Performance results for SPW implementations of IEEE 802.11a and HIPERLAN/2 WLAN standards

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High Speed Wireless LAN Standards

- IEEE 802.11a in U.S., HIPERLAN/2 developed by ETSI, MMAC in Japan, all operating in 5 GHz band
- Largely similar PHY, different MAC
- IEEE 802.11a: CSMA/CA (Collision Avoidance), extension of IEEE 802.11
- HIPERLAN/2: Centralized resource allocation, TDD/TDMA, 2 msec frame duration

IEEE 802.11a & HIPERLAN/2 PHY

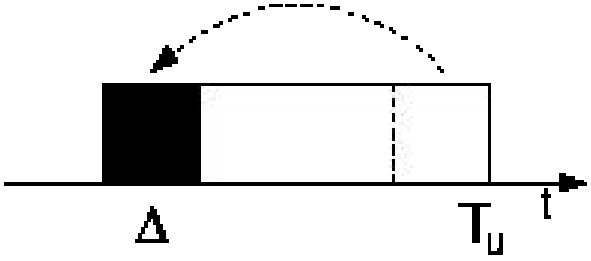
- PHY based on OFDM
- 64 point FFT, 48 data/4 pilot sub-carriers
- $\Delta f = 312.5$ kHz, $T_{FFT} = 3.2$ ms, $T_{sym} = 4$ μs
- Channel spacing : 20 MHz ; Data Rate: 6-54 Mbps
- Different preambles, used for AGC, timing, frequency offset and channel estimation

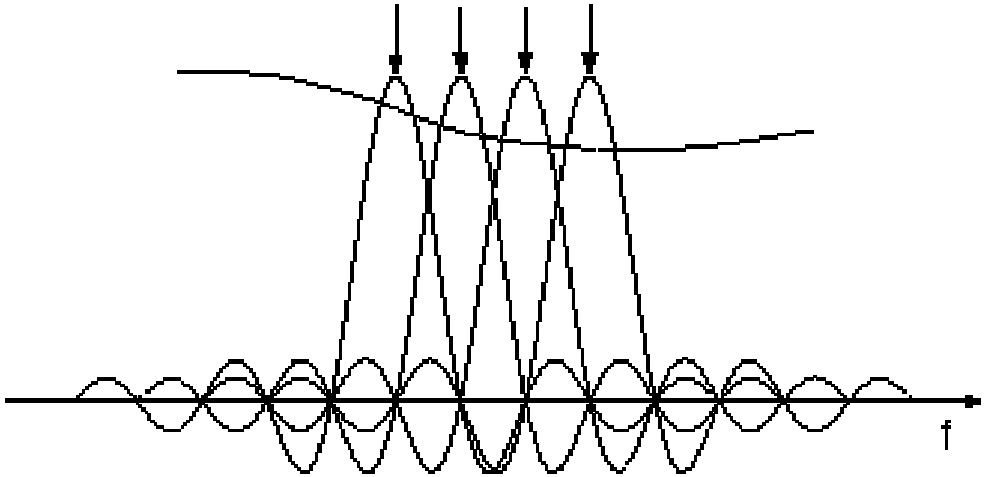
Orthogonal Frequency Division Multiplexing

- Split a high-rate data stream into N parallel low -rate streams, each transmitted over a separate subcarrier
- Subcarriers are orthogonal, spectrally efficient
- Longer symbol duration, decreased intersymbol interference

$$s(t) = \sum_{n} \left\{ \sum_{k=0}^{N-1} d_{k,n} e^{\frac{j2pk}{T_s}(t - nT_s)} \right\}$$

OFDM (cont'd)





