IEEE P802.11
Wireless LANs

Joint BreezeCom+ NEC Proposal for 5 GHz modulation method

Date: March 1998

Authors: Naftali Chayat, BreezeCom; Kazuhiro Okanoue and Tomoki Ohsawa, NEC

Introduction

This submission presents a joint proposal of BreezeCom and NEC for 5 GHz modulation method. The proposal draws on beneficial aspects of both proposal to create a combination which we believe improves on both.

Separate Proposals - Comparison

The original separate proposals already had many commonalties:

- Both used coherent modulation
- Both used 25 Mbit/s basic uncoded rate
- Both relied on equalization in detection
- Both used a sequence optimized for carrier acquisition and channel estimation
- Both used Hamming (31,26,3) Error Correcting Code with interleaving

The proposals differed mainly in

- Offset Quadrature Modulation versus non-offset Quadrature Modulation
- Multilevel modulation option versus binary only option
- GMSK-derived pulse shape versus Square Root Raised Cosine pulse shape
- 3/7 channels versus 4/10 channels in 100/200 MHz, respectively.

The Unified Proposal

The unified proposal uses the following parameters:

- The modulation is an Offset Quadrature Modulation. The motivation is to retain the smaller amplitude variation in the binary mode and to improve the spectral shape when operating close to saturation.
- The pulse shape is SRRC pulse with 50% rolloff, as in NEC proposal. This enables to achieve excellent ACI properties and out-of-band emission properties at small power amplifier backoff.
- We retain the multilevel optional mode which enables to double the data rate when propagation conditions allow.
- The preamble will be based on the BreezeCom approach but will be lengthened to 320 bits instead of 256 to allow for better AGC convergence and diversity selection. The new sequence will have five repetitions of the subsequence –B32 instead of three repetitions.
- The interleaving method from BreezeCom proposal is adopted.
- The frequency plan is modified to 20 MHz spacing with 20 MHz distance from band edges. The resulting center frequencies are 5170, 5190, …, 5230 MHz (9 channels) and 5745, 5765, 5785 and 5805 MHz (4 channels) for the lower/middle and the upper U-NII bands, respectively. The spacing between the channels and the distance from band edges were chosen to relax the specifications on PA backoff requirements and even permitting saturated operation.

In addition to the major changes mentioned, we decided to adopt the following items:

- The waveform accuracy specification method will follow the spirit of definition as used in NEC proposal, with adaptation to Offset Quadrature Modulation instead of QPSK. The method is based on measuring the residual RMS intersymbol interference (ISI) after making least squares fit to several parameters- phase, frequency and timing offset and (this is a new addition) short (3 tap) ISI suppressing linear equalizer. The rationale for including the short equalizer option is that it will relax significantly the implementation accuracy requirements for filters in the transmitter, assuming that the receiver will implement equalizer anyway, and the residual transmitter inaccuracy will be absorbed in the channel model.
- The center frequency accuracy and clock frequency accuracy requirement will be 10 ppm. In fact, the +/-10 ppm accuracy requirement appears in the FCC document 97-5, as published in IEEE P802.11-97/10.

Performance Summary

The performance basically draws on the performance of OQM proposal by BreezeCom. The main point where significant changes are expected is the Adjacent Channel Interference (ACI) performance, due to different pulse shape and different channelization plan.

The ACI rejection performance depends on PA backoff and on PA model (see discussion in doc 98/106). The performance brought here uses the Rapp's model with P=1. The FCC 15.407.b.(1-3) requires the emissions in the first 10 MHz out of the band edge to be attenuated 27, 34 or 40 dB (in the low, mid and upper bands, respectively) and 37, 44 and 50 dB from there on. The proposed waveform satisfies the requirements of the lower band in saturation, in middle band with 0-1 dB backoff and in upper band with 4 dB backoff, in the binary mode.

The ACI performance at 2 dB backoff in the binary mode provides 23-24 dB rejection at 25 Mbit/s and 25-26 dB at 21 Mbit/s. In the quaternary mode 6 dB backoff was used for comparison, both because the quaternary constellation by itself has 2.55 dB peak-to-rms ratio and because it tolerates smaller distortion. The ACI rejection at 50 Mbit/s is 15 dB while at 42 Mbit/s it is 17 dB, for long packets (Note: about 10 dB improvement was observed in quaternary mode at 6 dB backoff when P=3 PA model was used).

Summary

The joint BreezeCom-NEC proposal draws the best elements from both proposals: it has an increased number of channels relatively to original BreezeCom proposal while retaining the capability to operate close to saturation of the RF power amplifier. The spacing between channels and from the band edge allow relaxed implementation of the transmitter in order to achieve the required ACI and regulatory requirements.