

# ISO/IEC 8802-11 :2005-08 (E)

## Information technology\_ - Telecommunications and information exchange between systems\_ - Local and metropolitan area networks\_ - Specific requirements\_ - Part\_11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications

---

### Contents

1.	Overview.....	1
1.1	Scope.....	1
1.2	Purpose.....	1
2.	Normative references.....	3
3.	Definitions .....	5
4.	Abbreviations and acronyms .....	9
5.	General description .....	13
5.1	General description of the architecture .....	13
5.1.1	How wireless LAN systems are different .....	13
5.1.1.1	Destination address does not equal destination location .....	13
5.1.1.2	The media impact the design .....	13
5.1.1.3	The impact of handling mobile stations.....	13
5.1.1.4	Interaction with other IEEE 802 layers.....	14
5.2	Components of the IEEE 802.11 architecture.....	14
5.2.1	The independent BSS (IBSS) as an ad hoc network.....	14
5.2.1.1	STA to BSS association is dynamic .....	14
5.2.2	Distribution system (DS) concepts .....	15
5.2.2.1	Extended service set (ESS): The large coverage network .....	15
5.2.3	Area concepts.....	16
5.2.4	Integration with wired LANs .....	18
5.3	Logical service interfaces.....	18
5.3.1	SS.....	19
5.3.2	DSS .....	19
5.3.3	Multiple logical address spaces .....	20
5.4	Overview of the services.....	21
5.4.1	Distribution of messages within a DS.....	21
5.4.1.1	Distribution .....	21
5.4.1.2	Integration .....	22
5.4.2	Services that support the distribution service .....	22
5.4.2.1	Mobility types .....	22
5.4.2.2	Association.....	22
5.4.2.3	Reassociation .....	23
5.4.2.4	Disassociation .....	23
5.4.3	Access and confidentiality control services.....	23
5.4.3.1	Authentication.....	24
5.4.3.2	Deauthentication .....	25
5.4.3.3	Privacy .....	25
5.5	Relationships between services.....	25
5.6	Differences between ESS and IBSS LANs.....	27
5.7	Message information contents that support the services.....	28
5.7.1	Data .....	29
5.7.2	Association.....	29
5.7.3	Reassociation .....	29
5.7.4	Disassociation .....	30
5.7.5	Privacy .....	30

5.7.6	Authentication.....	30
5.7.7	Deauthentication.....	31
5.8	Reference model.....	31
6.	MAC service definition.....	33
6.1	Overview of MAC services.....	33
6.1.1	Asynchronous data service.....	33
6.1.2	Security services.....	33
6.1.3	MSDU ordering.....	33
6.2	Detailed service specification.....	34
6.2.1	MAC data services.....	34
6.2.1.1	MA-UNITDATA.request.....	34
6.2.1.2	MA-UNITDATA.indication.....	35
6.2.1.3	MA-UNITDATA-STATUS.indication.....	36
7.	Frame formats.....	39
7.1	MAC frame formats.....	39
7.1.1	Conventions.....	39
7.1.2	General frame format.....	39
7.1.3	Frame fields.....	40
7.1.3.1	Frame Control field.....	40
7.1.3.2	Duration/ID field.....	43
7.1.3.3	Address fields.....	43
7.1.3.4	Sequence Control field.....	45
7.1.3.5	Frame Body field.....	45
7.1.3.6	FCS field.....	45
7.2	Format of individual frame types.....	46
7.2.1	Control frames.....	46
7.2.1.1	RTS frame format.....	46
7.2.1.2	CTS frame format.....	47
7.2.1.3	ACK frame format.....	47
7.2.1.4	PS-Poll frame format.....	47
7.2.1.5	CF-End frame format.....	48
7.2.1.6	CF-End+CF-Ack frame format.....	48
7.2.2	Data frames.....	48
7.2.3	Management frames.....	50
7.2.3.1	Beacon frame format.....	51
7.2.3.2	IBSS ATIM frame format.....	52
7.2.3.3	Disassociation frame format.....	52
7.2.3.4	Association Request frame format.....	52
7.2.3.5	Association Response frame format.....	52
7.2.3.6	Reassociation Request frame format.....	53
7.2.3.7	Reassociation Response frame format.....	53
7.2.3.8	Probe Request frame format.....	53
7.2.3.9	Probe Response frame format.....	54
7.2.3.10	Authentication frame format.....	55
7.2.3.11	Deauthentication.....	55
7.3	Management frame body components.....	56
7.3.1	Fixed fields.....	56
7.3.1.1	Authentication Algorithm Number field.....	56
7.3.1.2	Authentication Transaction Sequence Number field.....	56
7.3.1.3	Beacon Interval field.....	56

