Minutes to IEEE P802.11 WLAN High Data Rate FH-PHY Group
Ad-Hoc Group Meeting
Vancouver
March 1994
Minutes by: Jerry Loraine
Symbionics Ltd

SESSION 1
Evening 7 March 1994

1. ROLL CALL AND MEETING LOGISTICS

Attendance record circulated.

2. REVIEW MEETING SCOPE AND PURPOSE

Chairman's Address:

Acceptance of minutes delayed subject to review by the chairman.

Primary Objectives:

Select Modulation Scheme, proposals currently are:

- Pi/4 DQPSK
- FQPSK
- 4 FSK

Announcement Juan (Proxim). Have withdrawn their paper and their proposal for 4 FSK, due primarily to the response in main Plenary session where it was obvious this higher data rate scheme would have a difficult passage. They are too small a company to pursue their proposal through the various committees. Proxim apologise for their action. The apology was accepted with regret by the Chairman and all present.

Summary of schemes proposed:

- 4 FSK
- Pi/4 DQPSK
- FQPSK
Forty minutes was allotted to each proposal. Running order of presentations:

- Symbionics and π/4 DQPSK
- Lannair and 4 FSK
- UC Davis FQPSK

3. UPDATE AGENDA

Presentations of three modulation schemes.
Clear channel assessment.

4. PRESENTATIONS

4.1 JL, Symbionics and Pi/4 DQPSK.

Kamilo: what is the voltage and efficiency of the PA
JL: >30% at 3.0V minimum

Prof. Mathiogopolos: Please explained how modelled
JL: Simulations, realistic transmitter plus Gaussian noise, increase RMS phase error. Receiver in a simulation of a complete coherent receiver.

Juan: How do you propose CCA with non multiple data rate systems
JL: Use power in the channel

Dean: How do you propose rate switch from base GFSK?
JL: Optimum solution is use π/4 QPSK preamble 1100110011...(bit wise), could add GFSK header but this is inefficient.

Kamilo: Can you achieve 1Watt
JL: No need for this, Europe and current FH specification is 100mW, but yes 1W can be achieved.

Dean: Spectral mask meets integrated value in adjacent channel
JL: yes.

M.Brennan: How would lower rate only set up NAV with higher rate.
JL: Through GFSK

Tentative Minutes of HS FHSS PHY Grp  2  Vancouver, BC, March 1994
Ed: Can the radio talk at 1Mb/sec GFSK

JL: Yes

Dean: NAV needs reception of whole packets

Wayne: NAV covered in the MAC

Jim McD: Can you compare pi/4 and FQPSK

JL: Experience is with non FQPSK systems as the modulation scheme is a recent introduction and not in any major systems.

Jim Renfro: Question withdrawn.

4.2 Naftali's 4 FSK

Jim McD: Can you share with us some measured data, or give us some timescales? Can you verify that the SNR's required are achievable?

NC: We have no measured results, we are on solid theoretical ground, we cannot give timescales for results.

Hussien: What is the required Eb/No for 10-5 Eb/No for selective diversity?

NC: Expect 22dB without implementation loss (perfect simulation), of the order of 23 to 24dB with implementation loss.

Feher: Do you have results with realistic filters?

NC: No. We expect only 1dB loss.

Feher: You need adaptive filters to cope with this?

NC: Yes, you need linear adaptive filters to correct.

Prof Mathaiogpolos: I have points, copied from Jim McDi's paper P802.11 93/102:

i) SRRC filters ... irrelevant
ii) Four level slicer... we will not use this in the system, an ADC is used.
iii) DSP or Large gate array needed for demodulation...
iv) Centre frequency tolerance is more critical
v) Deviation control is critical
vi) Phase distortion is critical
vii) Longer preamble is required

Jim McD: This does look economically viable?

Rob Carl: We believe it is cost effective and will be releasing IC's soon to perform a 4GFSK system.

Juan: Yes we also believe it is economically viable.
Did you compare the scheme to the template?

No, we have not done this yet.

How fast can we switch rates:

1 usec for 4 FSK.

For GFSK to \( \pi/4 \), on a bit boundary, that is one symbol is GFSK and the next is \( \pi/4 \).

4.3 Kamilo Feher's FQPSK presentation.

Siemens: Werner ..... presentation on PMB2306T and PMB2205 I/Q 5V Modulator

Andromeda: Peter Blomeyer, used Feher's Modem and Siemens ICs for IR, to be presented at the IR group.

Feher's presentation.

