September 1997 doc.: IEEE P802.11-97/86

Suggested 802.11 High Rate PHY Technique

Harris High Rate data modulation demonstration

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September 1997 doc.: IEEE P802.11-97/86

Standard Definition Issues

- 10+ MBps Physical Layer standard
  - Provide backwards compatibility to IEEE 802.11 at 1&2 MBps?
  - Separate or integrated section for higher rates?
- Limited bandwidth available in the ISM bands
  - Maximize bits/Hz
  - Desire at least 3 channels
- Meet FCC requirements for ISM bands
  - FCC is comfortable with any solution that derives >10 dB from spreading function and passes CW test
  - Preliminary testing shows that the Harris technique will pass
- Textbook technique available without patent issues.

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Harris High Rate 802.11 Features

- Provides 10+ MBps wireless LAN data rates while maintaining interoperability with 1 & 2 MBps WLANs
- Increases data rate by ≥5x with no increase in the transmit bandwidth requirement

  Rate switching during packets is supported already
- 1, 2, 5.5, &11 MBps capability
- Fits in a PCMCIA package, uses existing RF and IF

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Suggested Technical Approach

- Utilize MOK/PSK modulation techniques to realize 4 to 8 bits/symbol
- Use existing preamble and header to insure interoperability.
- Increase symbol rate to 1.375 MSps (8 chip symbols) and hold existing spread rate
- Use existing 802.11 DS parts for the RF & IF circuits

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Additional Modifications to Standard

- Use last bit of PLCP header as an absolute phase reference for high rate demodulation.

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Performance Predictions

- MOK modulation is slightly more efficient than BPSK due to embedded coding properties. Theoretical performance is 7.8 dB Eb/N0 for 1.0e-5 BER.
- With 8 bits per symbol, Es/N0 is 16.8 dB.
- Should readily meet -80 dBm sensitivity but, we might want to spec it at -75dBm to provide margin
- Will pass FCC CW jamming test with margin
  - J/S suffers with higher Es/N0
  - FCC allows SNR to be defined as Es/N0

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Effects of Long Preamble

- The use of the interoperable preamble will reduce the average data rate.
- Longer packets will be less impacted.
- Overall network loading will impact the effective rates.
- A high rate preamble would alleviate these effects, but would eliminate interoperability.

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Submission

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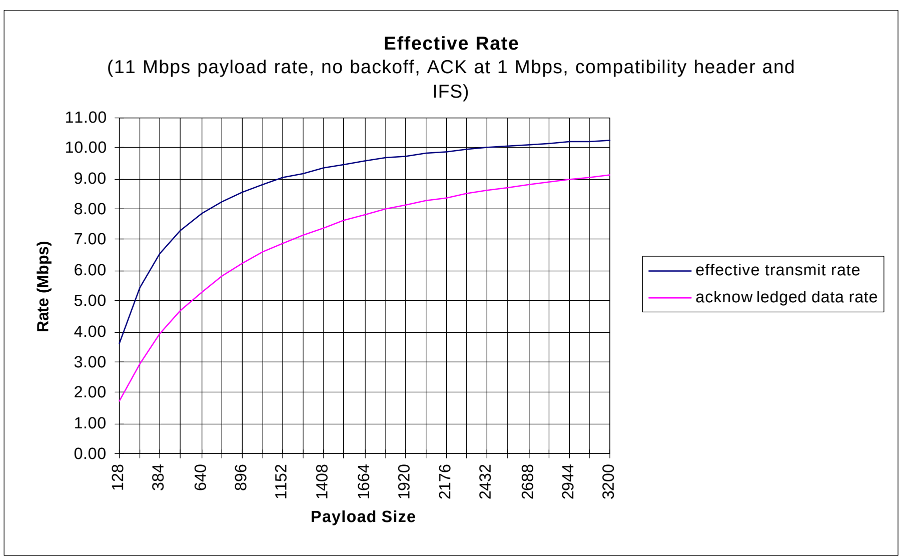
Effective rate versus packet size