7.3.1.4	Capability Information field .....	56
7.3.1.5	Current AP Address field.....	58
7.3.1.6	Listen Interval field.....	59
7.3.1.7	Reason Code field.....	59
7.3.1.8	AID field .....	60
7.3.1.9	Status Code field .....	60
7.3.1.10	Timestamp field .....	61
7.3.2	Information elements .....	61
7.3.2.1	SSID element .....	62
7.3.2.2	Supported Rates element .....	62
7.3.2.3	FH Parameter Set element .....	63
7.3.2.4	DS Parameter Set element .....	63
7.3.2.5	CF Parameter Set element.....	64
7.3.2.6	TIM .....	64
7.3.2.7	IBSS Parameter Set element.....	65
7.3.2.8	Challenge Text element .....	65
7.3.2.9	Country information element.....	66
7.3.2.10	Hopping Pattern Parameters information element.....	67
7.3.2.11	Hopping Pattern Table information element .....	67
7.3.2.12	Request information element .....	68
8.	Authentication and privacy .....	71
8.1	Authentication services .....	71
8.1.1	Open System authentication .....	71
8.1.1.1	Open System authentication (first frame).....	71
8.1.1.2	Open System authentication (final frame).....	71
8.1.2	Shared Key authentication .....	72
8.1.2.1	Shared Key authentication (first frame).....	72
8.1.2.2	Shared Key authentication (second frame).....	72
8.1.2.3	Shared Key authentication (third frame) .....	73
8.1.2.4	Shared Key authentication (final frame).....	73
8.2	The WEP algorithm .....	73
8.2.1	Introduction.....	73
8.2.2	Properties of the WEP algorithm.....	74
8.2.3	WEP theory of operation .....	74
8.2.4	WEP algorithm specification .....	76
8.2.5	WEP Frame Body expansion.....	76
8.3	Security-Related MIB attributes .....	77
8.3.1	Authentication-Related MIB attributes.....	77
8.3.2	Privacy-Related MIB attributes .....	77
9.	MAC sublayer functional description.....	83
9.1	MAC architecture.....	83
9.1.1	DCF.....	83
9.1.2	PCF .....	83
9.1.3	Coexistence of DCF and PCF .....	84
9.1.4	Fragmentation/defragmentation overview .....	84
9.1.5	MAC data service .....	85
9.2	DCF .....	85
9.2.1	CS mechanism .....	86
9.2.2	MAC-Level acknowledgments .....	86
9.2.3	IFS.....	86

9.2.3.1	SIFS .....	87
9.2.3.2	PIFS .....	87
9.2.3.3	DIFS .....	88
9.2.3.4	EIFS .....	88
9.2.4	Random backoff time .....	88
9.2.5	DCF access procedure .....	89
9.2.5.1	Basic access .....	89
9.2.5.2	Backoff procedure .....	90
9.2.5.3	Recovery procedures and retransmit limits .....	91
9.2.5.4	Setting and resetting the NAV .....	92
9.2.5.5	Control of the channel .....	93
9.2.5.6	RTS/CTS usage with fragmentation .....	94
9.2.5.7	CTS procedure .....	95
9.2.6	Directed MPDU transfer procedure .....	95
9.2.7	Broadcast and multicast MPDU transfer procedure .....	96
9.2.8	ACK procedure .....	96
9.2.9	Duplicate detection and recovery .....	97
9.2.10	DCF timing relations .....	98
9.3	PCF .....	99
9.3.1	CFP structure and timing .....	100
9.3.2	PCF access procedure .....	101
9.3.2.1	Fundamental access .....	101
9.3.2.2	NAV operation during the CFP .....	102
9.3.3	PCF transfer procedure .....	102
9.3.3.1	PCF transfers when the PCF STA is transmitter or recipient .....	103
9.3.3.2	Operation with overlapping point-coordinated BSSs .....	104
9.3.3.3	CFPMaxDuration limit .....	105
9.3.3.4	CF usage rules .....	105
9.3.4	CF polling list .....	105
9.3.4.1	Polling list processing .....	106
9.3.4.2	Polling list update procedure .....	106
9.4	Fragmentation .....	106
9.5	Defragmentation .....	107
9.6	Multirate support .....	108
9.7	Frame exchange sequences .....	109
9.8	MSDU transmission restrictions .....	110
9.9	Operation across regulatory domains .....	111
9.9.1	Operation upon entering a regulatory domain .....	111
9.9.2	Support for FH PHYs .....	111
9.9.2.1	Determination of hopping patterns .....	111
10.	Layer management .....	115
10.1	Overview of management model .....	115
10.2	Generic management primitives .....	116
10.3	MLME SAP interface .....	116
10.3.1	Power management .....	117
10.3.1.1	MLME-POWERMGT.request .....	117
10.3.1.2	MLME-POWERMGT.confirm .....	117
10.3.2	Scan .....	118
10.3.2.1	MLME-SCAN.request .....	118
10.3.2.2	MLME-SCAN.confirm .....	119
10.3.3	Synchronization .....	120
10.3.3.1	MLME-JOIN.request .....	120

