Tentative minutes of the IEEE 802.11 TGa (5 GHz) meeting held at Lynnwood, WA, January 19-23, 1998

Chair: Naftali Chayat

Secretary/Editor: Mike Trompower

Monday, 19 January 1998
meeting called to order at 11:00 by Naftali

Set Agenda:
- approval of Minutes from November Meeting
- review of current submissions
- acceptance of new modulation submissions
- acceptance of other papers not directly related to modulation methods
- set agenda for March Meeting

Motion 1(approved by unanimous consent): motion to approve agenda as established above

Motion 2(approved by 20-0-5): motion to approve minutes of November meeting task group A

New Document list is the following:
> OQM PHY - Naftali (98/21)
> OFDM Phy - Richard VanNee (98/12)
> QPSK Phy - (98/34, 98/35)
> OFDM - (98/02, 98/03)
> Bi-Orth - Cafarella (98/17,98/13)
> L-PPM - Reza Ahi (98/38)

No new modulation methods were introduced

No other submissions were requested.

Tuesday, 20 January 1998
meeting called to order at 08:30 by Naftali

presentation of document 98/12 by Richard VanNee
title "OFDM Physical Layer Specification"
- Key OFDM parameters
  - bit rates of 10,20, 30Mbps in order to allow comparison
  - 48 subcarriers, 64 point fft, 4.8us symbol time, 800 ns guard time (allows 200ns delay spread handling at 20Mbps), 16-QAM and QPSK, coding rates of 1/2 and 3/4, channel spacing of 15MHz
- Channelization
  - spectrum mask shows 3dB bandwidth of 12 MHz and 20dB bandwidth of 15 MHz
  - allows 5 channels in 100 MHz with 12.5 MHz of guard bands at edges
  - allows 11 channels in 200 MHz with 17.5 MHz of guard bands at edges
- Frame Format
  - SYNC pattern = 11symbols OFDM symbols
  - SIGNAL field = 2 symbols of OFDM symbols
  - scrambling must start from the beginning of the Service field
- Coding and Interleaving
  - rate 1/2 length 7 convolutional code, puncturing 2 out of 6 bits gives rate 3/4
  - block interleaver over 1 OFDM symbol providing interleaving depth of 4.8usec
  - gray code mappings to make QPSK or 16-QAM from binary code output
- Training Structure
  - 1usec short training symbols for resolving frequency errors up to 500 KHz
  - 4.8 usec training symbols used for channel estimation
  - length 12 and length 48 complementary codes used to get training signal with peak to average -power ratio of 3dB
  - 4bits of information on modulation and coding by QPSK modulation of two short training symbols
  - BPSK/QPSK/16-QAM/64-QAM
  - coding rates of 1/.75/.5/??
- Questions
  - there is the potential for near-far problems as with any other system. an adjacent channel with higher power would interfere (adjacent channel) at greater levels but the author believes that coding would overcome the interference.

presentation of document 98/03 by Hitoshi Takanashi
title "Performance of DQPSK-OFDM in Multipath Rayleigh Fading Channels"
- Key OFDM parameters
  - very similar to Lucent proposal - bit rates 20Mbps, 48 subcarriers, 64 point fft, ??us symbol time,
- Description of Channel Model
  - 18 pulses
- Conclusions
  - can handle delay spreads of 400ns and more is tolerable
  - OBO (output power backoff) of 4 or 5 dB is enough
  - can adopt Hiperlan spectrum allocation
  - 20dB Eb/No is needed in Rayleigh fading channel
  - propagation loss of up to 92dB is possible in Rayleigh fading

presentation of document 98/02 by Hitoshi Takanashi
title "Proposal for 5GHz modulation"
- PLCP Specification
  - -uses AGC-pull-in and synchronization symbols
  - -the header and crc is protected by FEC
  - -transmit and receive procedures will need bit stuffing to get full sybols
- Key points
  - -96 bits per OFDM symbol
  - -modulation causes a DC offset so that the center carrier which is affected is not used to transmit any data.
  - -raised cosine windowing is used to reduce adjacent channel interference
  - -84 samples per symbol - 64 point FFT, 12 ???, 4 ???
- Questions
  - -bandpass sampling could be used to avoid DC offset problems (single A/D and AC coupling)
  - -European Digital Audio Broadcast is an example of a system that does not use the center carrier to avoid DC offset problems