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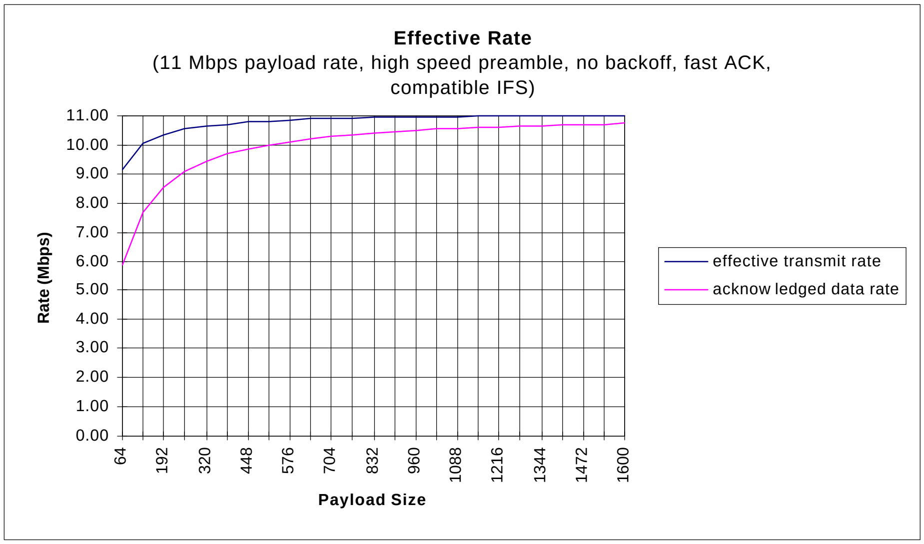
Effective rate versus packet size for short preambles



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Loading Effect Assumptions

- RetryMax=6, all transmissions are either successful or abandoned after RetryMax retries.
- Load is the probability that the medium will be busy when sensed.
- CCA is perfect and all stations can hear every other station (no transmissions are clobbered by hidden node problem).

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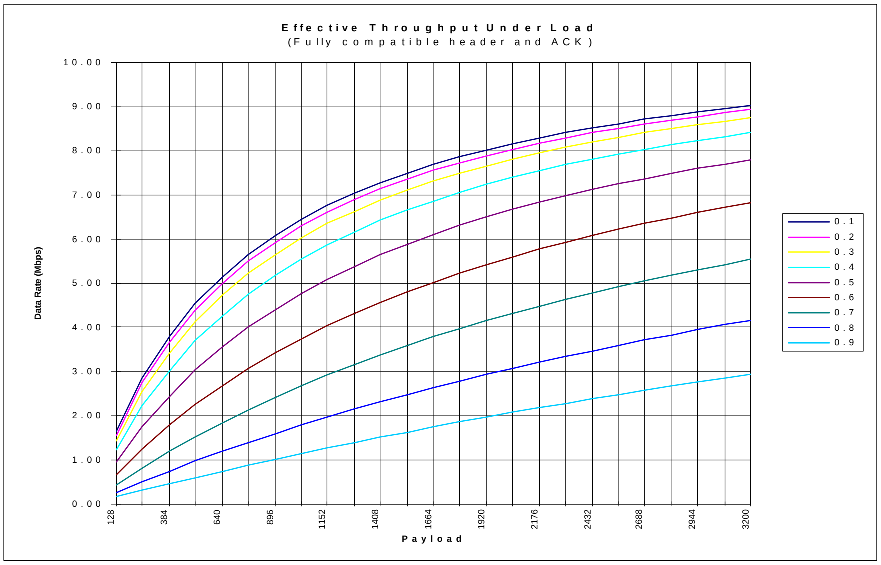
Effective rate versus loading