	10.3.3.2	MLME-JOIN.confirm	121
10.3.4		Authenticate	122
	10.3.4.1	MLME-AUTHENTICATE.request	122
	10.3.4.2	MLME-AUTHENTICATE.confirm	123
	10.3.4.3	MLME-AUTHENTICATE.indication	123
10.3.5		Deauthenticate	124
	10.3.5.1	MLME-DEAUTHENTICATE.request	124
	10.3.5.2	MLME-DEAUTHENTICATE.confirm	125
	10.3.5.3	MLME-DEAUTHENTICATE.indication	125
10.3.6		Associate	126
	10.3.6.1	MLME-ASSOCIATE.request	126
	10.3.6.2	MLME-ASSOCIATE.confirm	127
	10.3.6.3	MLME-ASSOCIATE.indication	127
10.3.7		Reassociate	128
	10.3.7.1	MLME-REASSOCIATE.request	128
	10.3.7.2	MLME-REASSOCIATE.confirm	129
	10.3.7.3	MLME-REASSOCIATE.indication	129
10.3.8		Disassociate	130
	10.3.8.1	MLME-DISASSOCIATE.request	130
	10.3.8.2	MLME-DISASSOCIATE.confirm	130
	10.3.8.3	MLME-DISASSOCIATE.indication	131
10.3.9		Reset	131
	10.3.9.1	MLME-RESET.request	132
	10.3.9.2	MLME-RESET.confirm	132
10.3.10		Start	133
	10.3.10.1	MLME-START.request	133
	10.3.10.2	MLME-START.confirm	134
10.4		PLME SAP interface	135
10.4.1		PLME-RESET.request	135
	10.4.1.1	Function	135
	10.4.1.2	Semantics of the service primitive	135
	10.4.1.3	When generated	135
	10.4.1.4	Effect of receipt	135
10.4.2		PLME-CHARACTERISTICS.request	135
	10.4.2.1	Function	135
	10.4.2.2	Semantics of the service primitive	135
	10.4.2.3	When generated	136
	10.4.2.4	Effect of receipt	136
10.4.3		PLME-CHARACTERISTICS.confirm	136
	10.4.3.1	Function	136
	10.4.3.2	Semantics of the service primitive	136
	10.4.3.3	When generated	138
	10.4.3.4	Effect of receipt	138
10.4.4		PLME-DSSSTESTMODE.request	138
	10.4.4.1	Function	138
	10.4.4.2	Semantics of the service primitive	138
	10.4.4.3	When generated	139
	10.4.4.4	Effect of receipt	139
10.4.5		PLME-DSSSTESTOUTPUT.request	139
	10.4.5.1	Function	139
	10.4.5.2	Semantics of the service primitive	139
	10.4.5.3	When generated	139
	10.4.5.4	Effect of receipt	139

10.4.6	PLME-TXTIME.request.....	140
10.4.6.1	Function .....	140
10.4.6.2	Semantics of the service primitive.....	140
10.4.6.3	When generated .....	140
10.4.6.4	Effect of receipt .....	140
10.4.7	PLME-TXTIME.confirm.....	140
10.4.7.1	Function .....	140
10.4.7.2	Semantics of the service primitive.....	140
10.4.7.3	When generated .....	140
10.4.7.4	Effect of receipt .....	140
11.	MLME .....	141
11.1	Synchronization .....	141
11.1.1	Basic approach.....	141
11.1.1.1	TSF for infrastructure networks.....	141
11.1.1.2	TSF for an IBSS.....	141
11.1.2	Maintaining synchronization .....	141
11.1.2.1	Beacon generation in infrastructure networks .....	141
11.1.2.2	Beacon generation in an IBSS .....	142
11.1.2.3	Beacon reception.....	142
11.1.2.4	TSF timer accuracy.....	143
11.1.3	Acquiring synchronization, scanning .....	143
11.1.3.1	Passive scanning .....	144
11.1.3.2	Active scanning.....	144
11.1.3.3	Initializing a BSS.....	145
11.1.3.4	Synchronizing with a BSS .....	145
11.1.4	Adjusting STA timers .....	146
11.1.5	Timing synchronization for FH PHYs.....	146
11.2	Power management .....	146
11.2.1	Power management in an infrastructure network .....	146
11.2.1.1	STA Power Management modes .....	147
11.2.1.2	AP TIM transmissions .....	148
11.2.1.3	TIM types.....	148
11.2.1.4	AP operation during the CP .....	149
11.2.1.5	AP operation during the CFP.....	149
11.2.1.6	Receive operation for STAs in PS mode during the CP .....	150
11.2.1.7	Receive operation for STAs in PS mode during the CFP.....	150
11.2.1.8	STAs operating in the Active mode.....	151
11.2.1.9	AP aging function .....	151
11.2.2	Power management in an IBSS .....	151
11.2.2.1	Basic approach.....	151
11.2.2.2	Initialization of power management within an IBSS.....	153
11.2.2.3	STA power state transitions .....	153
11.2.2.4	ATIM and frame transmission.....	153
11.3	Association and reassociation .....	154
11.3.1	STA association procedures.....	154
11.3.2	AP association procedures .....	154
11.3.3	STA reassociation procedures .....	155
11.3.4	AP reassociation procedures.....	155
11.4	MIB definitions .....	155