presentation of document 98/17 by John Cafarella
title "Proposal for 5GHz Physical Layer Specification"
- Key parameters
  - -removed SERVICE field because it is not used
  - -40 symbol SYNC, 1 symbol SFD, 1 symbol SIGNAL, 3symbol LENGTH, 4symbol Reed -Solomon CRC
  - -LENGTH field reports the number of data bytes (not the time in microseconds)
  - -bit rates of 2,8,12,18,24 Mbps
  - -channelization = 48MHz each, 2 channels per 100MHz, 6 channels possible in 5GHz
  - -different data codes (and/or search codes) can be used to provide additional channels
  - -scramble codes can be used to provide additional channel separation
  - -significant overlap of cells, requires frequency separation,
  - -minimal overlap of cells only requires the use of different codes
  - -frequency tolerance of +/-10 ppm,
  - -chip clock tolerance of +/-4ppm
  - -slot time of 25usec, TX/RX = 10usec, RX/TX=5usec, CCA=10usec
  - - -80dBm RX sensitivity (could do better if the manufacturer chooses)
  - -35 dB adjacent channel rejection is specified.

presentation of document 98/34 by Tomoki Ohsawa
title "QPSK Modulation for 5GHz (comparison)"
- Key parameters
  - -QPSK moduation
  - -root Nyquist filter with 50%rolloff
  - -10 and 12.5Msymbol/sec
  - -FEC (31,26) BCH
- review of receiver architecture
  - -description of symbol state transitions
  - -correlation function of SEQ64
  - -receiver performance using 64 and 1000 bytes packets was shown with AWGN and various delay spreads with and without FEC
  - -adjacent channel separation of 17.5 MHz is suggested to get 20dB of isolation

-description of AFC structure - about 30ppm tolerance is required for reasonable performance
CCA mechanism using envelope detection was described (less than 5usec processing time)
- Frame Structure
    -124 symbol SYNC, 8 symbol SFD, 16 symbol PLCP
- Channelization
    -18.75 MHz per channel
- Questions
    -the presenter proposes that the final version will have only one symbol rate and they have not determined which is the best rate

presentation of document 98/21 by Naftali Chayat
title "Proposed text for Offset QPSK Modulation for 5GHz"
- Key parameters
    -previous presentations stressed similarities to HiperLan. This time this criteria is removed.
    -21Mbps (up to 50Mbps) using 25Msymbol/sec rate
    -Rate field is defined to be 4 bits with 2 bits being used to identify the coding method used.
    -proposed code is (31,26,3) Hamming code
    -interleaver structure is changed from previous submission. now proposing a parallel scheme in order to take advantage of no latency of filling the table on transmit process
    -Method supports future channel hopping definition, however difficulties of hopping over channels in UNII band with different transmit power requirements should be considered
    - 40ns symbol time
    - proposal to use 800ns air propagation time
- Frame Format
    -256 bit total: 96bit sync (3 x 32 repetition), 128 bit SFD, 32 bit tail + PLCP information + CRC
    -4 bit RATE signaling (2 for rate, 2 for coding)
    -8 bit reserved field
    -synchronous scrambler as used in current FH system
- Channelization
    -25 MHz spacing
- Questions
    -why are most proposals using relatively weak coding schemes rather than specifying a better trellis code?
    -soft decoding methods could be used to get simpler implementations? hard decoding method gives about 2dB coding gain

Wednesday, 21 January 1998
meeting called to order at 08:30 by Naftali

Naftali reports on evening meeting in which TGB (high speed 2.4GHz task group) has made the decision to delay the selection of a modulation until May 1998. He asks the feeling of this group whether to adopt the same time frame or continue upon the current schedule which requires a modulation selection in March 1998.

general feeling of group is that each person will interpret (and weight) the comparison criteria according to his particular needs/requirements.

