF Channel Characterization," Paper No. JTC(AIR)/94.01.17-238R4, Jan. 17, 1994 and for a summary of the models: Pahlavan and Levesque, "Wireless Information Networks", J.W. Wiley & Sons, 1995

worse in office and industrial environments. 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 do not yield the stated cost benefit

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, 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.

JTC Indoor Residential Models:

Model	RMS delay	% of Homes
A	18 ns	60%
B	70 ns	35%
C	150 ns	5%

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.

Proposed reduction in transmit power is not adequate to keep the interference level the same as of current regulation

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 document 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.

Increased hopping rates will increase interference to other users

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 has shown that the current rules provide sufficient ways for innovation[7] and has

[7] See IEEE Std 802.11b: Supplement to STANDARD [for] Information Technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements-Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher speed Physical Layer (PHY) extension in the 2.4 GHz band.

provided information supporting the HWN[8] that wide band FHSS systems do not provide higher rates at low cost. The Committee also provides analysis supporting its earlier claims that, a) the proposed reduction in transmit power is inadequate to compensate for the increased interference, and that b) increased hopping rates will increase interference potential.

The Committee plans to continue development of advanced Radio LAN standards for the 2.45 GHz band and welcomes participation from all industry experts to develop guidelines that optimizes the use of the band by all devices.

Respectfully,

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[8] See paragraph 7 of the NPRM