Frequency Hop Topics from January 1995

Jim McDonald
Motorola Inc.
50 E Commerce Dr.
Schaumburg, IL 60173
708 576 3169
jim_mcdonald@wes.mot.com

Abstract:

Three issues surfaced during the January 1995 Frequency Hop meeting that the FH Group requested that I bring to the attention of all interested IEEE 802.11 members via the Reflector. An effort to that during the week of 2/26/95 was unsuccessful. The Reflector message is therefore circulated via this submission.
Since this is now a submission, the original Reflector text is expanded to include motions relative to adopting PER rather than BER in PMD specifications.

Text of the Original Reflector Message

Summary:

At the January meeting, there was a discussion in the Frequency Hop Group relating to RF conformance testing criteria. Three issues surfaced that suggest committee attention. The first is a possible conversion of the criteria for sensitivity and related specifications such as IM and desensitization from bit error rate, BER, to packet error rate, PER. The second had to do with the relative merits of hardware testing versus radiated tests. The third involved the concept of performing conformance testing in a dynamic or hopping mode.

The committee requested that I use the Reflector to bring these issues the attention of all interested parties in IEEE802.11. As we move forward with defining the test certification, these issues will require the attention of the committee.

The committee also asked that I address the question of scheduling submissions and discussion of these issues at the March 95 meeting. I believe that the priority consideration of the March meeting should be dealing with the comments from the draft ballot. The issue of PER vs BER surfaced in the comments as well as in the conformance testing discussion during the Jan 95 meeting. Therefore, I believe that an hour of discussion of the PER issue is appropriate during the March meeting if it is focused on the draft standard aspect not just the conformance testing question. On the other hand, I believe discussion topics 2 and 3 below should wait until we have make progress on the draft comments. While I encourage submissions on topics 2 and 3 below, I question whether we will have time to address those submissions during the March 95 meeting.

1. PER vs BER

Commenting first on the PER issue, it became apparent during discussion of compliance testing in Jan 95 that BER is an abstract issue. As the system is now defined, there does not seem to be a means for measuring BER and thus determining when the RF signal level is at a high enough level to provide a BER

better than 10^-5. Packet Error Rate, (perhaps defined in terms of frame error rate or fragment error rate) is a more appropriate criteria because it results directly from the CRC checking process.

To implement a change from BER to PER we would need to defined the packet or fragment length. 400 bytes would be logical since this is the maximum MPDU the FH PHY will support. The next step would be to define a test using PER that provides essentially the same sensitivity criteria as the BER based criteria already defined. This conversion should be the topic of a submission. Submissions on this topic are therefore requested.

The simplest conversion would be to maintain the same criteria just converted to a PER form using a packet or frame length of 400 bytes or 3200 bits. Considering an assumed test length of 10^6 bits, there would be 312.5 frames of 3200 bits. A BER or 10^-5 would suggest 10 errors in the 312.5 packets. The packet error rate, PER, is then 3.1%, which can be rounded to 3.0%

One would then state the sensitivity of the Frequency Hop PHY in the 1 Mb/s mode as -80 dBm for a PER of 3.0%. I would ask a representative of the High Data Rate Group to comment on the proper conversion for the 2 Mb/s mode.

2. Hardwired vs Radiated Testing.

The draft standard, as it now stands, has the RF parameters defined in terms of hardwired parameters. For most specifications, such as RF sensitivity and RF power, a hardwired test criteria was generally acceptable to the committee members present. It was mentioned that manufacturers of products with integral antennas would need to equip sample products with RF connectors to meet the criteria of ETSI. Thus, hardwired testing for IEEE802.11 conformance testing is not necessarily an additional burden. There was, however, some concern expressed over the feasibility of independent verification of RF test performance where integral antenna(s) would need to be removed and replaced by connector(s). Since it may not be appropriate or possible to require manufacturers to provide instructions for replacement of integral antenna(s) with connector(s), it may not be practical to perform independent verification of all performance factors of every product.