12.	PHY service specification.....	157
12.1	Scope.....	157
12.2	PHY functions.....	157
12.3	Detailed PHY service specifications.....	157
12.3.1	Scope and field of application .....	157
12.3.2	Overview of the service .....	157
12.3.3	Overview of interactions.....	157
12.3.4	Basic service and options.....	157
12.3.4.1	PHY-SAP peer-to-peer service primitives.....	158
12.3.4.2	PHY-SAP sublayer-to-sublayer service primitives .....	158
12.3.4.3	PHY-SAP service primitives parameters.....	158
12.3.4.4	Vector descriptions .....	159
12.3.5	PHY-SAP detailed service specification .....	159
12.3.5.1	PHY-DATA.request .....	159
12.3.5.2	PHY-DATA.indication .....	159
12.3.5.3	PHY-DATA.confirm .....	160
12.3.5.4	PHY-TXSTART.request.....	160
12.3.5.5	PHY-TXSTART.confirm .....	161
12.3.5.6	PHY-TXEND.request.....	161
12.3.5.7	PHY-TXEND.confirm.....	162
12.3.5.8	PHY-CCARESET.request .....	162
12.3.5.9	PHY-CCARESET.confirm .....	163
12.3.5.10	PHY-CCA.indication.....	163
12.3.5.11	PHY-RXSTART.indication.....	164
12.3.5.12	PHY-RXEND.indication .....	164
13.	PHY management.....	167
14.	Frequency-Hopping spread spectrum (FHSS) PHY specification for the 2.4 GHz industrial, scientific, and medical (ISM) band .....	169
14.1	Overview.....	169
14.1.1	Overview of FHSS PHY.....	169
14.1.2	FHSS PHY functions.....	169
14.1.2.1	PLCP sublayer .....	169
14.1.2.2	PLME.....	169
14.1.2.3	PMD sublayer .....	169
14.1.3	Service specification method and notation .....	169
14.2	FHSS PHY-specific service parameter lists.....	170
14.2.1	Overview.....	170
14.2.2	TXVECTOR parameters.....	170
14.2.2.1	TXVECTOR LENGTH.....	170
14.2.2.2	TXVECTOR DATARATE.....	170
14.2.3	RXVECTOR parameters .....	170
14.2.3.1	TRXVECTOR LENGTH .....	171
14.2.3.2	RXVECTOR RSSI .....	171
14.3	FHSS PLCP sublayer .....	171
14.3.1	Overview.....	171
14.3.1.1	State diagram notation .....	171
14.3.2	PLCP frame format.....	172
14.3.2.1	PLCP Preamble.....	173
14.3.2.2	PLCP Header field.....	173
14.3.2.3	PLCP data whitener .....	174

14.3.3	PLCP state machines .....	175
14.3.3.1	Transmit PLCP .....	175
14.3.3.2	CS/CCA procedure .....	178
14.3.3.3	Receive PLCP .....	181
14.4	PLME SAP layer management .....	184
14.4.1	Overview .....	184
14.4.2	FH PHY specific MLME procedures .....	184
14.4.2.1	Overview .....	184
14.4.2.2	FH synchronization .....	184
14.4.3	FH PLME state machines .....	184
14.4.3.1	Overview .....	184
14.4.3.2	PLME state machine .....	184
14.4.3.3	PLME management primitives .....	186
14.5	FHSS PMD sublayer services .....	187
14.5.1	Scope and field of application .....	187
14.5.2	Overview of services .....	187
14.5.3	Overview of interactions .....	187
14.5.4	Basic service and options .....	187
14.5.4.1	PMD_SAP peer-to-peer service primitives .....	187
14.5.4.2	PMD_SAP sublayer-to-sublayer service primitives .....	188
14.5.4.3	PMD_SAP service primitives parameters .....	188
14.5.5	PMD_SAP detailed service specification .....	188
14.5.5.1	PMD_DATA.request .....	188
14.5.5.2	PMD_DATA.indicate .....	189
14.5.5.3	PMD_TXRX.request .....	189
14.5.5.4	PMD_PA_RAMP.request .....	190
14.5.5.5	PMD_ANTSEL.request .....	190
14.5.5.6	PMD_TXPWRLVL.request .....	191
14.5.5.7	PMD_FREQ.request .....	192
14.5.5.8	PMD_RSSI.indicate .....	192
14.5.5.9	PMD_PWRMGMT.request .....	193
14.6	FHSS PMD sublayer, 1.0 Mbit/s .....	193
14.6.1	1 Mbit/s PMD operating specifications, general .....	193
14.6.2	Regulatory requirements .....	193
14.6.3	Operating frequency range .....	194
14.6.4	Number of operating channels .....	195
14.6.5	Operating channel center frequency .....	195
14.6.6	Occupied channel bandwidth .....	197
14.6.7	Minimum hop rate .....	197
14.6.8	Hop sequences .....	198
14.6.9	Unwanted emissions .....	200
14.6.10	Modulation .....	200
14.6.11	Channel data rate .....	201
14.6.12	Channel switching/settling time .....	201
14.6.13	Receive to transmit switch time .....	201
14.6.14	PMD transmit specifications .....	202
14.6.14.1	Nominal transmit power .....	202
14.6.14.2	Transmit power levels .....	202
14.6.14.3	Transmit power level control .....	202
14.6.14.4	Transmit spectrum shape .....	202
14.6.14.5	Transmit center frequency tolerance .....	203
14.6.14.6	Transmitter ramp periods .....	203
14.6.15	PMD receiver specifications .....	203
14.6.15.1	Input signal range .....	203

