November 1997 Doc: IEEE P802.11-97/144

Proposed 802.11 High Rate PHY Technique

Harris High Rate data modulation

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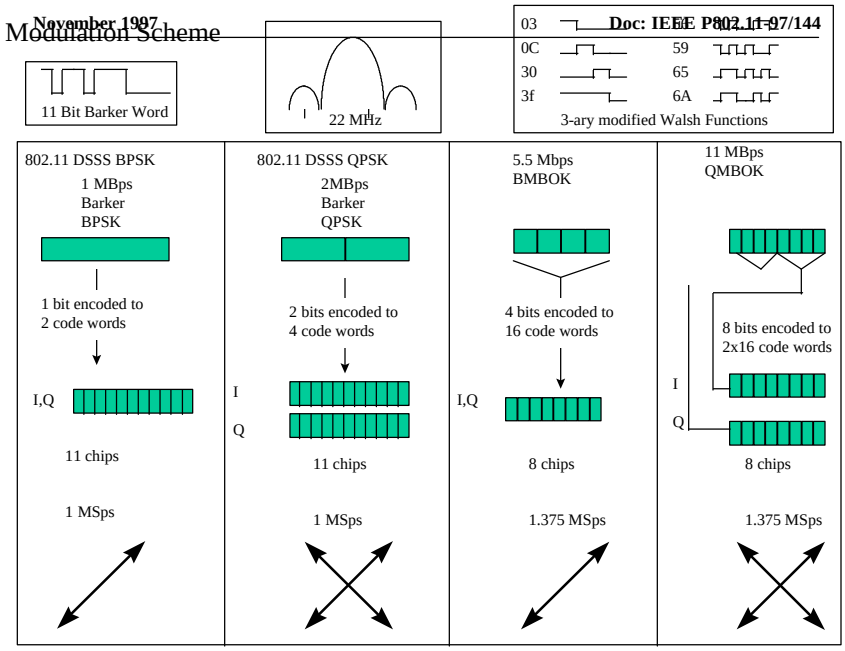
Suggested Technical Approach

- 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

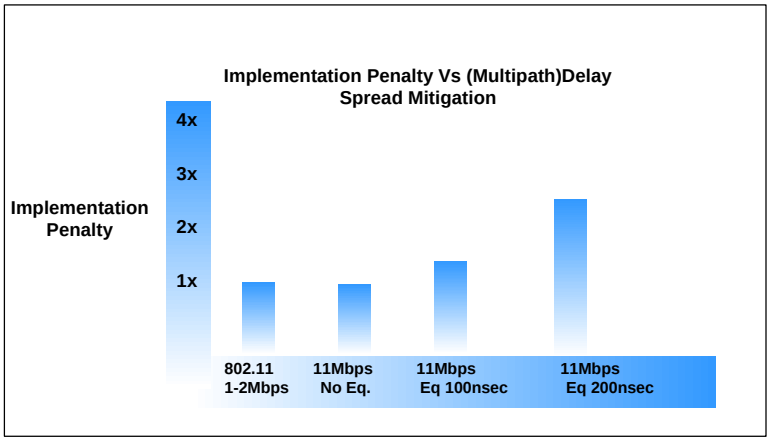


Harris High Rate 802.11 Features

- Harris approach allows a total raw system throughput of 33 MBps in the band versus 20 MBps for 32 MCps MSK and 6 for the existing 802.11 2 MBps
- Less interference with FH and DS by using less bandwidth and shorter packets
- Less complexity; can work without equalizer or channel estimator (but can use them for more greater delay spread since it has enough preamble)

More Features

- Less power amplifier backoff than PPM
- Less bandwidth than 16 chips per symbol
- Simple implementation
- No MAC changes



Performance

- Has proven -85 dBm sensitivity for 2% PER
- Will pass FCC CW jamming test with margin
  - FCC allows SNR to be defined as Es/N0
  - Measured 2 dB of margin on CW jammer test
- Range demonstrated to over 100 ft

Range Testing

- Harris has implemented the technique in an integrated circuit and demonstrated that in a typical radio design.
- Since a suitable MAC is not available we tested the radio with a substitute controller that allows BER and PER testing in the actual environment and the lab.
- We tested the PER performance in our facility in Palm Bay.