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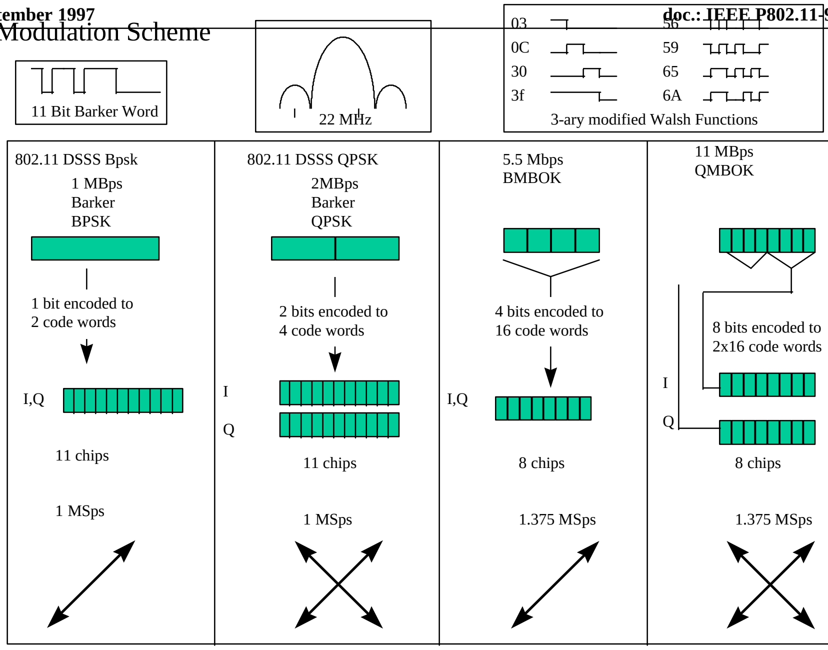
Modulation Scheme



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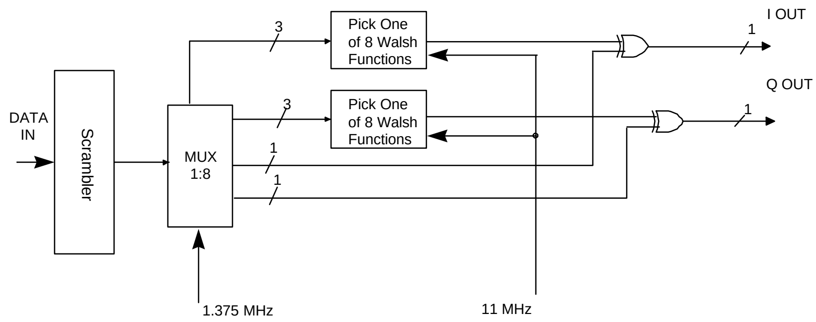
MOK Modulation Approach for 11 MBps



Data Rate = 8 bits/symbol * 1.375 MSps = 11 MBps

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MOK properties

- This modulation is the most power efficient available
- The spectrum is like 802.11 DSSS
- Multipath performance is nominal for the SNR
- Requires a cover sequence to avoid the Wal0 CW modulation (modified Walsh Functions)
- Requires coherent processing
- Moderate implementation complexity (~25% extra)

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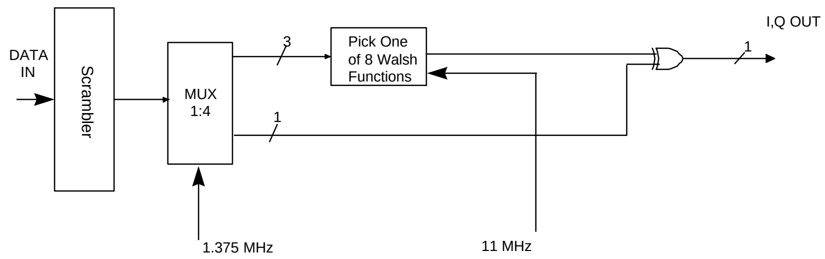
MOK Modulation Approach for 5.5 MBps



Data Rate = 4 bits/symbol * 1.375 MSps = 5.5 MBps

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5.5 MBps properties

- The 5.5 MBps mode uses BPSK modulation which is much more rugged than QPSK
- This modulation will achieve comparable range to the 2 MBps QPSK 802.11 mode.
- Stations can easily fall back to this mode when stressed, then 1 MBps if really stressed.

