802.11a - High Speed PHY in the 5 GHz band PHY overview

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What is 802.11?

• Finalized a standard for Wireless LANs in the 2.4 GHz ISM band in July 1997
  – Single MAC, three PHYs: FHSS, DSSS, IR
  – Connectionless services

• Today the group works on
  – High speed PHY in the 5 GHz band
  – Higher speed PHY in the 2.4 GHz band
  – Wireless PAN (Personal Area Networks)
802.11 TGa status

- Task Group a formed in July 97
- Modulation selected in July 98
- Text finalized in Nov 98
- First letter ballot issued Nov 98, processed Jan 99, 82% support after revision
- Reconfirmation ballot issued Jan 99, to be processed in March 99, initially 92% support
802.11a - 5 GHz High Speed PHY

Presentation Overview

• Main parameters
• OFDM basics
• ECC, Modulations, Preamble design
• Channelization schemes
• Spectral mask requirements
• Overview of cooperation with other standards bodies (BRAN, MMAC)
Main Parameters

• 20 MHz channel spacing
  – 16.6 MHz signal bandwidth

• Multiple data rates-  6 to 54 Mbit/s
  – support of 6, 12 and 24 Mbit/s rates is mandatory

• OFDM modulation
  – BPSK, QPSK, 16QAM or 64QAM on each subcarrier
  – pilot assisted coherent detection

• 802.11 multirate mechanism support
OFDM Frame Structure

- Carrier spacing is 312.5 KHz
- Fourier transform performed over 3.2 microseconds
- 0.8 microsecond Guard Interval for ISI rejection
Data and Pilot subcarriers

- 52 non zero subcarriers
  - 48 data subcarriers
  - 4 carrier pilot subcarriers

- Center frequency subcarrier not used
  - Leakage in quadrature modulators may corrupt the data
Error Correction Coding

• ECC is a must - some subcarriers may fade
• Bit Interleaved Convolutional Coding used
  – more robust that trellis in Rayleigh fading
• Industry standard K=7, R=1/2 code
  – higher coding rates (2/3, 3/4) derived by puncturing
  – tail zero bits added to message (trellis termination)
• Interleaver spans one OFDM symbol
  – latency and complexity considerations
Supported Rates and Modulations

<table>
<thead>
<tr>
<th>Constellation</th>
<th>coding rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/2</td>
</tr>
<tr>
<td>BPSK</td>
<td>6 Mbit/s</td>
</tr>
<tr>
<td>QPSK</td>
<td>12 Mbit/s</td>
</tr>
<tr>
<td>16 QAM</td>
<td>24 Mbit/s</td>
</tr>
<tr>
<td>64 QAM</td>
<td></td>
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</tbody>
</table>

• Modulation of the data subcarriers by either
  – BPSK, QPSK, 16QAM or 64QAM
  – 1, 2, 4, or 6 bits/subcarrier, correspondingly

• 12 Msubcarriers/sec (48 subcarriers each 4 μsec)
Preamble Structure

• Nine repetitions of short sequence in the beginning
  – Signal Detection, AGC convergence, Diversity resolution, Timing estimation, Coarse frequency estimation

• Two repetitions of long sequence with Guard Interval
  – Fine frequency estimation, Channel Estimation
Channelization in US

8 carriers in 200 MHz / 20 MHz spacing

4 carriers in 100 MHz / 20 MHz spacing
Spectral Mask Requirement

- The mask determines worst case ACI
- The need to pass local regulatory requirements is explicitly mentioned
Coordination with other Standards Committees

- 802.11 TGa cooperates with the European ETSI BRAN (Broadband Radio Access Networks) and with Japanese MMAC (Mobile Multimedia Advisory Council) to achieve commonality in PHY specifications
- MMAC Wireless Ethernet group will adopt 802.11a
- MMAC Wireless ATM group and BRAN agreed on basic parameters (52 subcarrier OFDM, channel spacing), but adapt some details such as preamble structure and rate signaling to their requirements