HIGH SPEED FREQUENCY HOPPING PHY PROPOSAL

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Proxim

Introduction

In the June 1993 802.11 plenary meeting, Proxim introduced a proposal for a 1.6 Mbps, 4FSK Frequency Hopping PHY with a backoff data rate of 800 Kbps (GMSK). This proposal was based on what Proxim believed were optimum modulation parameters given the regulatory environment consistent with 802's 1Mbps requirement. Since then, this committee approved a 1 Mbps GFSK FH PHY. In doing so the committee elected to sacrifice some performance for the simplicity of an FSK approach.

Proposal

Following the committee's lead, Proxim has evaluated the performance impact of scaling the original 1.6 Mbps proposal to 2 Mbps. The advantages of having a high data rate mode that is an exact multiple of the 1 Mbps base data rate, are obvious and will be reviewed shortly. Additionally, the high rate mode should net significant improvement over the base mode, to provide the necessary incentive for manufacturers to include it in their implementation. The results of our evaluation indicate that it is possible to scale the 4FSK rate up to 2 Mbps, sustaining only a small penalty in performance. This performance penalty is, in fact, not as great for the 4FSK mode as it is for scaling the base GFSK mode, and it should therefore be agreeable to the group. In both cases the degradation is small when everything is considered.

Advantages to using 2 Mbps 4FSK modulation as the high speed mode of a 1Mbps GFSK System:

- Both receiver and transmitter architectures (including modulator/demodulator) can be the same for the high speed mode as for the base mode, simplifying implementation.
- Coherent or non-coherent types of demodulation can be used.
- Symbol rate is the same for the high rate and the base mode. Filters do not have to change.
- Clock recovery is easier since symbol rate does not change. The same preamble can be used for high speed packets as for the normal packets simplifying the gear switch algorithms in the MAC.
- Modulation based CD can be implemented if desired. Since symbol rate does not change, symbol timing information can be used to generate a qualifier for CD.
- High rate functionality can be implemented as an enhancement to the radio's back end, leaving the front end untouched (all the way through the modulator/demodulator). Class C amplification and hard limiting in the demodulation can be used.

Areas of Special Attention:

- There is a slight hit on performance (in terms of Eb/No) over slightly more bandwidth efficient modulation techniques.

- The FM linearity and FM sensitivity have to be controlled somewhat better than for GFSK (but only to approximately 10% which is not an excessively stringent requirement).

The following table summarizes the principal characteristics of this proposal in the familiar format. Some details have been left out and will be presented in further contributions.

1.	Tx & Rx	Frequency Range	2.4 to 2.4835 GHz U.S.A 2.471 to 2.497 GHz Japan 2.4 to 2.485 GHz Europe	
2a.	Tx & Rx	Minimum number of hopping channels / set	75	
3.	Tx & Rx	No. of hops per sec.	16	
4.	Tx	Transmitted power levels (mW)	a. max. 1000, 100 mW b. 250, 50, 10 mW (Optional)	a.. US/Europe, Japan
5.	Tx	Optional Transmitted power control	Four levels	
6.	Tx	Max. Radiated EIRP	per FCC part 15.247 in US per ETSI res 02-09 in Europe per RCR STD-33 in Japan	
7.				Deleted
8.	Tx	Modulation Frequency Deviation	$\Delta F = \pm 225$ KHz	h = 2/3 ΔF where ΔF = Peak Deviation
9.				
10.	Rx	Receiver Minimum input level sensitivity	-75 dBm @ 10^{-5} BER	
11.	Rx	Receiver Maximum input level	- 20 dBm	
12.	Rx	Alternate channel interference tolerance	-45 dB	
12a.	Rx	Adjacent channel rejection	NA	
13.	Tx & RX	Channel bandwidth (allocated) @20 dB	1 MHz per FCC part 15.247	
14.	Tx	Occupied channel bandwidth (spectrum shape)	20 dBc @ $\Delta F = \pm 0.5$ MHz 45 dBc @ $\Delta F = \pm 2.0$ MHz 64 dBc @ $\Delta F = \pm 5.0$ MHz	BT = .5
15.	Tx & Rx	Receiver center frequency acceptance range	+/- 150 KHz	
16.	Tx & Rx	Modulation	4FSK	4 level CPFSK.
17.	Tx & Rx	Channel Data Rate	2 Mbps	

18.	Tx & Rx	Fallback data rate	a. 1 Mbps	
19.		Phy supplied Clock Jitter	< .0625 µsec (rms)	
19a.		Bit Clock Accuracy (baseband)	< 100 ppm	
20.				Deleted
21.	Tx & Rx	Preamble length	50 symbols (50 µsec)	Includes clock recovery, carrier recovery (if used), CD resp. time, antenna div. etc.
22.	Tx & Rx	Clock Recovery	withstands patterns up to (7) continuous 1's or 0's with no degradation in output SNR and BER. Scrambling polynomial: $1+x^{-4}+x^{-7}$	
23.	Rx	Carrier detect response time	<50 µsec	CD should be based on detecting signals with the appropriate modulation.
24.	Tx & Rx	Spurious emissions in the frequency band (@ ΔF≥ º4 MHz from Fc)	-64 dBc	
25.	Tx & Rx	Spurious emissions out of band	per FCC part 15.247, 15.205 and 15.209 in USA per ETSI RES 02-09 in Europe.	
26.	Tx & Rx	Switching time TX to Rx	TBD	
27.	Tx & Rx	Switching time RX to TX	TBD	
28.	Tx & Rx	Channel switching time (hop settling time)	300 µsec	
29.				deleted
30.	Rx	BER at specified Eb/No	BER $\leq 10^{-5}$ @ Eb/No = 22.5 dB	It will depend on type of demodulator used.
31.	Tx & Rx	Channel availability	99.5 %	
32.	Tx	TX Frequency Stability	20 ppm	
33.		Data Line / Clock input / output jitter	TBD	
34.				deleted
35.				deleted
36.	Tx & Rx	Antenna port impedance (if exposed)	50 ohms	
37.	Tx & Rx	VSWR	Device shall stand $0 \leq VSWR \leq \infty$ with no damage - Operational VSWR = TBD	for conformance testing
38.				deleted
39.				deleted

40.		Interface lines to Convergence layer (when exposed)	Rx Data Tx Data Rx/Tx clock Data valid Control line Status line Ctl/Status clock RSSI	
41.		PHY-MAC Net Management info/control variables		
42.		Other PHY-MAC Net Management info/control variables		
43.		Safety Requirements	Compliance with applicable Safety Agencies requirements [TBD]	
44.		DTE/DCE Interface	TBD	
45.		ACK protocol support	TBD	