High Rate DS PHY

IEEE 802.11 High data rate PHY extensions

- Introduction
- Definition
- Technical Approach
- Performance Predictions

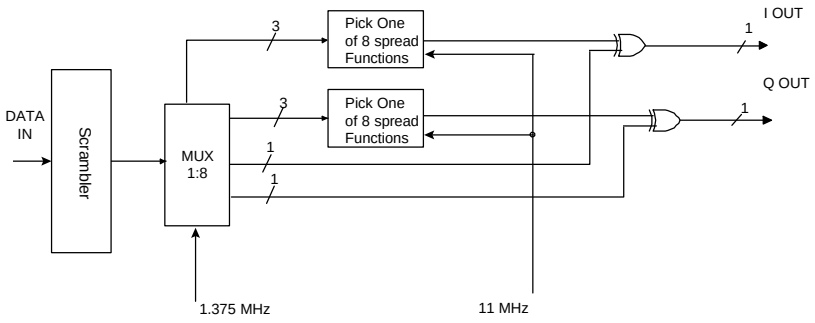
Tradeoffs

- The 802.11 PHY group has identified a need for higher data rates
- For higher data rates, we need a new DSSS waveform that has:
  - » good power efficiency (range)
  - » "10 dB PG", i.e. will pass FCC CW jammer test
  - » acceptable multipath performance
  - » Low to moderate amplitude modulation
  - » low implementation cost
- It would be desirable to use the existing preamble and PLCP header, so it would be interoperable with lower rate stations.

Modulation Options

- There are several options for increasing the data rate
  - » Multiple bits per symbol
    - – M-Ary Orthagonal Keying
    - – Cyclic Code Shift Keying
    - – M-QAM with 11 MCps spreading
  - » M parallel carriers
    - – Orthogonal Frequency Division Multiplex (OFDM)
    - – M parallel orthogonal Spread signals
  - » Others
- Higher spread rate not considered, it reduces number of available channels too much

MOK Modulation Approach for 11 MBps

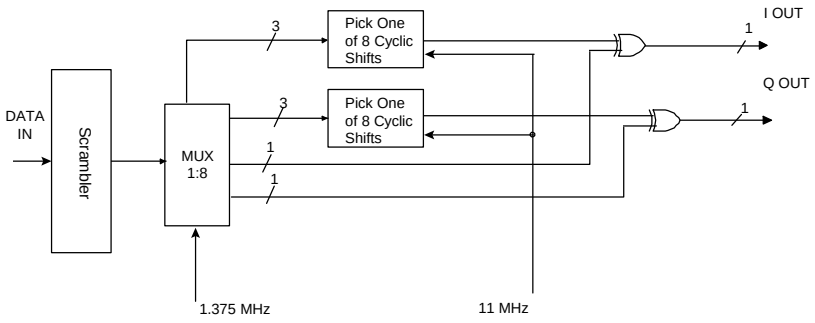


Data Rate = 8 bits/symbol * 1.375 MSps = 11 MBps

MOK properties

- This modulation is most power efficient
- The spectrum is like the 802.11 DSSS
- Multipath performance is nominal for the SNR
- Requires coherent processing
- Moderate implementation complexity

CCSK Modulation Approach for 11 MBps

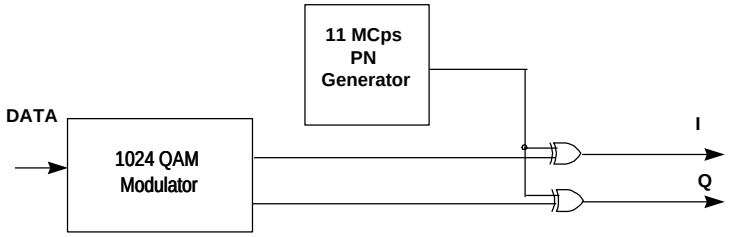


Data Rate = 8 bits/symbol * 1.375 MSps = 11 MBps

CCSK properties

- The CCSK modulation symbols are not orthogonal, so they do not achieve as high an efficiency as MOK.
- The CCSK symbols are susceptible to long range multipath.
- Requires the least hardware to implement.