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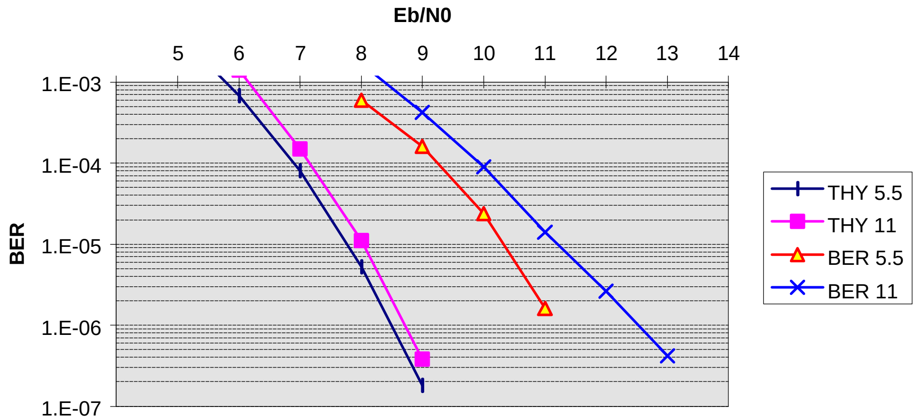
HFA 3860 BER performance



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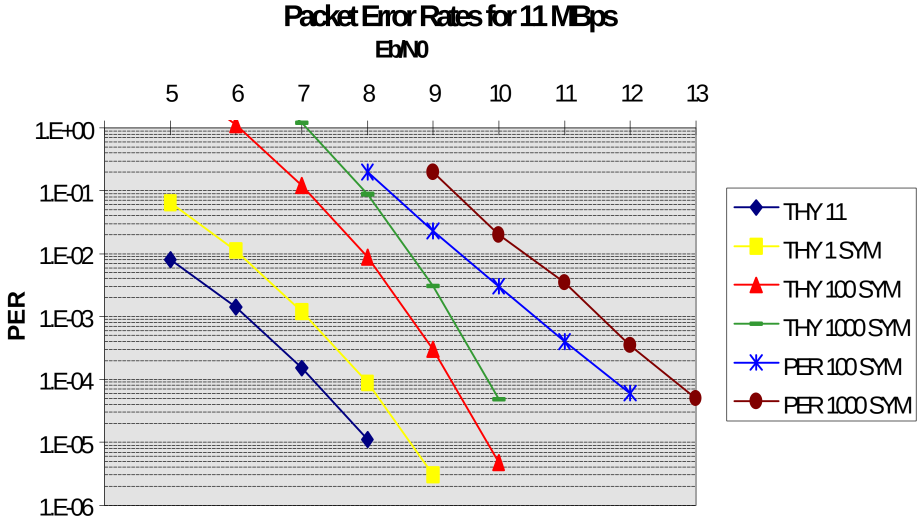
HFA 3860 PER performance



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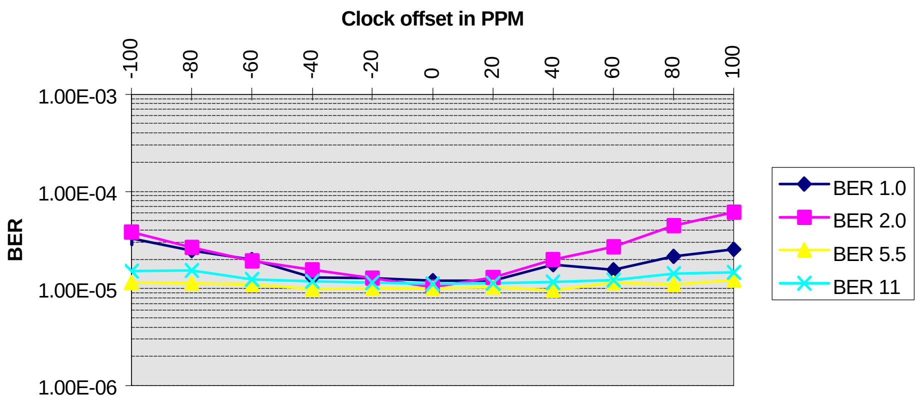
BER versus Clock Offset Performance