IEEE 802.11a parameters

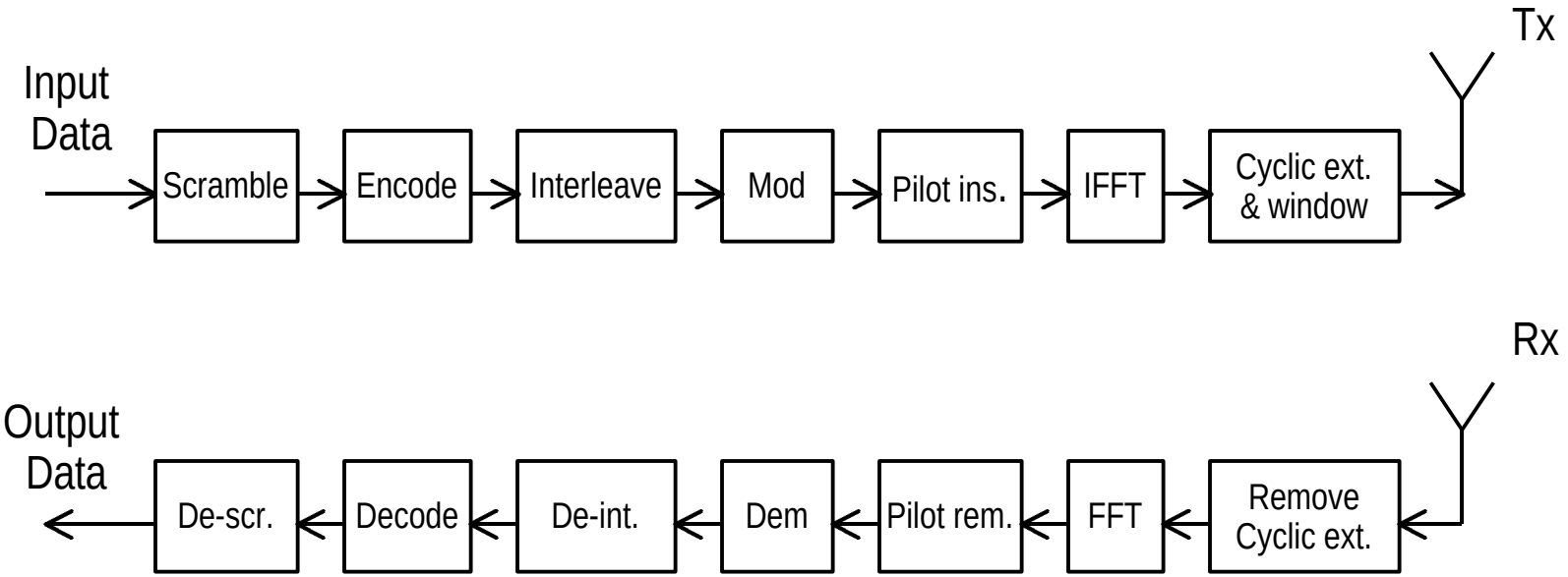
Data Rate	**6, 9, 12, 18, 24, 36, 48, 54 Mbps**
Modulation	**BPSK, QPSK, 16-QAM, 64-QAM**
Coding rate	**1/2, 2/3, 3/4**
Number of subcarriers	**48**
Number of pilots	**4**
OFDM symbol duration	**4us**
Guard interval	**800 ns**
Subcarrier spacing	**312.5 kHz**
Channel spacing	**20 MHz**

IEEE 802.11a & HIPERLAN/2 parameters

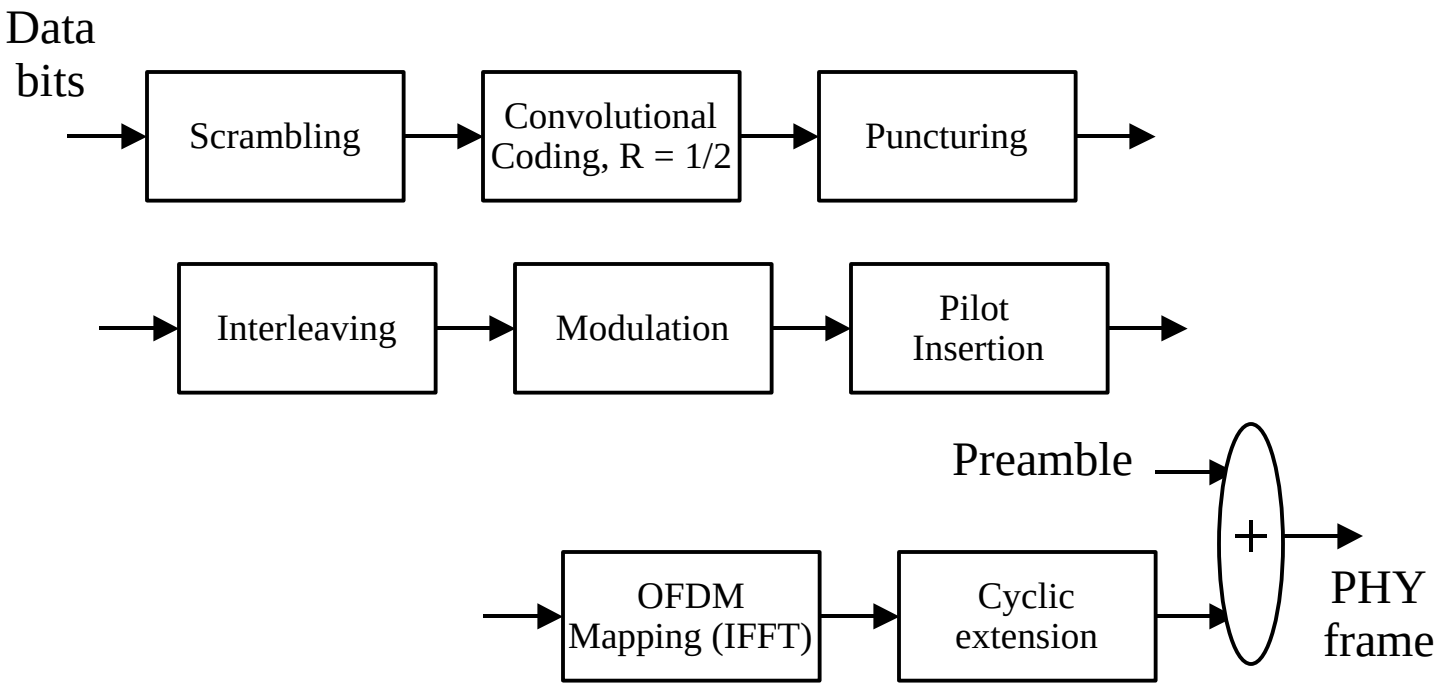
Data rate (Mbps)	Modulation	Coding rate (R)	Coded bits per subcarrier (N_BPSC)	Coded bits per OFDM symbol (N_CBPS)	Data bits per OFDM symbol (N_DBPS)
6	BPSK	1/2	1	48	24
9	BPSK	3/4	1	48	36
12	QPSK	1/2	2	96	48
18	QPSK	3/4	2	96	72
24*	16-QAM	1/2	4	192	96
27**	16-QAM	9/16	4	192	108
36	16-QAM	3/4	4	192	144
48*	64-QAM	2/3	6	288	192
54	64-QAM	3/4	6	288	216