Intellectual property statement on FQPSK.

What IC's are available?

Cannot answer as under NDA

3 points: power consumption, Teledyne and Xylinx IC are real battery killers;
Should look at IC prices, they are beyond that needed;
Look at parts outlines, they are too big for PCMCIA.

Just showing commitment of vendors by listing names.

What are FQPSK's disadvantages

I charge a royalty or licence and I propose it, therefore it is a credibility gap.

Why is 4 FSK written off as a low power consumption.

Not comparing like with like, e.g. you are assuming a DSP power hungry demod for 4 FSK versus an integrated solution for FQPSK, you should compare like with like. Similarly you have stated \( \pi/4 \) needs a 6-8dB back off, I have shown a 1dB back off is all that is required.

Showed eye diagram, indicating 25dB Eb/No OK.

Can you quote power consumption for the implementation.

No

Return to power consumption. Your demod at say 18k gates at 16MHz would it not use considerable power?
Feher: You should read NTTs paper.

Tim Blaney: We have seen no real figures for system power consumption, I cannot see the figures that justify the conclusions you have.

NC: Question to Feher. How do you migrate to >1.4MB/sec? Is a linear PA required.

Feher: Yes I have presented this information before.

NC: Is PMB2306 for not FQPSK only. It is for general market.

### 4.4 General Discussion On Schemes

The floor was opened to questions on the proposed schemes.

JL: My summary to date is that there are two key factors. Firstly the Eb/No of 4GFSK being 25dB versus 14dB for QPSK solutions. Secondly the data rate of the 4GFSK being 2MB/sec versus 1.5/1.4Mb/sec for pi/4DQPSK and FQPSK. The difference between pi/4 and FQPSK is the well proven nature of pi/4 versus the potential benefits offered by FQPSK if it is possible to use a non linear amplifier. However, my presentations showed that the pi/4 does not impose a penalty on the radio system cost or performance.

MR: 8dB Eb/No does not effect packet error a great deal

Feher: Experimental results show 4GFSK very susceptible to multipath compared to QPSK. It will not hit product requirement of this group.

Bob Crowder: We want integer multiple in the MAC and not packet by packet data rate switch.

Wayne: I have felt we should have integer multiples.

Juan: We are offering higher data rate (2Mb/sec) over a lesser range, that is the coverage is 99.5% (GFSK) to 99.0% 4GFSK.

Feher: We require 99.5% coverage.

MR: We can implement cheap and simple adaptive equalisers, we will share information on this scheme if this scheme is selected.

Feher: Have you done simulations with real multipath?

NC: Simulated multipath with 150nsec.

Feher: Should refer to TIA data which showed QPSK to be very superior.

Wayne: We shall take a straw poll of which scheme to use, then I propose we adjourn.

Motion: Propose Feher, seconded Hussien.
'I propose FQPSK be adopted as the higher rate (FH) scheme.'
March 1994

Motion Tim Blaney, defer until tomorrow afternoon:

For 17, Against 9, Abs 4

The vote on this motion was deferred to the next session.

Rob Move to adjourn, unanimous yes.
SESSION 2

Evening 7 March 1994

This was an informal session to agree the way forward to meet the requirements of the Phy group.

Specific answers are required to the following questions:

- Why 4GFSK, what is the improved network throughput with 2Mb/sec.
- How 4GFSK operates in a mixed network and gives fair access (CCA).
- Packet lengths.
- Need to specify 4GFSK modulation mask, e.g. frequency, jitter, phase noise e.t.c.
- How fast can gear shift happen.
- How address the Eb/No 'problem'.
SESSION 3

Morning 8 March 1994

The full PHY group directed the HS-FHSS ad hoc group to adopt 4GFSK as the higher rate for the 802.11 Frequency Hopping standard. In the full PHY group meeting, 7 March 1994, the group voted by >75% that the Higher Speed modulation scheme should be 4GFSK.

Objectives: Fill in template for 4GFSK

First objective is to specify the transmit 'waveform'. Discussion as to whether we specify Coherent or non coherent.

JL: Diagram of what is required:

JL proposed 2 specs.

Non coherent: jitter, zero crossing error and long term frequency drift in a packet.

Coherent: specify deviation, transmit filter and RMS phase error.

Straw poll: Who is for coherent?

Unanimous no.

Brian: We should consider adding spec. to enable coherent demodulation to overcome the Eb/No argument.

JL: There was a clear vote at the Phy meeting which showed that 2Mb/sec was more important than the Eb/No.

