IEEE 802.11
Wireless Access Methods and Physical Layer Specifications

Draft Proposal for a Frequency Hopping Spread Spectrum PHY Standard

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This version of the draft incorporates agreed changes made from comments received in the January 11,1993 interim meeting in Agoura Hills (mainly by Jim McDonald and Francois Le Maut. (docs. IEEE 802.11 93/4 and 93/11)

Introduction

This contribution is intended to provide a framework for the definition of the IEEE 802.11 FHSS PHY standard. It also outlines some of the criteria used for defining this PHY. First PHY will be defined at 2.4 GHz, other frequencies will follow. Some parameters in the specifications require inputs from the MAC group and an agreed channel model. Committee members are invited to provide inputs to the completion of this document. The specification was put in a table format for as long as it is a "live" document . Once finalized, the spec. will be converted to the std. IEEE 802 format.

Requirements outline:

- Compliance with Regulatory Agencies for unlicensed operation
- Compliance with 802.11 PAR (Data Rate at least 1 Mbps, etc.)
- Operation in a multi-network environment (multiple collocated networks)
- Able to cover a Minimum Area.
- Suitable for low power consumption implementations
- Cost effective
- Ensure Interoperability between conformant FHSS stations.
- Modes of operation:
  - peer to peer with no prior knowledge
  - node to AP and AP to node
- Support asynchronous and time deterministic connectivity.
- Support a specified number of stations per cell (Access Point)
- Suitable for small size implementation
- Robust operation in narrow band and partial band interference as well as multipath fading.
- Graceful degradation under load and interference.

Specifications

The following table represents a template for Frequency Hopping PHY specification. Several blanks were left for those items that will be determined after the channel model is agreed and after PHY MAC interface is determined; Other parameters have to be worked out between PHY and MAC groups.

	Parameter	Proposed Spec.	Comments/Notes
1.	Frequency Range	2.4 to 2.4835 GHz	Other frequency bands will follow.
2.	Minimum number of hopping channels / set	75	per FCC part 15.247/ for reference only
3.	No of hops per sec.	2.5 to 40	
4.	Transmitted power levels [mW]	a. max. 1000 mW / 100 mW b. 250,100,50,10 mW (optional) levels	a. default US / Europe b. optional levels
5.	Optional Transmitted power control	Four discrete levels as above or continuous	per PHY group vote on 1/11/93
6.	Max. Radiated EIRP	per FCC part 15.247 in US per ETSI res 02-09 in Europe	Total radiated power including antenna gain As defined by regulatory agencies in each country/. for reference only
7.			Deleted
8.	Frequency deviation	ΔFmax= 300KHz(?)	&Required for interoperability
9.			Merged into 25.
10			deleted per Mc-Donald's suggestion
11			deleted per Mc-Donald's suggestion
12	Adjacent Channel selectivity	-20 dB at adjacent channel center -65 dB @Δf=+/- 2 MHz	For specification of the transmitted spectrum mask; To facilitate interoperability
13	Channel bandwidth (allocated)	1 MHz per FCC part 15.247	For reference only; will be deleted .
14	Occupied channel bandwidth (spectrum shape)	-20 dBc @ Δf=±0.5 MHz -65 dBc @ Δf±2 MHz -85 dBc @ Δf±3 MHz	Required for coexistance of multiple networks.
15	Receiver center frequency acceptance range	+/- TBD [Hz]	For interoperability purposes
16	Modulation	4 level CPFSK with baseband shaping TBD .	shaping TBD after channel model agreed.

17	Channel Nominal Data Rate	1.25 Mbps	
18	Fallback data rate	800 Kbps, 500 Kbps, 250 Kbps	per Mc Donald and Le Maut
19.	Phy supplied Clock Jitter	0.0625 microsec.	
20			Deleted per McDonald and Le Maut
21	Preamble length	a. 32 bit times b. Variable PHY preamble	& TBD
22	Clock recovery	withstands patterns up to (7)continuous 1's or (7) 0's with no degradation in output signal to noise ratio and bit error rate. Scrambling polynomial TBD.	Implies use of a scrambler. Polynomial TBD.
23	Carrier (energy)detect response time	TBD	& Required for upper layers decision making.
24	Spurious emissions in the frequency band (@ $\Delta f \geq 1$ MHz from Fc)	-65 dBm	
25	Spurious emissions out of band	-per FCC part 15.247,15.205 and 15.209 in USA -per ETSI RES 02-09 in Europe.	for reference only
26	Switching time TX to RX	100 microsec.	per Le Maut Time from full power transmission to full sensitivity receiver availability. It includes preamble time used for receiver synchronization.
27	Switching time RX to TX	TBD	time from full sensitivity reception to full power transmitter availability
28	Channel switching time (hop settling time)	300μS max.	Elapsed time from receipt of hop command until unit frequency settles within +/- ΔF= Receiver Acceptance range or TX frequency tolerance (whichever is tighter)
29			deleted

30	BER at specified Eb/No	10 exp. -6 @ Eb/No = 17 dB	Includes modem implementation margin; this is a MAC requirement.
31	Channel availability	99.5 %	Could also be specified as probability of outage. With no interference. from the PAR.
32	TX Frequency Stability	15 ppm	
33	Data Line / Clock input / output Jitter	TBD	& Includes static and dynamic Jitter (see 802.3 definition) dependent on MAC requirements.
34			deleted
35			deleted
36	Antenna port impedance (if exposed)	50 ohms	for interoperability at antenna port.
37	VSWR	Devices shall stand 0≤VSWR≤∞ 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/Sta clock***	& Timing and levels TBD.

41	PHY-MAC Net Management info./control variables	a. Signal Quality b. Loop back c. No. of channels available d. Channel in use (sequence) e. No. of diversity channels f. Which Diversity in use g. Alternate Diversity use h. Lock i. No. of RX signal strength levels j. RX signal strength levels k. RX Signal Strength l. PHY type m. Channel quality n. Channel available (for LBT) o. No. of TX power levels p. Read TX output level q. Set TX output level r. Hop [?] s. Transmit t. Receive u. Sleep mode v. Wake-up w. Standby mode (low power) x. Data rate -indication - command y. Jabber control function z. Jabber indication	&,* Most signals are bi-directional
42	Other PHY-MAC Net Management info./control variables	a. PHY initialize b. PHY specific tally collection c. Adaptive power control by learning reception statistics.	*
43	Safety Requirements	Compliance with applicable Safety Agencies requirements	For reference only
44	DTE/DCE Interface	TBD	*
45	ACK protocol support	TBD	*

Notes:
& indicates dependency on the channel model.
* indicates inputs from MAC group.
Status of the receive signal is on a per frame basis
Status of the PHY control parameter ison a per frame basis
1. Coding not addressed yet.
2. Issue: how to deal with diversity? .