* IEEE 802.11a
** HIPERLAN/2

Baseband OFDM transceiver



Baseband Transmitter



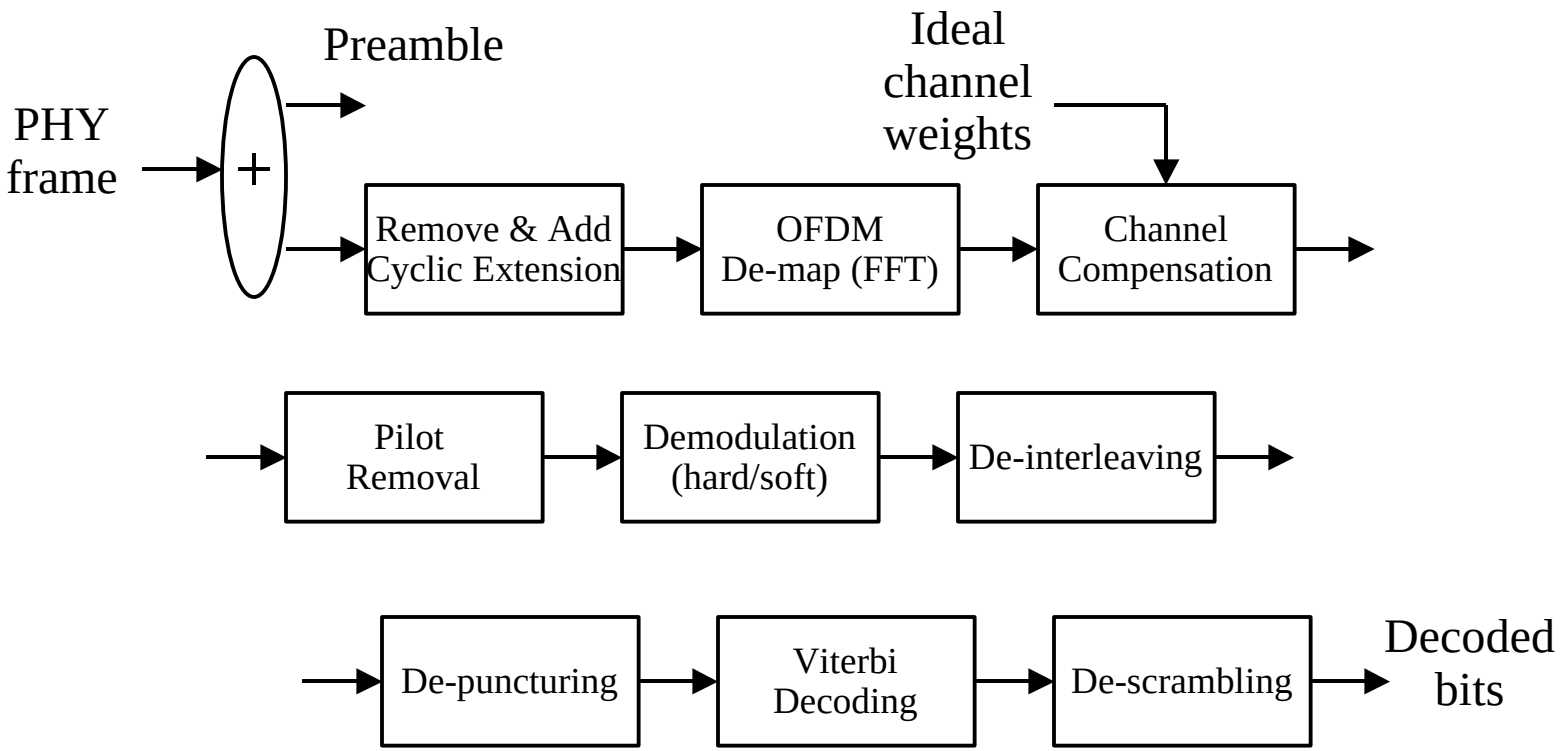
Channel Model

- Multi-path, frequency-selective fading channel
- Discrete time tapped delay line model
- Exponentially decaying tap weights with Rayleigh distribution
- RMS delay spread: 50-250 nsec

Baseband Receiver

- *Ideal* receiver
- Assume perfect knowledge of timing and channel
- Provide a baseline for receiver performance