Naftali creates a straw poll to determine the relative importance of the current list of criteria in attempt determine the groups ability to choose a single modulation in March.

NOTE: (there are approximately 45 attendees in the room)
discussion which occurred before each straw poll follows the table

Criteria Parameter	Definition	Relative Importance
Sensitivity	those that feel sensitivity is MAJOR parameter	YES=5 / NO=2
Multipath robustness (using current noise free model with 10% PER at 20Mbps)	assuming receiver complexity is: 50ns a suitable minimal delay spread requirement 100ns 150ns 250ns	complex/simple/noneed C=0 / S=24 / N=0 C=2 / S=21 / N=0 C=16 / S=9 / N=2 C=0 / S=2 / N=20
Radio requirements: PA backoff linearity phase noise frequency stability	How many feel that the radio requirements will be the MAJOR reasoning affecting their choice of a modulation scheme?	(YES=17 / NO=3)
Baseband processing complexity	How many feel that the baseband processing complexity will be the MAJOR reasoning affecting their choice of a modulation scheme?	(YES=18 / NO=2)
Power consumption	How many feel that the product power consumption will be the MAJOR reasoning affecting their choice of a modulation scheme?	(YES=17 / NO=1)
Reuse related parameters CCI and ACI BW / # of channels restricted band edge performance	those that feel CCI and ACI is important? those that feel channelization is important? those that feel performance at band edges is imprt?	(YES=19 / NO=0) (YES=24 / NO=0) (YES= / NO=)
Special Technologies		

general discussion:
Sensitivity:
- sensitivity is a nonlinear function and difficult to quantify across implementations and differing modulations.

Multipath Robustness:
- multipath tolerance is not enough of a measure by itself, this measure must also account for noise models as well. additionally the measurement must be taken near the receiver's noise floor.

- we are reminded of a previous paper which reported that typical office environments have about 30ns delay spread whereas warehouses have about 200ns delay spread. the paper suggested that 50ns delay spread be used for modulation comparison purposes.
- It is pointed out that today's typical users will want high speed and want connectivity simultaneously in both environments.
- measurements performed by several companies show that multipath affects can be assumed constant for packet lengths of at least 1ms. non mobile environments can have stability for 5ms packet sizes.
- a vendor implementation may support greater delay spreads by switching to a lower rate. The selection ought to take into consideration that a lower rate support is favorable

Radio requirements

- there should be a cost limit placed on the implementation in order to have a reasonable comparison. Solving phase noise problems and frequency stability issues can solved by applying more resources. PA linearity affects power consumption and cost. It was pointed out that IEEE cannot discuss the cost of implementation but only have work towards a technical solution providing interoperability.

Power consumption

- the consumption measured for the whole product.

Reuse Parameters

- band edge and regulatory restrictions are not uniform from domain to domain and provide for irregular specifications
- some implementations may choose to back off power in order to meet (help meet) the restrictions
- should the standard support multiple spectral masks for multiple power levels and/or bands

Thursday, 22 January 1998
meeting called to order at 6:30PM by Naftali

presentation of document 98/38 by Reza Ahi
title "LPPM Modulation Physical Layer Specification"
- Key parameters
   -bit rates of 10 and 20 Mbps
- Frame Structure
   -12symbols for AGC, 8symbols for sync, 40symbols for diversity, 4 for resync
- channelization
   -26.6 MHz bandwidth using about 23MHz between center frequencies
   - 3 channels per 100MHz UNII bands
   - expect about 30dB adjacent channel rejection (still under investigation)

questions
   -Naftali presents argument that actual channel bandwidth is closer to 80MHz.
   -Reza states he will confirm for next meeting.
   -Reza confirms that there will slight variations in packet size and precise determination of packet size will not be possible.
   -Reza states that the advantage of using 'differential' PPM is to increase the data rate. The average pulse length will be 200ns instead of the maximum length of 330ns

Naftali reviews the criteria (97/62r2) required by the presenters to make public before the March meeting (Feb23).

establish agenda for March meeting
-Review of Proposals
-presentation of submissions
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March agenda approved by consensus

meeting closed 3:00