IEEE 802.11
Wireless Access Methods and Physical Layer Specifications

Draft Proposal for a Higher Data Rate Frequency Hopping Spread Spectrum PHY Standard

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This is a revised version of documents IEEE P802.11/93-83r1 and 93-210 that presents Higher Data Rate Frequency Hopping template for proposed specs. For the previous versions please refer to document 802.11/93-83r1 and 802.11/93-210.

Introduction

This contribution is intended to provide a framework for the definition of the IEEE802.11 Higher Data Rate 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. Study group members are encouraged 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 text format. This version includes changes from November 1993 meeting. Closed issue for this group are marked. All others are open for inputs and changes.

Requirements outline:

- Compliance with Regulatory Agencies for unlicensed operation
- Compliance with 802.11 PAR (Data Rate at least 1 Mbps, etc.)
- Operation in a multinetwork environment (collocated networks)
- Minimum Area coverage
- Suitable for low power consumption implementations
- Cost effective
- Ensure Interoperability between conformant 802.11 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.

For modulation requirements see DOC 93/164

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.

No.		Parameter	Specification	Comments
1.	Tx & Rx	Frequency Range	2.402 to 2.482 GHz U.S.A 2.471 to 2.497 GHz Japan 2.402 to 2.498(*)GHz Europe Channel centers in 1 MHz steps starting at first specified frequency (e.g. 2402 GHz).	Other frequency bands will follow. * Changes due in 1995 **CLOSED**
2a.	Tx & Rx	Minimum number of channels / set	75 in U.S.A 20 in Europe 10 in Japan	Per FCC part 15.247 **CLOSED**
3.	Tx & Rx	Minimum number of hops per sec.	2.5	**CLOSED**
3b.	Tx & Rx	Hopping sequence(s)	TBD	**CLOSED**
4a.	Tx	Transmitted power levels	a. Max. 1000 / 100 /10 b. 250,100,50,10 mW (optional levels)	a. U.S.A / Europe / Japan b. Optional levels **CLOSED**
4b.	Tx	Minimum transmitted power level	10 mW 1 mW for battery operated equipment	Required for conformance testing.
5.	Tx	(Optional) Transmitter power control	Four discrete levels as in 4a or continuous; control mandatory above 100 mW.	per PHY group vote on 1/11/93 **CLOSED**
6.	Tx	Max. Radiated EIRP	Per FCC part 15.247 in US Per ETS 300-328 in Europe Per TBD in Japan	Total radiated power including antenna gain As defined by regulatory agencies in each country. **-for reference only** **CLOSED**
7.	Rx	Receiver Minimum input level sensitivity	- 80 dBm @ 10^{-5} BER	Modulation Dependent
8.	Rx	Receiver maximum input level	- 20 dBm	
9.	Rx	Alternate channel interference tolerance	45 dB at 10^{-5} measured by the following method: input an in-channel receive signal level that provides 10^{-5} BER, and increase this signal level by 1 dB; an alternate channel signal modulated in the same fashion is increased in level until BER is 10^{-5}. The difference between the desired and undesired signal levels is greater than 45 dB; all measured in an AWGN channel	To allow specification of the transmitted spectrum mask; To facilitate Interoperability
10.	Tx & Rx	Occupied Bandwidth @20 dB	±500 KHz	Per PHY motion of 5/11/93 **CLOSED**
11.	Tx	Occupied channel Bandwidth (spectrum shape)	20 dBc @ Δf=±0.5 MHz from Fc 45 dBc @ Δf=± 2 MHz from Fc 60 dBc @ Δf=± 3 MHz from Fc	Defines transmitted spectrum mask. Required for coexistence of multiple networks. -20 dBc at ±0.5 MHz is per FCC part 15.247 for FH