- A framework to design and verify the performance of different pieces of a practical receiver

Baseband Ideal Receiver

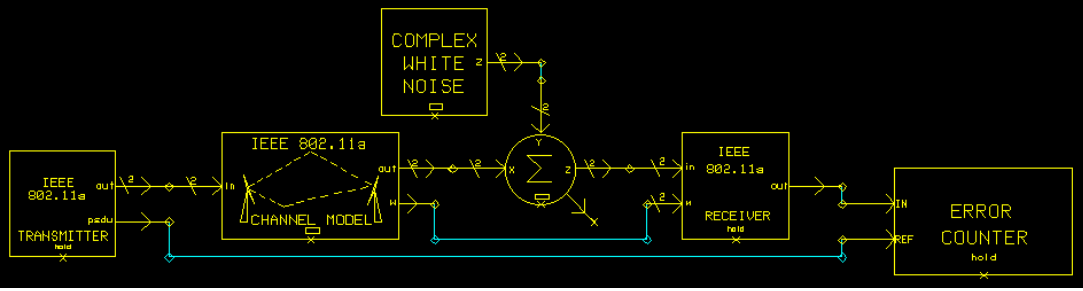


IEEE 802.11a ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) SYSTEM IN 5 GHz BAND

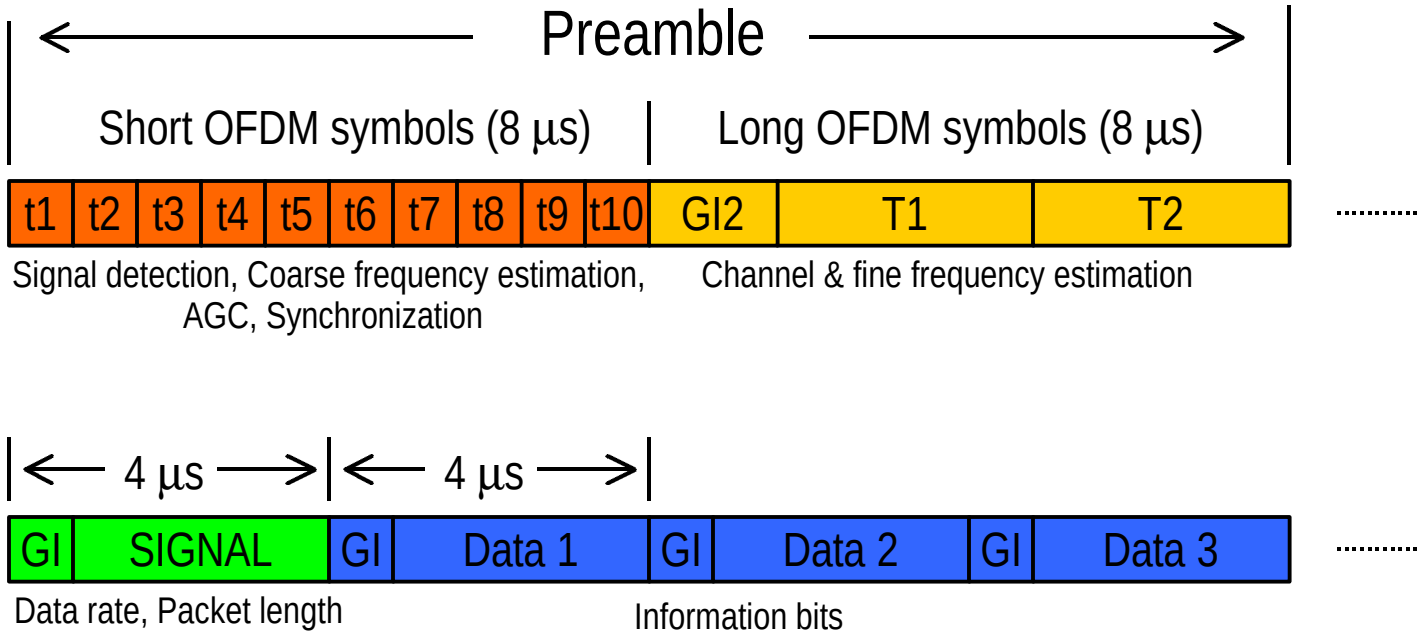
MAIN PARAMETERS:	
Data Rate (Mbps)	36
PSDU length	54
Eb/N0 (dB)	20.0
Decoding	hard
Channel	Fading
Delay spread (ns)	100.0
Number of paths	12
Fading over packets	fix