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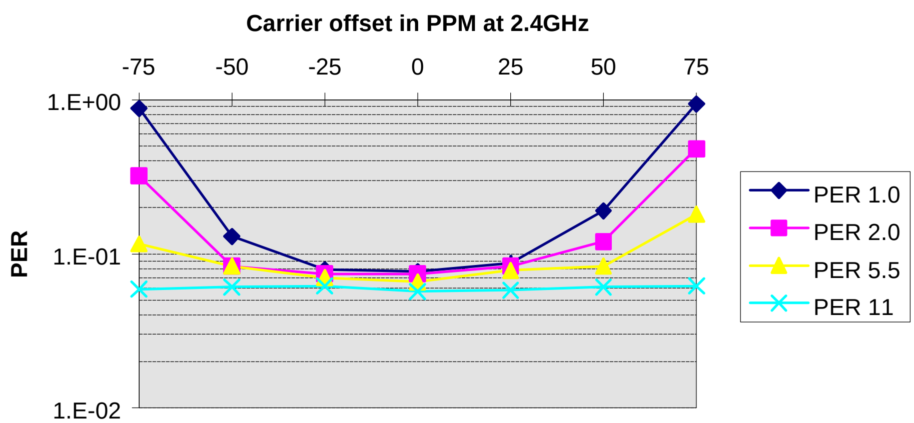
BER versus Carrier Offset Performance



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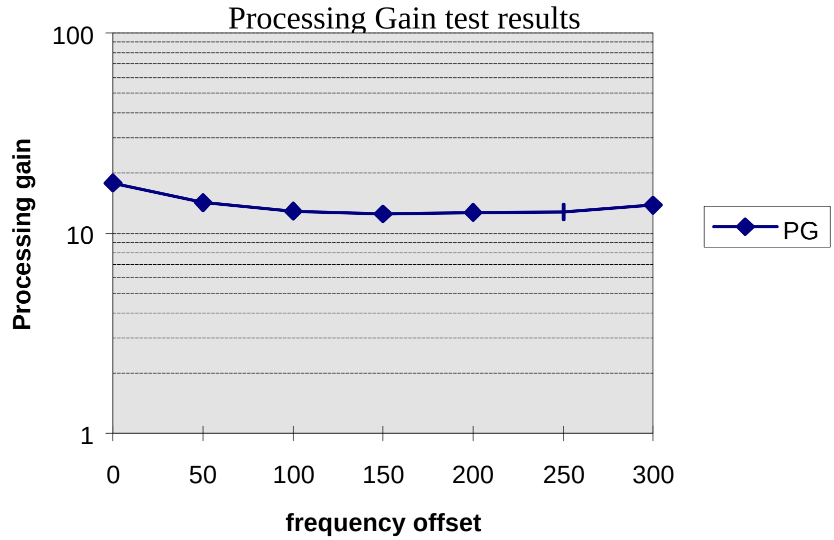

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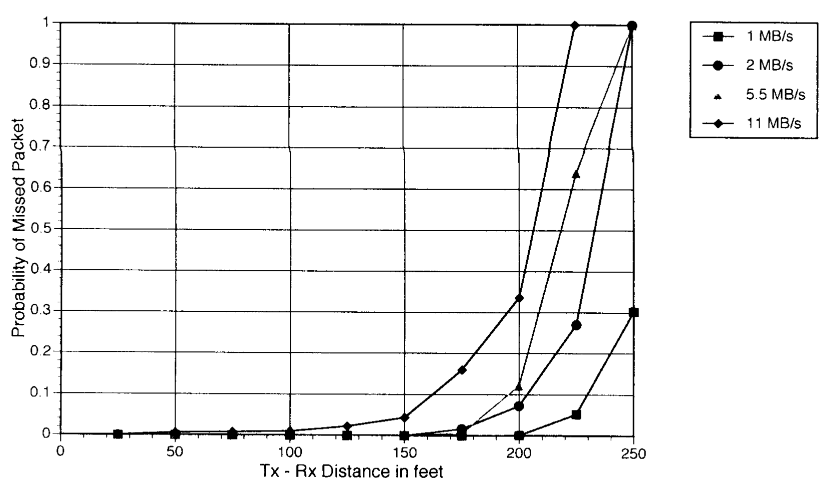
Propagation Simulations

Simulation results show probability of a missed packet.
100 trials per point. Packet length = 200 symbols
3 bit A/D Carrier and Chip Loops active.
Dual Antenna Diversity (assuming no correlation)

SAW is 3-pole Butterworth over passband
and 50 MHz 30 dB BW



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