	14.6.15.2 Receive center frequency acceptance range .....	203
	14.6.15.3 CCA power threshold .....	203
	14.6.15.4 Receiver sensitivity .....	203
	14.6.15.5 Intermodulation .....	204
	14.6.15.6 Desensitization (Dp) .....	204
	14.6.15.7 Receiver radiation .....	204
	14.6.16 Operating temperature range .....	204
14.7	FHSS PMD sublayer, 2.0 Mbit/s .....	204
	14.7.1 Overview .....	204
	14.7.2 4GFSK modulation .....	205
	14.7.2.1 Frame structure for HS FHSS PHY .....	206
	14.7.3 Channel data rate .....	206
	14.7.3.1 Input dynamic range .....	206
	14.7.3.2 Receiver sensitivity .....	207
	14.7.3.3 IMp .....	207
	14.7.3.4 Dp .....	207
14.8	FHSS PHY MIB .....	207
	14.8.1 FH PHY attributes .....	207
	14.8.2 FH PHY attribute definitions .....	209
	14.8.2.1 dot11PHYType .....	209
	14.8.2.2 dot11RegDomainsSupported .....	209
	14.8.2.3 dot11CurrentRegDomain .....	209
	14.8.2.4 dot11TempType .....	210
	14.8.2.5 dot11CurrentPowerState .....	210
	14.8.2.6 dot11SupportedDataRatesTX .....	210
	14.8.2.7 dot11SupportedDataRatesRX .....	210
	14.8.2.8 aMPDUMaxLength .....	210
	14.8.2.9 dot11SupportedTxAntennas .....	211
	14.8.2.10 dot11CurrentTxAntenna .....	211
	14.8.2.11 dot11SupportedRxAntenna .....	211
	14.8.2.12 dot11DiversitySupport .....	211
	14.8.2.13 dot11DiversitySelectionRx .....	212
	14.8.2.14 dot11NumberSupportedPowerLevels .....	212
	14.8.2.15 dot11TxPowerLevel1-8 .....	212
	14.8.2.16 dot11CurrentTxPowerLevel .....	212
	14.8.2.17 dot11HopTime .....	213
	14.8.2.18 dot11CurrentChannelNumber .....	213
	14.8.2.19 dot11MaxDwellTime .....	213
	14.8.2.20 dot11CurrentSet .....	213
	14.8.2.21 dot11CurrentPattern .....	213
	14.8.2.22 dot11CurrentIndex .....	213
	14.8.2.23 dot11CurrentPowerState .....	214
14.9	FH PHY characteristics .....	214
15.	DSSS PHY specification for the 2.4 GHz band designated for ISM applications .....	217
	15.1 Overview .....	217
	15.1.1 Scope .....	217
	15.1.2 DSSS PHY functions .....	217
	15.1.2.1 PLCP sublayer .....	217
	15.1.2.2 PMD sublayer .....	217
	15.1.2.3 PLME .....	217
	15.1.3 Service specification method and notation .....	218
15.2	DSSS PLCP sublayer .....	218

15.2.1	Overview.....	218
15.2.2	PLCP frame format.....	218
15.2.3	PLCP field definitions .....	218
15.2.3.1	PLCP SYNC field.....	218
15.2.3.2	PLCP SFD.....	219
15.2.3.3	PLCP IEEE 802.11 SIGNAL field .....	219
15.2.3.4	PLCP IEEE 802.11 SERVICE field .....	219
15.2.3.5	PLCP LENGTH field.....	219
15.2.3.6	PLCP CRC field.....	219
15.2.4	PLCP/DSSS PHY data scrambler and descrambler .....	221
15.2.5	PLCP data modulation and modulation rate change.....	221
15.2.6	Transmit PLCP .....	221
15.2.7	Receive PLCP .....	222
15.3	DSSS PLME .....	225
15.3.1	PLME_SAP sublayer management primitives .....	225
15.3.2	DSSS PHY MIB .....	226
15.3.3	DS PHY characteristics .....	227
15.4	DSSS PMD sublayer.....	227
15.4.1	Scope and field of application .....	227
15.4.2	Overview of service .....	228
15.4.3	Overview of interactions.....	228
15.4.4	Basic service and options.....	228
15.4.4.1	PMD_SAP peer-to-peer service primitives .....	228
15.4.4.2	PMD_SAP peer-to-peer service primitive parameters .....	229
15.4.4.3	PMD_SAP sublayer-to-sublayer service primitives .....	229
15.4.4.4	PMD_SAP service primitive parameters.....	229
15.4.5	PMD_SAP detailed service specification .....	230
15.4.5.1	PMD_DATA.request .....	230
15.4.5.2	PMD_DATA.indicate .....	231
15.4.5.3	PMD_TXSTART.request .....	231
15.4.5.4	PMD_TXEND.request.....	232
15.4.5.5	PMD_ANTSEL.request.....	232
15.4.5.6	PMD_ANTSEL.indicate.....	232
15.4.5.7	PMD_TXPWRLVL.request .....	233
15.4.5.8	PMD_RATE.request.....	233
15.4.5.9	PMD_RATE.indicate.....	234
15.4.5.10	PMD_RSSI.indicate.....	234
15.4.5.11	PMD_SQ.indicate .....	235
15.4.5.12	PMD_CS.indicate .....	235
15.4.5.13	PMD_ED.indicate.....	236
15.4.5.14	PMD_ED.request.....	236
15.4.5.15	PHY-CCA.indicate .....	237
15.4.6	PMD operating specifications, general.....	237
15.4.6.1	Operating frequency range.....	237
15.4.6.2	Number of operating channels .....	238
15.4.6.3	Spreading sequence.....	238
15.4.6.4	Modulation and channel data rates .....	239
15.4.6.5	Transmit and receive in-band and out-of-band spurious emissions .....	239
15.4.6.6	TX-to-RX turnaround time .....	239
15.4.6.7	RX-to-TX turnaround time .....	239
15.4.6.8	Slot time.....	240
15.4.6.9	Transmit and receive antenna port impedance .....	240
15.4.6.10	Transmit and receive operating temperature range.....	240