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The floor plan of the test area

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Pictures of test area

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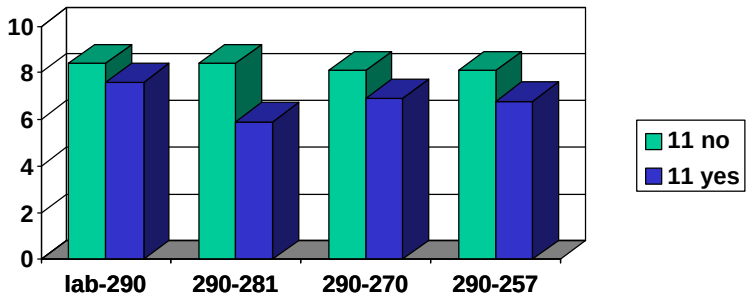
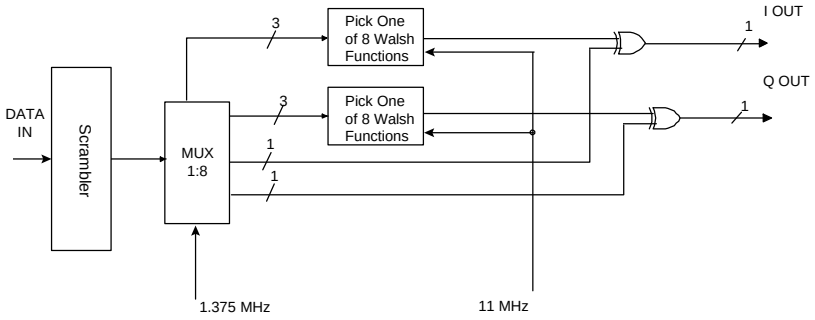
Range testing



These tests show achieved transmission rates for 512 byte packets and are all in the 50-100 ft range.. No/Yes refers to rotation of the radio.

MOK Modulation Approach for 11 MBps

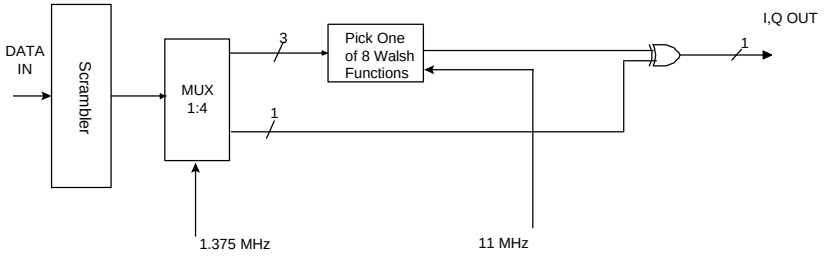


Data Rate = 8 bits/symbol * 1.375 MSps = 11 MBps

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 baseband processing circuitry)