OTHER PARAMETERS (EDITABLE):	
Time windowing	no
Example mode	no

UNEDITABLE PARAMETERS:	
SERVICE bits	16
TAIL bits	6
PAD bits	122
Data bits	576
Modulation	16QAM
Coding rate	3/4
N_BPSC (Bits per subcarrier)	4
N_CBPS (Coded bits per OFDM symbol)	192
N_DBPS (Data bits per OFDM symbol)	144
Number of OFDM symbols	4
SNR (dB)	23.371

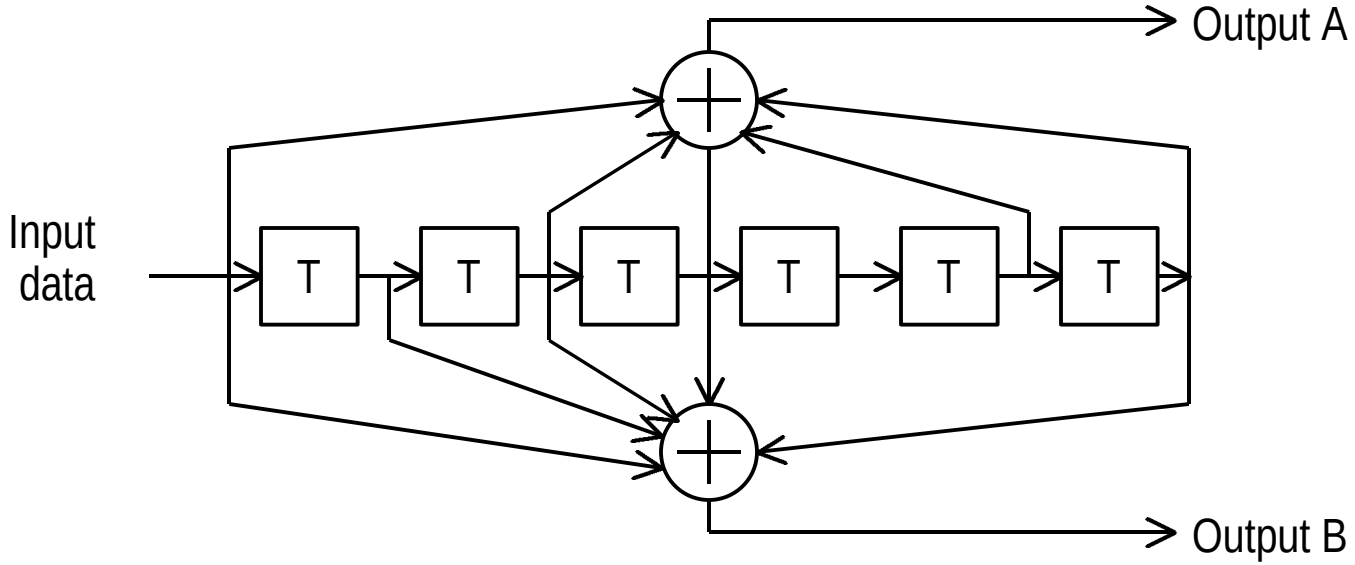


Packet Structure



Coding

- Convolutional codes
  - Rate 1/2, constraint length = 7
  - Rates 2/3 & 3/4 achieved with puncturing

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Ideal Channel Compensation

- Store weights of the tapped delay line channel model
- Perform FFT on the weights to find the frequency response of the channel
- Compensate the channel in the frequency domain