15.4.7	PMD transmit specifications.....	240
15.4.7.1	Transmit power levels.....	240
15.4.7.2	Minimum transmitted power level.....	240
15.4.7.3	Transmit power level control.....	240
15.4.7.4	Transmit spectrum mask.....	240
15.4.7.5	Transmit center frequency tolerance.....	241
15.4.7.6	Chip clock frequency tolerance.....	241
15.4.7.7	Transmit power-on and power-down ramp.....	241
15.4.7.8	RF carrier suppression.....	242
15.4.7.9	Transmit modulation accuracy.....	242
15.4.8	PMD receiver specifications.....	244
15.4.8.1	Receiver minimum input level sensitivity.....	244
15.4.8.2	Receiver maximum input level.....	244
15.4.8.3	Receiver adjacent channel rejection.....	244
15.4.8.4	CCA.....	245
16.	Infrared (IR) PHY specification.....	247
16.1	Overview.....	247
16.1.1	Scope.....	248
16.1.2	IR PHY functions.....	248
16.1.2.1	PLCP sublayer.....	248
16.1.2.2	PMD sublayer.....	248
16.1.2.3	PLME.....	248
16.1.3	Service specification method and notation.....	248
16.2	IR PLCP sublayer.....	249
16.2.1	Overview.....	249
16.2.2	PLCP frame format.....	249
16.2.3	PLCP modulation and rate change.....	249
16.2.4	PLCP field definitions.....	250
16.2.4.1	PLCP SYNC field.....	250
16.2.4.2	PLCP SFD field.....	250
16.2.4.3	PLCP DR field.....	250
16.2.4.4	PLCP DCLA field.....	250
16.2.4.5	PLCP LENGTH field.....	251
16.2.4.6	PLCP CRC field.....	251
16.2.4.7	PSDU field.....	251
16.2.5	PLCPs.....	251
16.2.5.1	Transmit PLCP.....	251
16.2.5.2	Receive PLCP.....	252
16.2.5.3	CCA procedure.....	252
16.2.5.4	PMD_SAP peer-to-peer service primitive parameters.....	252
16.3	IR PMD sublayer.....	253
16.3.1	Overview.....	253
16.3.2	PMD operating specifications, general.....	253
16.3.2.1	Modulation and channel data rates.....	253
16.3.2.2	Octet partition and PPM symbol generation procedure.....	254
16.3.2.3	Operating environment.....	254
16.3.2.4	Operating temperature range.....	255
16.3.3	PMD transmit specifications.....	255
16.3.3.1	Transmitted peak optical power.....	255
16.3.3.2	Basic pulse shape and parameters.....	255
16.3.3.3	Emitter radiation pattern mask.....	256
16.3.3.4	Optical emitter peak wavelength.....	258

16.3.3.5	Transmit spectrum mask .....	258
16.3.4	PMD receiver specifications .....	258
16.3.4.1	Receiver sensitivity .....	258
16.3.4.2	Receiver dynamic range .....	259
16.3.4.3	Receiver field of view (FOV) .....	259
16.3.5	ED, CS, and CCA definitions .....	259
16.3.5.1	ED signal .....	259
16.3.5.2	CS signal .....	259
16.3.5.3	CCA .....	260
16.3.5.4	CHNL_ID .....	260
16.4	PHY attributes .....	260
17.	Orthogonal frequency division multiplexing (OFDM) PHY specification for the 5 GHz band .....	263
17.1	Introduction .....	263
17.1.1	Scope .....	263
17.1.2	OFDM PHY functions .....	263
17.1.2.1	PLCP sublayer .....	263
17.1.2.2	PMD sublayer .....	263
17.1.2.3	PLME .....	263
17.1.2.4	Service specification method .....	264
17.2	OFDM PHY specific service parameter list .....	264
17.2.1	Introduction .....	264
17.2.2	TXVECTOR parameters .....	264
17.2.2.1	TXVECTOR LENGTH .....	264
17.2.2.2	TXVECTOR DATARATE .....	265
17.2.2.3	TXVECTOR SERVICE .....	265
17.2.2.4	TXVECTOR TXPWR_LEVEL .....	265
17.2.3	RXVECTOR parameters .....	265
17.2.3.1	RXVECTOR LENGTH .....	265
17.2.3.2	RXVECTOR RSSI .....	265
17.2.3.3	DATARATE .....	266
17.2.3.4	SERVICE .....	266
17.3	OFDM PLCP sublayer .....	266
17.3.1	Introduction .....	266
17.3.2	PLCP frame format .....	266
17.3.2.1	Overview of the PPDU encoding process .....	266
17.3.2.2	RATE-dependent parameters .....	268
17.3.2.3	Timing related parameters .....	268
17.3.2.4	Mathematical conventions in the signal descriptions .....	269
17.3.2.5	Discrete time implementation considerations .....	270
17.3.3	PLCP preamble (SYNC) .....	271
17.3.4	SIGNAL field .....	272
17.3.4.1	RATE field .....	273
17.3.4.2	PLCP LENGTH field .....	273
17.3.4.3	Parity (P), Reserved (R), and SIGNAL TAIL fields .....	274
17.3.5	DATA field .....	274
17.3.5.1	SERVICE field .....	274
17.3.5.2	PPDU TAIL field .....	274
17.3.5.3	Pad bits (PAD) .....	274
17.3.5.4	PLCP DATA scrambler and descrambler .....	275
17.3.5.5	Convolutional encoder .....	275
17.3.5.6	Data interleaving .....	276
17.3.5.7	Subcarrier modulation mapping .....	278

