IEEE P802.11
Wireless LANs

An Improved Rate Signalling

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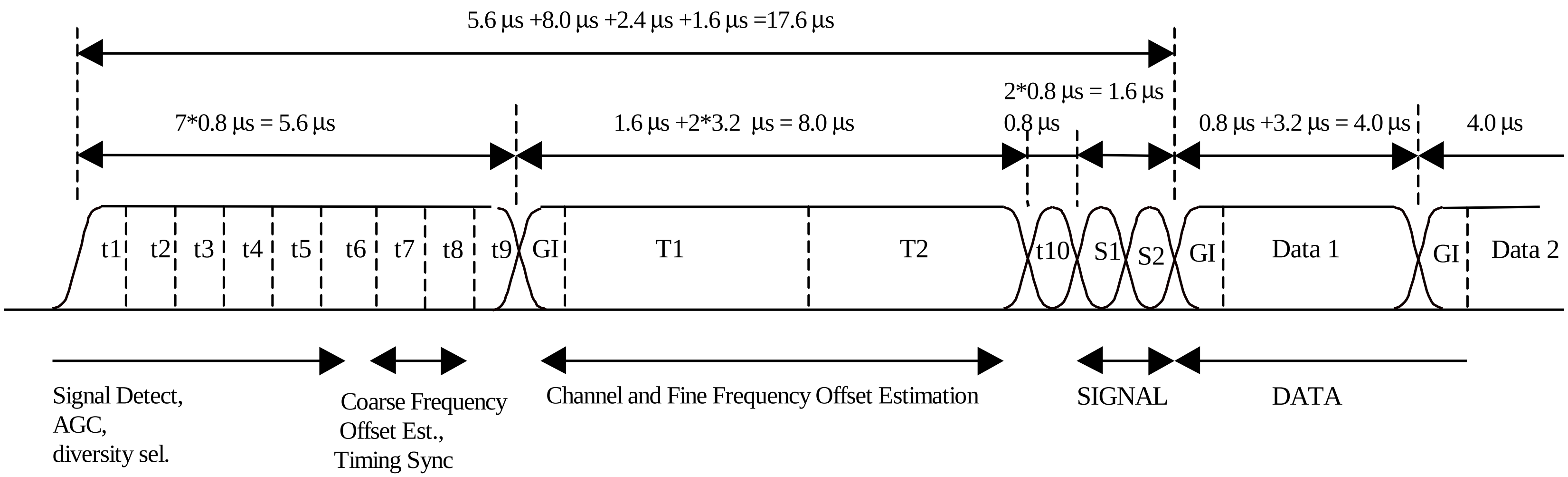
An Improved Rate Signalling

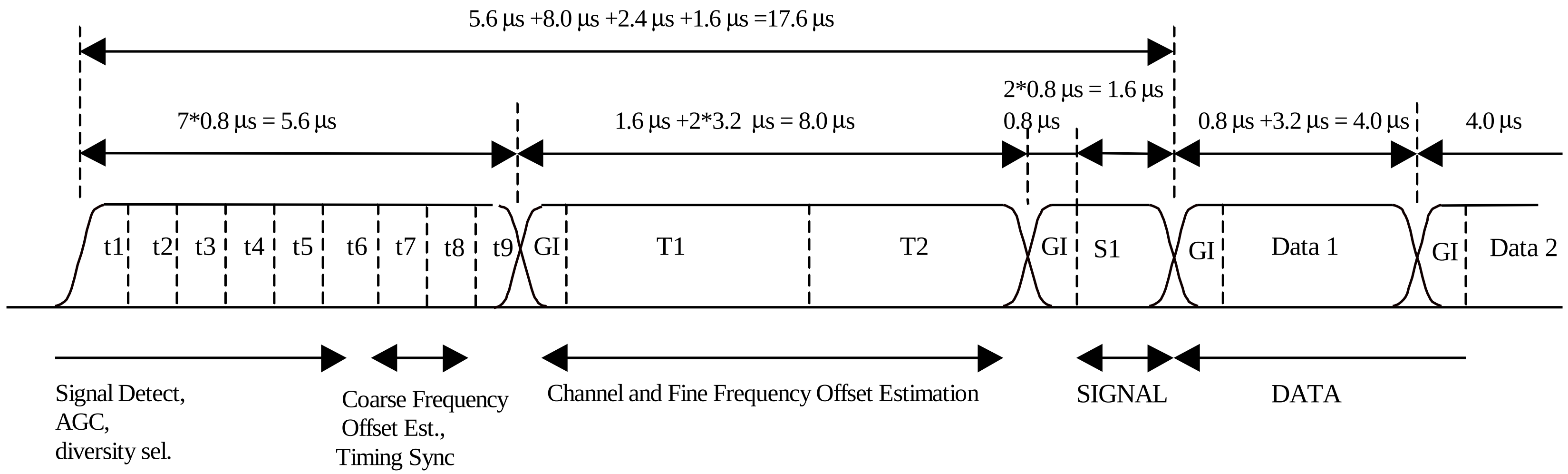
- The reliability of the rate-signaling scheme is crucial for the performance of the 802.11a Wireless LAN.
- We propose a new reliable scheme based on bi-orthogonal Hadamard coding and OFDM modulation.
- No overhead relative to current scheme
- Simple to implement.

Overview of current scheme



- 4 bits are conveyed by QPSK modulating the sequences S1 and S2.
- t10 serves as a guard interval.
- Overall length 0.8uS+0.8uS+0.8uS=2.4uS.
- In AWGN: same error rate as rate ½ BPSK OFDM. (6Mb/s).
- Non satisfactory performance under severe multipath conditions.