MOK Modulation Approach for 5.5 MBps

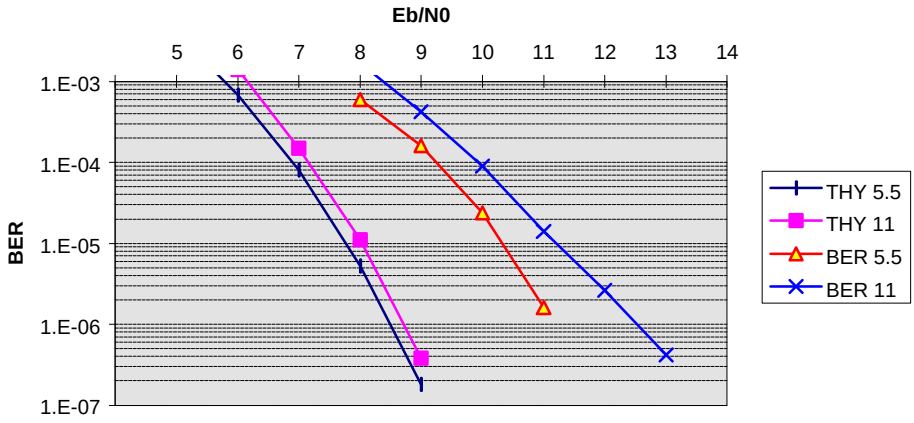


Data Rate = 4 bits/symbol * 1.375 MSps = 5.5 MBps

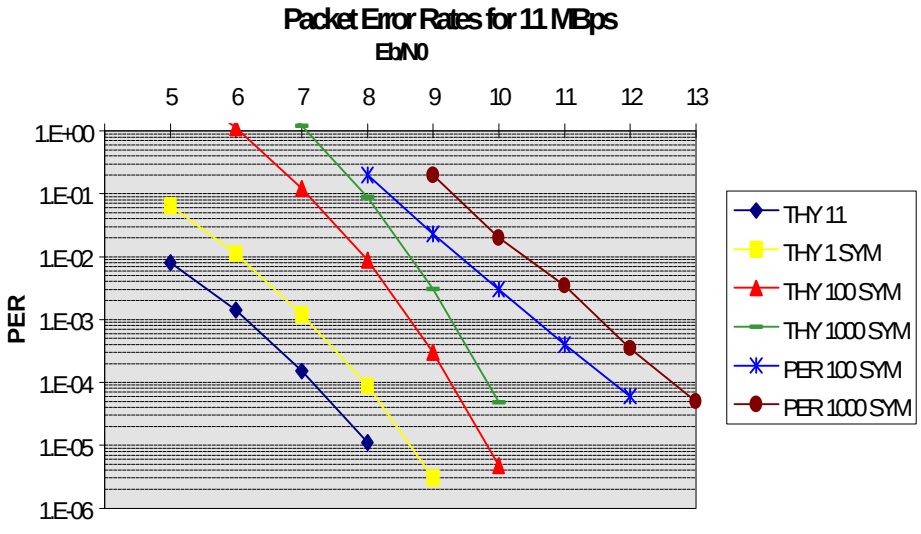
5.5 MBps properties

- The 5.5 MBps mode uses BPSK modulation which is more rugged than QPSK due to absence of I/Q cross sub channel interference
- Stations can easily fall back to this mode when stressed, then 1 MBps if really stressed.