We should go for a simple specification of the transmitter modulation that we can spec. today.

NC: Combination of modulation mask and eye should be sufficient.

Discussion of what 'h' should be. We should be simply related to the GFSK specification.

JL: What is \( h_{4\text{max}} \) to pass the FCC rules?

NC: 0.15, this is 150kHz.

Proposal \( h_{4\text{min}} = k \cdot h_{2\text{min}} \), where \( h_{2\text{min}} \) is two times the minimum deviation from the 2 GFSK specification. (i.e. 142kHz).

Unanimously passed.

For the time being \( k=0.45 \).

Discussion on above. Problems of centre frequency drift across a packet. This will be specified with an agreed test pattern. Pulse will provide a practical and measurable method for specifying this.

Passing through the template:
March 1994

Open Issues

Sensitivity: currently -80dBm.

Juan: Proposes sensitivity is -75dBm, seconded Brian

Yes= 4, No=0, A=3.

Motion passes.

Alternate channel interference: Same as GFSK.

Occupied bandwidth: Same as GFSK.

Transmit spectrum mask: as GFSK.

Modulation mask: see figure.

12a, 12b Transmitter and Receiver centre frequency tolerance: as GFSK.

13, Modulation 4GFSK.

14, Channel Nominal Data Rate, 2Mb/sec.

15a, Data rate change:

MR: Send Phy header and address fields in 2GFSK to enable other 2GFSK only stations to hear it.

Proposal, MR: Phy header sent in 2GFSK, with 4GFSK rate switch indicated in the Phy header (PSF). There are two bits required for this. Seconded Brian.

Passed unanimously.

NC: A 'coding' field should be added to enable coding to be added to this to enable the data to be protected.

General view was this would add too much complexity and should be dropped.

Summary:

- All control, broadcast, multicast packets are transmitted in 2GFSK.
- The switch to 4GFSK modulation, when selected by the MAC prior to a transmission, is handled in the Phy layer and is invisible to the MAC.
- The Phy header and end delimiter shall be transmitted in 2GFSK, the MAC MPDU shall be transmitted at the rate selected.
- The modulation rate selected for transmitting the MAC MPDU is identified by a field in the PSF of minimum length two bits.

16, Phy supplied clock jitter, as GFSK.

17, Bit clock accuracy, as GFSK.
Tentative Minutes of HS FHSS PHY Grp 10 Vancouver, BC, March 1994

18, Preamble length.

19, Clock recovery, as GFSK.

20, Carrier (energy) detect time, as GFSK.

21, Spurious Emissions in the frequency band, as GFSK.

22, Spurious Emissions, as GFSK.

23, Tx to Rx switching time, as GFSK.

24, Rx to Tx switching speed, as GFSK.

25, Channel Switching speed, as GFSK.

26, BER at specified Eb/No, <23dB.

27, Channel availability, as GFSK.

28, Data line/clock input/clock output.

29, Tx and Rx Antenna Port Impedance, as GFSK.

30, VSWR, as GFSK

31, Interface lines to upper layer (when exposed), as GFSK.

32, Phy-Mac Management, as GFSK.

33, Safety Requirements, as GFSK.

34, DTE/DTC Interface, as GFSK.

35, Higher Data Rate Negotiation, as per 15a.

Adjourn for Lunch

Re convene.

System Issues:

Slide Preparation For The Phy Group

Rate Switch:

See summary on 15.

The remaining issue is how the modulation rate switch is managed.

Additional problem is that how can the data rate be selected. It was pointed out that the rate switch was instantaneous and happened at the field/symbol boundary. The resources required from the MAC are minimal.
Juan: Note the switch functionality is similar to DSSS.

CCA

JL: Draw a table showing 4GFSK and 2GFSK and whether they are comparable for 4 means of CCA.

Table generated showing CCA methods are the same for the two.

<table>
<thead>
<tr>
<th>CCA Method</th>
<th>GFSK</th>
<th>4GFSK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy detect</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Clock detect</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Hybrid</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Packet Detect</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Throughput

Juan: Under no circumstances is data rate less. At least 50% better.

Meeting adjourned.
Attendees, Session 3.

Jerry Loraine                Symbionics
Rob Carl                     Pulse Spectrum
Naftali Chayat               Lannair
Brian Messenger              Proxim
Juan Grau                    Proxim
Hassan Ahmed                 Air Access
Wayne Moyers                 Wise
Fred Kamp                    Paradigm