Proposed Scheme



- 4 bits are conveyed by the sequence S1 spanning 1.6uS.
- Additional guard interval of 0.8uS.
- Overall length 2.4uS – same as before.

Coding and Modulation

- 3 LSB select one row of Hadamard 8 matrix.
- The MSB selects sign.
- The 8 binary symbols are repeated 3 times to form 24 vector.
- The vector is multiplied with a cover sequence.
- The result is used to modulate the even subcarriers of a 64 point OFDM symbol. The time domain vector has two identical halves.
- The time domain vector is cyclically extended and a window is applied to truncate it to length 2.4uS.

Decoding and Demodulation

- The 32 samples signal is cyclically extended to provide 64 samples.
- A 64-point FFT is used to demodulate.
- The even subcarriers are multiplied by the cover sequence.
- The subcarriers are combined to produce an 8-point vector.
- A Fast Hadamard Transform is applied.
- The location of peak determines 3 MSBs. The sign of the peak determines the MSB.

- Both modulation and demodulation require existing H/W: namely the 64 point FFT/IFFT
- Coding and decoding require an 8 point fast Hadamard transform.

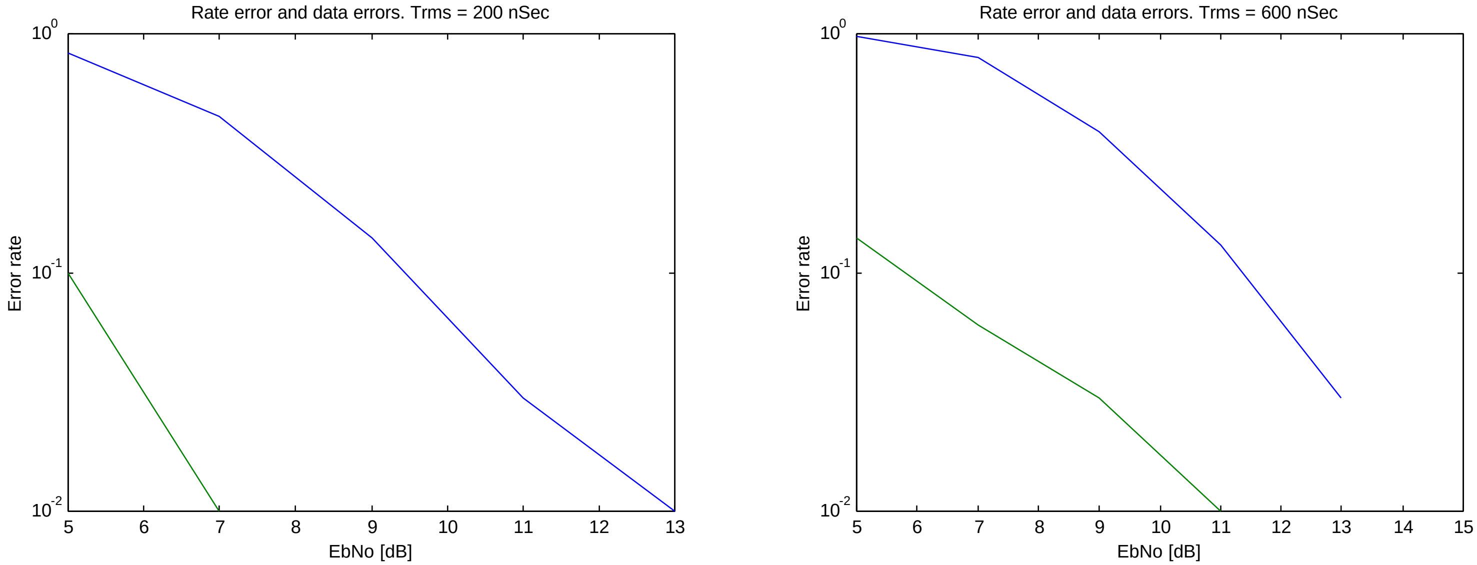
Performance in flat AWGN

- Let E_s denote the power per spectral line. Then for rate ½ k=7 BPSK we have $d^2_{free}=5*4E_s=20E_s$.
- For bi-orthogonal coding we have $d^2_{free}=2*8*3*E_s=48E_s$.

⇨ The bi-orthogonal scheme is better by 3.8dB than the coding scheme of the section.

Performance in severe multipath

Simulation results: 64bytes packets, 6Mb/s. Green : errors in rate field. Blue: errors in data.



Peak to Average Power Ratio

The cover sequence assures good PAP ratios for all codewords.

Codeword	PAP [dB]
1	3.2 dB
2	3.7 dB
3	4.6 dB
4	3.7 dB
5	3.2 dB
6	4.2 dB
7	4.6 dB
8	3.7 dB

PAP = 3.2dB… 4.6dB.

Extension to 5 bits

- Due to the proliferation of codes and data rates, (1/3 , 9/16 etc.) there is a need to convey more then 4 bits.
- The proposed scheme can be easily extended to support 5 bits.
- Performed by QPSK modulating the H_8 row.
- Decoding by complex 8-point FHT.
- Same minimum free distance of 48*E_s. Double number of minimum distance neighbours => Slight degradation in performance.

Conclusions

- A reliable method for transmitting the 4 bits of the rate field.
- Requires no overhead relative to the current scheme.
- Much lower error rate than the data section even in the most reliable mode, both under flat channel and under severe multipath conditions.
- Simple to implement. Uses existing modulation and demodulation mechanisms.
- Requires Fast Hadamard Transform to be implemented.
- Simple extension to 5 bits.