In favor of radiated test was the argument that no equipment modification would be required. The radiation chambers required however is a consideration.

Of more fundamental significance is an issue of antenna performance. In order to best appreciate this issue, one must don one's fairness hat and think in terms of what's fair. Let us suppose that product A is rather larger and has a good dipole antenna. Further assume that the hardwired sensitivity of product A just meets the hardwired specification of -80 dBm. In a radiated sense, the sensitivity averaged over all directions is also -80 dBm since the antenna is lossless. Sensitivity in the best direction would be -78 dBm since the dipole has about 2 dB directivity gain. Now consider product B, a very small product with a poor performing but very small antenna. Let's say the antenna in the best direction is -6 dB (6 dB or more loss). If we think in terms of radiated patterns, it might be that the radio product is mounted in a PCMCIA slot, and has poor radiation in directions blocked by the host computer. Let's suppose that this small product has a high performance receiver providing -85 dBm sensitivity on a hardwired basis. The excellent receiver FAILS OUR SPEC. WHY? It fails because the spec includes the antenna performance. The electronics of B is actually very superior to product A but the laws of nature as applied to small antennas and the shadowing effects of host computers prevent good antenna performance. The fairness argument leads one to conclude that the hardwired test is more appropriate.

The informal consensus of the members present at the January meeting, as metered with a straw pole, was that the hardwired measurements were preferred.

3. Dynamic Mode testing

The issue of dynamic mode testing surfaced as a result of consideration of real world performance problems that might escape detection if only conventional static testing was utilized in conformance testing. There is concern that switching transients might effect sensitivity, IM or selectivity measurements. For instance, if a receiver took too long to change frequencies it might not be able to receive the header of a packet that starts on a new dwell boundary.

The group, therefore, concluded that there is need for submissions that will address the question of dynamic mode testing.

Relevant Motions:

With respect to PER issue, the following motions are presented as a means of making the conversion to packet error rate.

Motion 1
Move that the test of section 10.6.26 be changed as follows:

10.6.26 Receiver Sensitivity

Sensitivity is defined as the minimum signal level required to produce a ~~BER of 10-5~~ PER of 3%. For this test the packet shall consist of a 400 byte MPDU of pseudorandom data. A conformant PMD shall have the minimum signal level be less than or equal to -80 dBm across the operating frequency range specified in 10.6.2.

Motion 2
Move that the test of section 10.6.27 be changed as follows:

10.6.27 Intermodulation

Intermodulation protection (IMp) is defined as the ratio to measured sensitivity of the minimum amplitude of one of the two equal level interfering signals at 4 and 8 MHz removed from center frequency, both on the same side of center frequency, that cause the ~~BER~~ PER of the receiver to be increased to ~~10-5~~ 3%, when the desired signal is 3 dB above sensitivity. Each interfering signal is modulated with the FH PMD modulation uncorrelated in time to each other or the desired signal. A conformant PMD shall have the IMp for the interfering signal at 4 and 8 MHz be greater than or equal to 30 dB. For the purpose of this specification, the packet shall consist of 400 byte MPDU of pseudorandom data.

Motion 3
Move that the test of section 10.6.28 be changed as follows:

10.6.28 Desensitization

Desensitization (Dp) is defined as the ratio to measured sensitivity of the minimum amplitude of an interfering signal that causes the ~~BER~~ PER of the receiver to be increased to ~~10-5~~ 3% when the desired signal is -77 dB (3 dB above sensitivity specified in Section 10.6.26). The interfering signal shall be modulated with the FHSS PMD modulation uncorrelated in time to the desired signal. For the purpose of this specification, the packet shall consist of 400 byte MPDU of pseudorandom data.

Interferer Frequency	DP Minimum
M=N+/-2	30dB
M=N+/-3 or more	40dB

Table 10-14: 1M Bit Desensitization

*M is the interferer frequency and N is the desired channel frequency