	17.3.5.8	Pilot subcarriers .....	281
	17.3.5.9	OFDM modulation.....	281
17.3.6		CCA .....	282
17.3.7		PLCP data modulation and modulation rate change.....	282
17.3.8		PMD operating specifications (general) .....	283
	17.3.8.1	Outline description.....	283
	17.3.8.2	Regulatory requirements.....	284
	17.3.8.3	Operating channel frequencies.....	284
	17.3.8.4	Transmit and receive in-band and out-of-band spurious emissions .....	285
	17.3.8.5	TX RF delay.....	285
	17.3.8.6	Slot time .....	286
	17.3.8.7	Transmit and receive antenna port impedance .....	286
	17.3.8.8	Transmit and receive operating temperature range.....	286
17.3.9		PMD transmit specifications.....	286
	17.3.9.1	Transmit power levels.....	286
	17.3.9.2	Transmit spectrum mask.....	287
	17.3.9.3	Transmission spurious .....	287
	17.3.9.4	Transmit center frequency tolerance.....	287
	17.3.9.5	Symbol clock frequency tolerance.....	287
	17.3.9.6	Modulation accuracy.....	288
	17.3.9.7	Transmit modulation accuracy test .....	288
17.3.10		PMD receiver specifications .....	289
	17.3.10.1	Receiver minimum input level sensitivity .....	289
	17.3.10.2	Adjacent channel rejection.....	290
	17.3.10.3	Nonadjacent channel rejection.....	290
	17.3.10.4	Receiver maximum input level .....	291
	17.3.10.5	CCA sensitivity.....	291
17.3.11		Transmit PLCP .....	291
17.3.12		Receive PLCP .....	293
17.4		OFDM PLME .....	295
	17.4.1	PLME_SAP sublayer management primitives .....	295
	17.4.2	OFDM PHY MIB .....	295
	17.4.3	OFDM TXTIME calculation .....	297
	17.4.4	OFDM PHY characteristics .....	298
17.5		OFDM PMD sublayer.....	299
	17.5.1	Scope and field of application .....	299
	17.5.2	Overview of service .....	299
	17.5.3	Overview of interactions.....	299
	17.5.4	Basic service and options.....	299
	17.5.4.1	PMD_SAP peer-to-peer service primitives .....	299
	17.5.4.2	PMD_SAP sublayer-to-sublayer service primitives .....	300
	17.5.4.3	PMD_SAP service primitive parameters .....	300
	17.5.5	PMD_SAP detailed service specification .....	300
	17.5.5.1	PMD_DATA.request .....	301
	17.5.5.2	PMD_DATA.indicate .....	301
	17.5.5.3	PMD_TXSTART.request .....	302
	17.5.5.4	PMD_TXEND.request.....	302
	17.5.5.5	PMD_TXPWRLVL.request .....	302
	17.5.5.6	PMD_RATE.request.....	303
	17.5.5.7	PMD_RSSI.indicate.....	303

18.	High Rate direct sequence spread spectrum (HR/DSSS) PHY specification .....	305
18.1	Overview .....	305
18.1.1	Scope .....	305
18.1.2	High Rate PHY functions .....	305
18.1.2.1	PLCP sublayer .....	306
18.1.2.2	PMD sublayer .....	306
18.1.2.3	PLME .....	306
18.1.3	Service specification method and notation .....	306
18.2	High Rate PLCP sublayer .....	306
18.2.1	Overview .....	306
18.2.2	PPDU format .....	306
18.2.2.1	Long PPDU format .....	307
18.2.2.2	Short PPDU format (optional) .....	307
18.2.3	PPDU field definitions .....	307
18.2.3.1	Long PLCP SYNC field .....	308
18.2.3.2	Long PLCP SFD .....	308
18.2.3.3	Long PLCP SIGNAL field .....	308
18.2.3.4	Long PLCP SERVICE field .....	309
18.2.3.5	Long PLCP LENGTH field .....	309
18.2.3.6	PLCP CRC (CRC-16) field .....	311
18.2.3.7	Long PLCP data modulation and modulation rate change .....	313
18.2.3.8	Short PLCP synchronization (shortSYNC) .....	313
18.2.3.9	Short PLCP SFD field (shortSFD) .....	313
18.2.3.10	Short PLCP SIGNAL field (shortSIGNAL) .....	314
18.2.3.11	Short PLCP SERVICE field (shortSERVICE) .....	314
18.2.3.12	Short PLCP LENGTH field (shortLENGTH) .....	314
18.2.3.13	Short CRC-16 field (shortCRC) .....	314
18.2.3.14	Short PLCP data modulation and modulation rate change .....	314
18.2.4	PLCP/High Rate PHY data scrambler and descrambler .....	314
18.2.5	Transmit PLCP .....	315
18.2.6	Receive PLCP .....	317
18.3	High Rate PLME .....	320
18.3.1	PLME_SAP sublayer management primitives .....	320
18.3.2	High Rate PHY MIB .....	321
18.3.3	DS PHY characteristics .....	322
18.3.4	High Rate TXTIME calculation .....	323
18.3.5	Vector descriptions .....	323
18.4	High Rate PMD sublayer .....	324
18.4.1	Scope and field of application .....	324
18.4.2	Overview of service .....	324
18.4.3	Overview of interactions .....	324
18.4.4	Basic service and options .....	324
18.4.4.1	PMD_SAP peer-to-peer service primitives .....	325
18.4.4.2	PMD_SAP sublayer-to-sublayer service primitives .....	325
18.4.5	PMD_SAP detailed service specification .....	325
18.4.5.1	PMD_DATA.request .....	325
18.4.5.2	PMD_DATA.indicate .....	326
18.4.5.3	PMD_MODULATION.request .....	327
18.4.5.4	PMD_PREAMBLE.request .....	327
18.4.5.5	PMD_PREAMBLE.indicate .....	328
18.4.5.6	PMD_TXSTART.request .....	328
18.4.5.7	PMD_TXEND.request .....	329
18.4.5.8	PMD_ANTSEL.request .....	329

