IEEE 802.11
Wireless Access Methods and Physical Layer Specifications

Higher Data Rate Frequency Hopping Spread Spectrum PHY Standard

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

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. The specification was put in a table format for as long as it is a "live" document. This spec. will be converted to the std. IEEE 802 text 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 multinetwork environment (collocated networks)
- Minimum Area coverage
- Suitable for low power consumption implementations
- Cost effective
- Ensure Interoperability between conformant 802.11stations.
- 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 and Europe 2.471 to 2.497 Ghz Japan Channel centers in 1Mhz steps starting at first specified frequency (e.g 2402 Ghz).	Other frequency bands will follow.
2a.	Tx & Rx	Minimum number of channels	75 in U.S.A 20 in Europe 10 in Japan	Per FCC part 15.247
3.	Tx & Rx	Minimum number of hops per sec.	2.5	
3b.	Tx & Rx	Hopping sequence(s)	As per 94/68	
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
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
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**
7.	Rx	Receiver Minimum input level sensitivity	- 80 dBm @ 10^{-5} BER, 1 Mbit/sec - 75 dBm @ 10^{-5} BER, 2 Mbit/sec	
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 Same for 2- and 4-GFSK
10.	Tx & Rx	Occupied bandwidth @20 dB	±500 Khz	Per motion of 5/11/93
11.	Tx	Occupied channel bandwidth (spectrum shape)	20 dBc @ Δf=± 0.5 Mhz from Fc 45 dBc @ Δf=± 2Mhz 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. Same for 2- and 4-GFSK
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	GFSK @BT=0.5, 2GFSK, h_2=0.32 min @ 1 Mbit/sec, 4GFSK, h_4=0.14 min @ 2 Mbit/sec, h_4/h_2=0.45+/-0.01	Same pulse shape for 2- and 4-GFSK. The maxinal h_2 and h_4 may depend on the FCC bandwidth interpretation. The spec is to be refined by Sep 1994.
14	Tx & Rx	Channel Nominal Data Rate	2 Mbit/sec	
15	Tx & Rx	Fallback data rate	1 Mbps (GFSK with BT=0.5)	
15a.	Tx&Rx	Data rate change method	PLCP contains rate indication field (TBD bits). The symbols starting at MPDU are either 2-level or 4-level symbols, according to rate	
16		Phy supplied Clock Jitter	0.0625 microsec.	
17		Bit Clock Accuracy (baseband)	Same for 2- and 4-GFSK	
18	Tx & Rx	Preamble length	Same for 2- and 4-GFSK	
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. Synchronous Scrambling with m-sequence generated by a polinomial : $1+x^{-4}+x^{-7}$.	Implies use of a self synchronized scrambler. Apple Computer offered to make proposal for an improved FH scrambler in May. To adopt same as 1 Mbit PMD.
20	Rx	Carrier (energy)detect response time	Same for 2- and 4-GFSK, TBD	& Required for upper layers decision making.
21	Tx & Rx	Spurious emissions in the frequency band	Same for 2- and 4-GFSK	
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
23	Tx & Rx	Switching time TX to RX	Same for 2- and 4-GFSK	
24	Tx & Rx	Switching time RX to TX	Same for 2- and 4-GFSK	
25	Tx & Rx	Channel switching time (hop settling time)	Same for 2- and 4-GFSK	
26	Rx	BER at specified Eb/No	BER=10^{-5} @ Eb/No=19 dB @ 1 Mbit/sec, @ Eb/No=23 dB @ 2 Mbit/sec,	For reference only, **sensitivity** to appear in final specifications.
27	Tx & Rx	Channel availability	99.5 %	Could also be specified as probability of outage. With no interference. From the PAR.
28		Data Line / Clock input / output Jitter	TBD	& Includes static and dynamic Jitter (e.g. 802.3 definition), dependent on MAC requirements.
29	Tx & Rx	Antenna port impedance (if exposed)	50 ohms	For interoperability and conformance testing at antenna port (when exposed).

30	Tx & Rx	VSWR	Devices shall stand 0≤VSWR≤∞ with no damage. Equipment to be stable under all phases of VSWR	For conformance testing.
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.
32		PHY-MAC Net Management info./control variables	**TBD,** see doc 802.11-94/068r ans 94/157 and 94/xxx	&,* Most signals are bi-directional
33		Safety Requirements	Compliance with applicable Safety Agencies requirements	**[TBD];** for reference only
34		DTE/DCE Interface	TBD	*

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