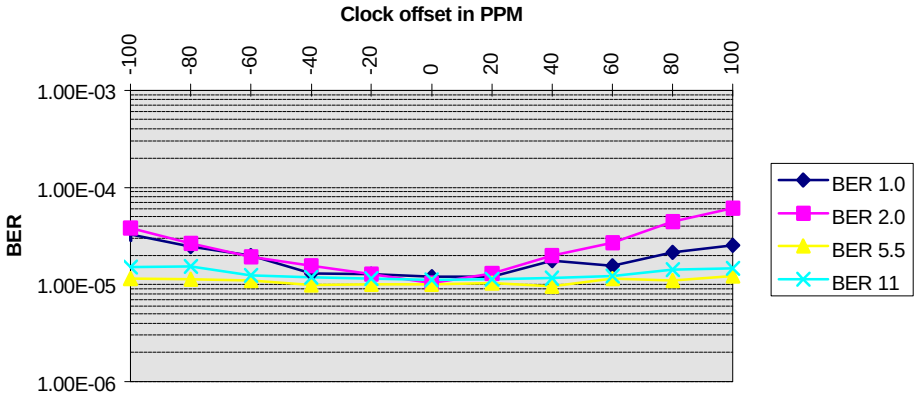
HFA 3860 BER performance



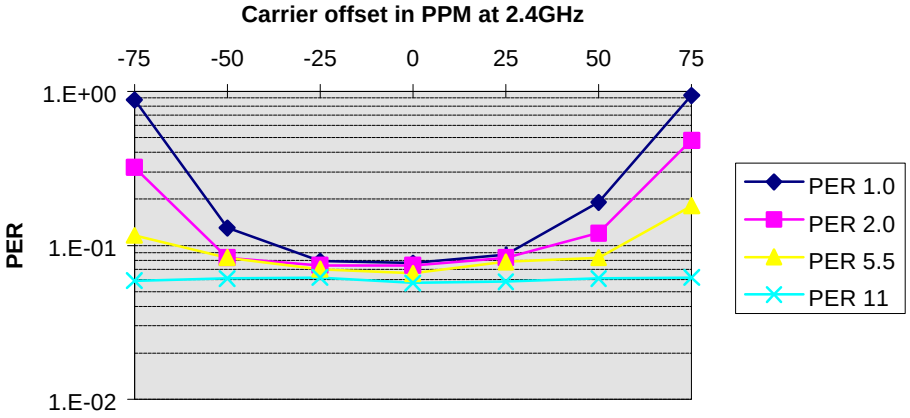
HFA 3860 PER performance



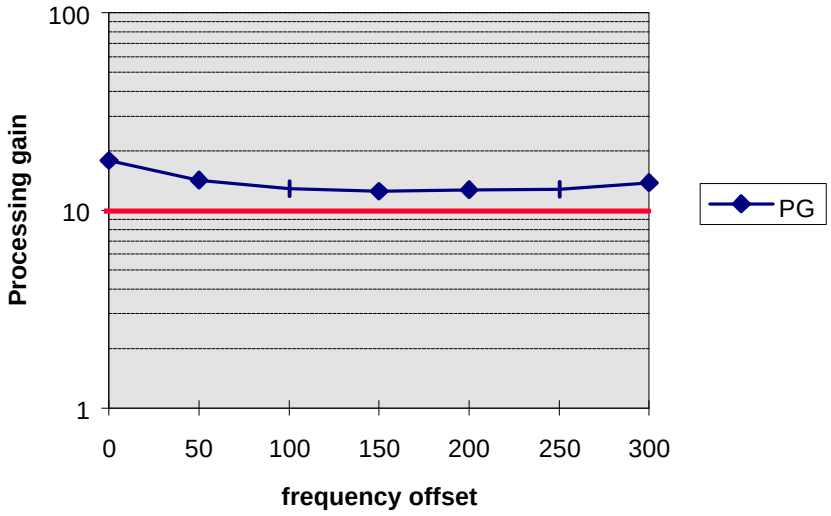
BER versus Clock Offset Performance



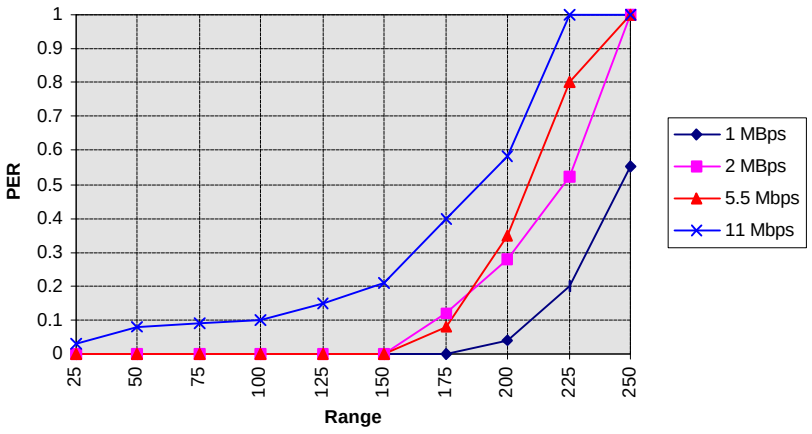
BER versus Carrier Offset Performance



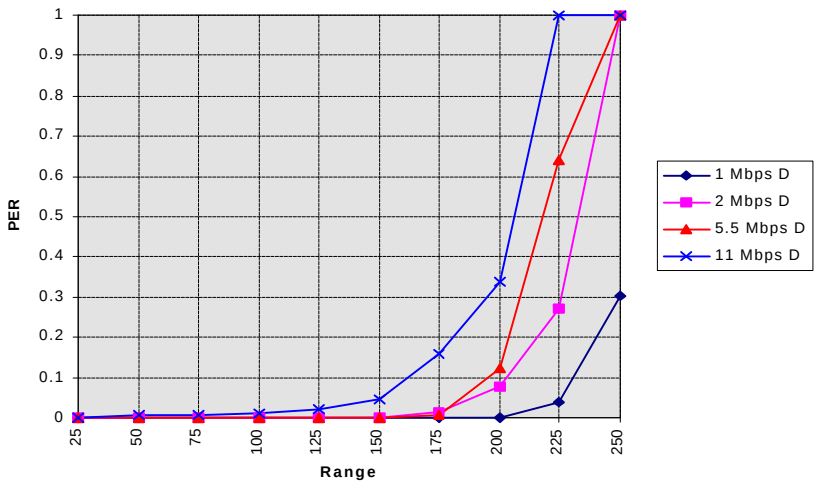
Processing Gain test results



Propagation Simulations without Diversity



Propagation Simulations with Optimal Diversity



Frequency disturbance tolerance

- FM deviation at 1kHz to cause modem to break lock
  - 1 Mbps >400kHz
  - 5.5 Mbps 48 kHz
  - 11 Mbps 25 kHz
- FM deviation at 1kHz to cause 10-5 BER
  - 1 Mbps >400kHz
  - 5.5 Mbps 48 kHz
  - 11 Mbps 25 kHz
- FM deviation at 1kHz to cause packet errors
  - 1 Mbps >400kHz
  - 5.5 Mbps 40 kHz
  - 11 Mbps 20 kHz

Like signal jamming

- The ability of the modulation to tolerate other networks in the area was tested. The results for S/J that causes 5% PER are:

Signal Jammer	1	2	5.5	11
1	6.2	7.6	6.9	8.7
2	4.2	6.5	4.0	6.7
5.5	0.9	4.9	3.0	7.9
11	0.9	3.1	1.9	6.8

The possibilities

- low cost with no post processing
- better with simple cross channel estimator and corrector
- very good performance with lots of processing
- all the above with the same waveform

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Interoperability

- If the committee decides to ignore compatibility, short headers can be used.
- Antenna diversity and equalization need a somewhat longer header than the shortest possible for maximum throughput.

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Variations

- Additional research is underway on variations to the chosen sequences for better multipath performance.
- If the 8 chips per symbol is a problem, higher numbers of chips per symbol are possible at some compromise in the data rate or spread rate.