18.4.5.9	PMD_TXPWRLVL.request .....	330
18.4.5.10	PMD_RATE.request .....	330
18.4.5.11	PMD_RSSI.indicate .....	331
18.4.5.12	PMD_SQ.indicate .....	332
18.4.5.13	PMD_CS.indicate .....	332
18.4.5.14	PMD_ED.indicate .....	333
18.4.5.15	PMD_ED.request .....	334
18.4.6	PMD operating specifications, general .....	334
18.4.6.1	Operating frequency range .....	334
18.4.6.2	Number of operating channels .....	335
18.4.6.3	Modulation and channel data rates .....	336
18.4.6.4	Spreading sequence and modulation for 1 and 2 Mbit/s .....	336
18.4.6.5	Spreading sequences and modulation for CCK modulation at 5.5 Mbit/s and 11 Mbit/s .....	336
18.4.6.6	DSSS/PBCC data modulation and modulation rate (optional) .....	338
18.4.6.7	Channel Agility (optional) .....	341
18.4.6.8	Transmit and receive in-band and out-of-band spurious emissions .....	344
18.4.6.9	TX-to-RX turnaround time .....	344
18.4.6.10	RX-to-TX turnaround time .....	344
18.4.6.11	Slot time .....	344
18.4.6.12	Channel switching/settling time .....	344
18.4.6.13	Transmit and receive antenna port impedance .....	344
18.4.6.14	Transmit and receive operating temperature range .....	344
18.4.7	PMD transmit specifications .....	344
18.4.7.1	Transmit power levels .....	345
18.4.7.2	Transmit power level control .....	345
18.4.7.3	Transmit spectrum mask .....	345
18.4.7.4	Transmit center frequency tolerance .....	346
18.4.7.5	Chip clock frequency tolerance .....	346
18.4.7.6	Transmit power-on and power-down ramp .....	346
18.4.7.7	RF carrier suppression .....	346
18.4.7.8	Transmit modulation accuracy .....	347
18.4.8	PMD receiver specifications .....	350
18.4.8.1	Receiver minimum input level sensitivity .....	350
18.4.8.2	Receiver maximum input level .....	350
18.4.8.3	Receiver adjacent channel rejection .....	350
18.4.8.4	CCA .....	350

Annex A (normative)	Protocol Implementation Conformance Statement (PICS) proforma .....	353
---------------------	---	-----

A.1	Introduction .....	353
A.2	Abbreviations and special symbols .....	353
A.2.1	Symbols for Status column .....	353
A.2.2	General abbreviations for Item and Support columns .....	353
A.3	Instructions for completing the PICS proforma .....	354
A.3.1	General structure of the PICS proforma .....	354
A.3.2	Additional information .....	354
A.3.3	Exception information .....	354
A.3.4	Conditional status .....	355
A.4	PICS proforma—IEEE Std 802.11, 2003 Edition .....	356
A.4.1	Implementation identification .....	356
A.4.2	Protocol summary .....	356
A.4.4	MAC protocol .....	357
A.4.3	IUT configuration .....	357

A.4.5	Frequency hopping (FH) PHY functions.....	362
A.4.6	Direct sequence PHY functions.....	364
A.4.7	IR baseband PHY functions.....	367
A.4.8	OFDM PHY functions.....	370
A.4.9	High Rate, direct sequence PHY functions.....	374
A.4.10	Regulatory Domain Extensions.....	379
Annex B (informative)	Hopping sequences.....	381
Annex C (normative)	Formal description of MAC operation.....	395
C.1	Introduction to the MAC formal description.....	398
C.1.1	Fundamental assumptions.....	398
C.1.2	Notation conventions.....	398
C.1.3	Modeling techniques.....	399
C.2	Data type and operator definitions for the MAC state machines.....	400
C.3	State machines for MAC stations.....	449
C.4	State machines for MAC AP.....	525
Annex D (normative)	ASN.1 encoding of the MAC and PHY MIB.....	595
Annex E (informative)	Bibliography.....	647
E.1	General.....	647
E.2	Specification and description language (SDL) documentation.....	648
Annex F (informative)	High Rate PHY/FH interoperability.....	649
F.1	Additional CCA recommendations.....	649
Annex G (informative)	An example of encoding a frame for OFDM PHY.....	651
G.1	Introduction.....	651
G.2	The message.....	651
G.3	Generation of the preamble.....	653
G.3.1	Generation of the short sequences.....	653
G.3.2	Generation of the long sequences.....	656
G.4	Generation of the SIGNAL field.....	658
G.4.1	SIGNAL field bit assignment.....	658
G.4.2	Coding the SIGNAL field bits.....	658
G.4.3	Interleaving the SIGNAL field bits.....	658
G.4.4	SIGNAL field frequency domain.....	659
G.4.5	SIGNAL field time domain.....	661
G.5	Generating the DATA bits.....	662
G.5.1	Delineating, SERVICE field prepending, and zero padding.....	662
G.5.2	Scrambling.....	663
G.6	Generating the first DATA symbol.....	666
G.6.1	Coding the DATA bits.....	666
G.6.2	Interleaving the DATA bits.....	667
G.6.3	Mapping into symbols.....	670
G.7	Generating the additional DATA symbols.....	671
G.8	The entire packet.....	672