Direct Sequence Spread Spectrum PHY

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Introduction:

This contribution is intended to provide an overview of a DSSS PHY and outlines the criteria for defining this PHY. The final specifications have to be worked out with the MAC definition and the agreed channel model. Committee members are welcomed to provide their inputs to the completion of this document.

Requirements:

- Compliance with Regulatory Agencies for unlicensed operation
- Compliance with 802.11 PAR (Data Rate exceeds 1Mbps, etc.)
- Operation in a multinetwork environment (multiple collocated networks)
- Minimum Area coverage
- Suitable for low power consumption implementations
- Cost effective, particularly low cost to produce
- 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 minimum number of stations per AP
- Suitable for small size implementation
- Robust considering narrow band and partial band interference and multipath fading
- Graceful degradation with increasing load and interference
- Use minimum transmit power required to achieve link

What DS can offer:

- Robust in the presence of medium duty-cycle interferers (microwave ovens)
- Entire band usable to implement multiple channels
- Best handling of multipath interference
- Extremely fast acquisition and turnaround time
- Low overhead for short packets
- Non coherent modulation implies simple, low cost realizations
- Both RSSI and correlation quality available as performance metrics
- Distributed demodulation improves cost-performance ratio
- Potential for highly integrated VLSI chipsets
- Adjustable transmitter power reduces spectrum contamination and interference
- Multiple overlapping networks provided by CDMA

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Specifications

The following table presents an example of Direct Sequence PHY specifications. Those items left blank can be determined only after the channel model is agreed by 802.11 and the PHY-MAC interface specified. A number of these parameters will eventually be worked out by negotiation between the PHY and MAC groups.

PARAMETER	Required Spec.	Proposed Spec.	Comments
Frequency Range	2400-2483.5 MHz	2400-2483.5 MHz	Other ISM frequency bands will follow
Spreading Sequence		32 chips per symbol	
Orthogonal Symbols		4	
Data Rate	1-20 Mbps	1.25 Mbps	Higher rates possible using more symbols
Transmitted Power	+30 dBm max.	0 to +30 dBm in 16 to 256 steps	Use min. required
Max. Radiated EIRP		6 dBW in US, TBD dBW in Europe, TBD dBW in Asia	Includes antenna gain. Normally defined by regulatory agencies in each country
Transmitted power variation (tolerance)	TBD dB	not important	to be negotiated over link to achieve required BER
Receiver Sensitivity		-90 dBm min.	
Max. Input signal at antenna connector with no performance degradation	TBD dBm	0 dBm	
Adjacent Channel selectivity		-25 dB at channel boundary	
Channel Bandwidth		40 MHz	FCC 15.247 is ref.
Occupied channel bandwidth (spectrum shape)			
Spurious emissions in band		-80 dBc	
Spurious emissions out of band	-20 dBw in US, -60 dBw/100 kHz @ 1 to 10 Gz, -66 dBw/100 kHz @ 30 MHz to 1 Gz		dependent on country

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Switching time TX to RX		10 uS	Time from full power output to full sensitivity receiver availability. This parameter should include any preamble time used for receiver synchronization
Switching time RX to TX		10 uS	Time from full sensitivity reception to full power transmitter availability
Channel switching time (hop settling time)		not applicable	Elapsed time from receipt of hop command until unit frequency settles with +/- ΔF=Receiver Acceptance range or TX frequency tolerance (whichever is tighter)
Modulation		BPSK	
Demodulation		non coherent, multiple parallel digital correlators	
BER at specified Receiver Sensitivity	10E-7	10E-7	
Channel availability		99.5%	Could also be specified as probability of outage with no interference
TX/RX frequency stability		+/- 50 ppm	
Receiver Frequency acceptance range		+/- TBD Hz	
Data Line/Clock Input/Output jitter			Include static and dynamic jitter (see 802.3 definition), negotiate this parameter with MAC
Min. reception range		333 feet	Conditions TBD
Max. required range		1000 feet	Conditions TBD
Antenna port impedance		50 ohms	
VSWR		Devices shall stand infinite transmit VSWR with no damage, operation VSWR TBD	

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Interface to MAC		RX Data, TX Data, RX/TX clock, Frequency control, TX/RX switching, Received Signal Quality, Net Management Info., TX Power control, Sleep	Timing and logic levels TBD
Safety Requirements		Compliance with applicable Safety Agencies requirements	

Field Experience

- Superior performance with both interference and fading
- Good propagation characteristics both indoors and outdoors
- Highly robust
- Reduced necessity for retires

Conclusions

Direct Sequence Spread Spectrum provides an economical, technically feasible solution meeting the requirements for a wireless LAN. When coupled with a suitable protocol it exhibits superior performance in the presence of narrow band and partial band interference and multipath propagation as proven by field experience.