11a.	Tx	Modulation mask	TBD	&: Required for Interoperability Modulation Dependent
12a.	Tx	Transmitter Center frequency tolerance	± 25 ppm or TBD	A transmitter shall maintain the frequency within +/- 25 ppm of the specified CF. over +0 ° C to + 40 ° C indoors. -15 ° C to + 55 ° C for portables -20 ° C to + 55 ° C for outdoor (per Chadwick / ETSI recomm.)
12b.	Rx	Receiver center frequency acceptance range	± 25 ppm	For Interoperability purposes
13.	Tx & Rx	Modulation	**TBD**	
14.	Tx & Rx	Channel Nominal Data Rate and Increments Channel Minimum Data Rate	TBD 1.5 Mbps	
15.	Tx & Rx	Fallback data rate	1 Mbps (GFSK with BT= 0.5) {? 800 Kbps, 500 Kbps, 250 Kbps}	
15a.	Tx & Rx	Data rate change method		
16.		PHY supplied Clock Jitter	0.0625 microsec.	Place holder. To be specified as % of bit time
17.		Bit Clock Accuracy (baseband)		
18.	Tx & Rx	Preamble length	TBD	&
19.	Tx & Rx	Clock recovery	Withstands patterns of up to (7)continuous 1's or (7)continuous 0's with no degradation in output signal to noise ratio and bit error rate. Scrambling polynomial : $1+x^{-4}+x^{-7}$.	Implies use of a self synchronized scrambler. Apple Computer offered to make proposal for an improved FH scrambler in May.
20.	Rx	Carrier (energy)detect response time	TBD	& Required for upper layers decision making.
21.	Tx & Rx	Spurious emissions in the frequency band	64 dBc (@ $\Delta f \geq \pm 4$ MHz from Fc)	Chadwick's proposal
22.	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.	For reference only **CLOSED**
23.	Tx & Rx	Switching time TX to RX	100 microsec.	Time from full power transmission to full sensitivity receiver availability. It should include any preamble time used for receiver synchronization.
24.	Tx & Rx	Switching time RX to TX	TBD	Time from full sensitivity reception to full power transmitter availability

25.	Tx & Rx	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)] This parameter is MAC dependent
26.	Rx	BER at specified Eb/No (pending channel model)	10 exp. -5 @ Eb/No= 19 dB	-Includes modem implementation margin -This is a MAC requirement.
27.	Tx & Rx	Channel availability	99.5 %	Could also be specified as probability of outage. With no interference. From the PAR. **CLOSED**
28.		Data Line / Clock input / output Jitter	TBD	& Includes static and dynamic Jitter (e.g. 802.3 definition), dependent on MAC requirements. **CLOSED / PHY-MAC Intfc.**
29.	Tx & Rx	Antenna port impedance (if exposed)	50 ohms	For Interoperability and conformance testing at antenna port (when exposed). **CLOSED / PHY**
30.	Tx & Rx	VSWR	Devices shall stand $0 \leq VSWR \leq \infty$ with no damage. Equipment to be stable under all phases of VSWR	For conformance testing. **CLOSED / PHY**
31		Interface lines to upper layer (when exposed)	***RX Data*** ***TX Data*** ***RX/TX clock*** ***Data valid*** ***Control line*** ***Status line*** ***Ctl./Sta clock***	* Timing and levels TBD. **CLOSED / PHY**
32.		PHY-MAC Net Management info./control variables	**TBD by PHY Group**	&,* Most signals are bi-directional **CLOSED / PHY**
33.		Safety Requirements	Compliance with applicable Safety Agencies requirements	**[TBD];** for reference only **CLOSED**
34.		DTE/DCE Interface	TBD	*** CLOSED / PHY**
35	Tx & Rx	Higher Data Rate Negotiation	Preamble same as GFSK	Requires additional inputs. Last motion in November 93 stated that preamble will be at GFSK rate and data rate for the rest of the packet is at the negotiated rate.

Notes: & indicates dependency on the channel model. * indicates inputs from MAC group.