QAM approach



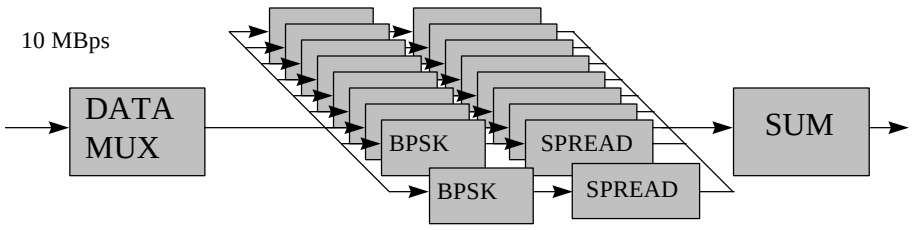
10 bits/symbol * 1 MSps = 10 MBps

QAM properties

- 1024 QAM is very sensitive to distortion and would need an equalizer to even be considered.
- Does not achieve a good Eb/N0

Parallel Spread Channels Approach

Orthogonal Code Division Multiplex (OCDM)



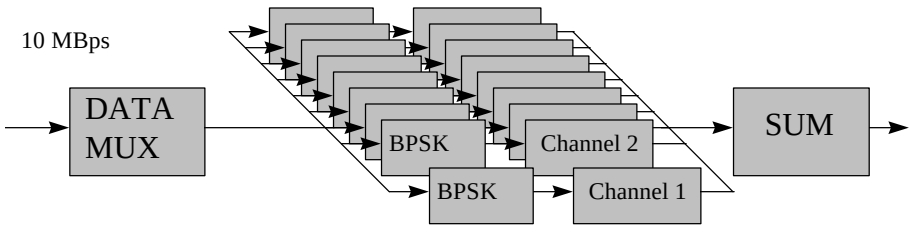
16 SPREAD CHANNELS AT 0.68 kBps = 10 MBps

OCDM Properties

- Multiple summed orthogonal signals produce a high degree of incidental amplitude modulation.
- Good Eb/N0 (power efficiency)
- Same spectrum as 802.11 currently
- Moderate implementation complexity

OFDM Approach

Orthogonal Frequency Division Multiplex (OFDM)



16 FREQUENCY CHANNELS AT 0.68 kBps * 1 bit/channel = 10 MBps

OFDM Properties

- Best use of the spectrum with flat characteristic.
- Large degree of amplitude modulation.
  - » Means that a very linear power amplifier is required
- Complex processing (FFT)
  - » More cost and power consumption
- Good spectrum and power efficiency in waveform
- Can use differential, non-coherent processing

Trade Table

Scheme	MOK	CCSK	QAM	OCDM	OFDM
Eb/N0	1	2	5	2	2
Multipath	2	4	3	1	1
Jamming	1	1	4	1	1
Spectrum	2	2	3	2	1
AM Mod	2	2	3	4	4
Range	1	2	5	2	2
Complexity	1	1	3	2	5
total weight	10	13	26	14	16

Lower is better

Standard Definition Issues

- Lack of 10+ MBps Physical Layer standard
  - Provide backwards compatibility to IEEE 802.11 at 1&2 MBps
- Limited bandwidth available in the ISM bands
  - Maximize bits/Hz
  - Need at least 3 channels
- Meet FCC requirements for ISM bands
  - Preliminary review is encouraging
  - FCC is comfortable with any solution that passes CW test
- Interoperate with 1&2 MBps equipment

High Rate 802.11 Features

- Provide 10+ MBps wireless LAN data rates while maintaining interoperability with 1 & 2 MBps WLANs
- Increase data rate by at least 5x with no increase in the transmit bandwidth requirement
- Rate switching during packets is supported already

Modifications to Standard

- To get high rate use more complex modulation at same spread rate.
- Use standard PLCP preamble and header to establish carrier phase and frequency lock.