# IEEE P802.11 Wireless LANs

Title: **Minutes to IEEE P802.11 WLAN High Data Rate FH-PHY Group Ad-Hoc Group Meeting**

Vancouver

Dates: March 1994

Minutes by: Jerry Loraine
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## 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 Have withdrawn their paper and their proposal for 4 FSK, due primarily to the response in main Plenary session where it was obvious this higher data rate scheme would have a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 pi/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 pi/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

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Jim Renfro: Question withdrawn.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 implementaion 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 McD'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.

Feher: Did you compare the scheme to the template?

NC: No, we have not done this yet.

Ed: How fast can we switch rates:

NC: 1usec for 4 FSK.

JL: 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 Fehers Modem and Siemens ICs for IR, to be presented at the IR group.

Feher's presentation.

Intellectual property statement on FQPSK.

Rob Carl: What IC's are available?

Feher: Cannot answer as under NDA

Rob Carl: 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.

Feher: Just showing commitment of vendors by listing names.

Bob Crowder: What are FQPSK's disadvantages

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

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

JL: 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.

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

Rob Carl: Can you quote power consumption for the implementation.

Feher: No

Brian: 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 benfits offered by FPSK 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.'

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 $h_{4max}$ to pass the FCC rules?

NC: 0.15, this is 150kHz.

Proposal $h_{4min} = k*h_{2min}$, where $h_{2min}$ 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:

## Open Issues

**Sensitivity: currently -80dBm.**

Juan: Proposes sensitivity is -75dBm, seconded Brian

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

Motion passes. **Issue Closed**

**Alternate channel interfernce: Same as GFSK.** **Issue closed.**

**Occupied bandwidth: Same as GSFK.** **Issue closed.**

**Transmit spectrum mask: as GFSK.** **Issue closed.**

**Modulation mask: see figure.** **Issue still open.**

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

**13, Modulation 4GFSK.** **Issue closed.**

**14, Channel Nominal Data Rate, 2Mb/sec.** **Issue closed.**

**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 delimeter 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.** **Issue closed.**

**17, Bit clock accuracy, as GFSK.**

**18, Preamble length.**

| | |
|---|---|
| **19, Clock recovery, as GFSK.** | **Issue Closed.** |
| **20, Carrier (energy) detect time, as GFSK.** | **Issue Closed** |
| **21, Spurious Emissions in the frequency band, as GFSK.** | **Issue Closed** |
| **22, Spurious Emissions, as GFSK.** | **Issue Closed** |
| **23, Tx to Rx switching time, as GFSK.** | **Issue Closed** |
| **24, Rx to Tx switching speed, as GFSK.** | **Issue Closed** |
| **25, Channel Switching speed, as GFSK.** | **Issue Closed.** |
| **26, BER at specified Eb/No, <23dB.** | **Issue Open.** |
| **27, Channel availability, as GFSK.** | **Issue Closed.** |
| **28, Data line/clock input/clock output.** | **Issue Closed.** |
| **29, Tx and Rx Antenna Port Impedance, as GFSK.** | **Issue Closed.** |
| **30, VSWR, as GFSK** | **Issue Closed.** |
| **31, Interface lines to upper layer (when exposed), as GFSK.** | **Issue Closed.** |
| **32, Phy-Mac Management, as GFSK.** | **Issue Closed.** |
| **33, Safety Requirements, as GFSK.** | **Issue Closed.** |
| **34, DTE/DTC Interface, as GFSK.** | **Issue Closed.** |
| **35, Higher Data Rate Negotiation, as per 15a.** | **Issue Closed.** |

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.

| CCA Method | GFSK | 4GFSK |
|---|---|---|
| Energy detect | yes | yes |
| Clock detect | yes | yes |
| Hybrid | yes | yes |
| Packet Detect | yes | yes |

**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 |