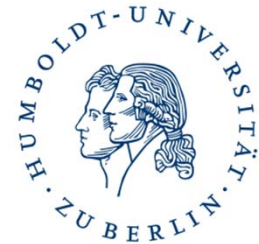


Drahtlose Breitbandkommunikation - Entzerrung



**Humboldt-Universität zu Berlin, Institut für Informatik,
IHP, Leibniz Institut für innovative Mikroelektronik, Frankfurt (Oder)**

Vorlesung Drahtlose Breitbandkommunikationssysteme

Prof. Dr. Eckhard Grass

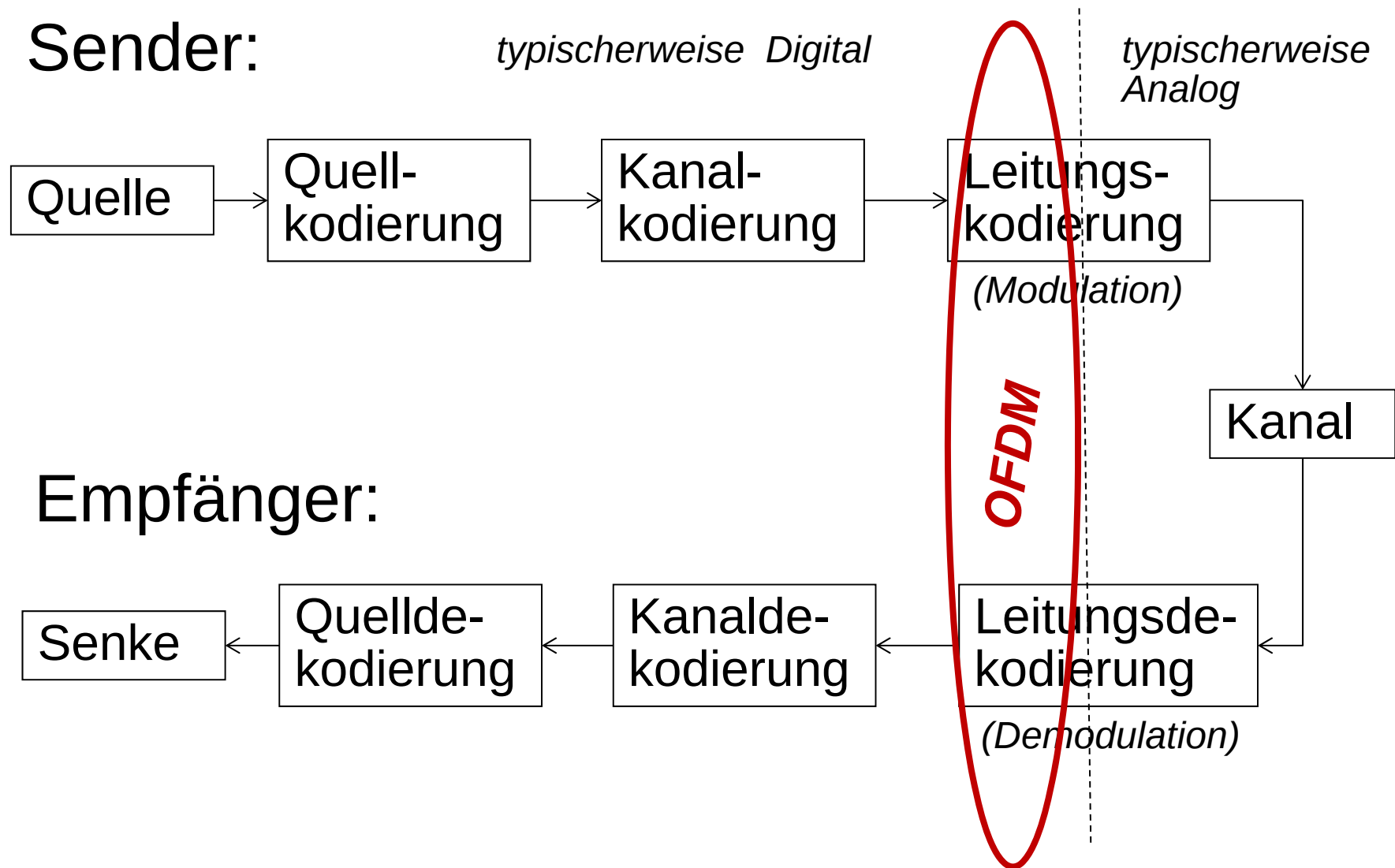
grass@ihp-microelectronics.com

grass@informatik.hu-berlin.de

<http://www.informatik.hu-berlin.de/~grass/bbk>

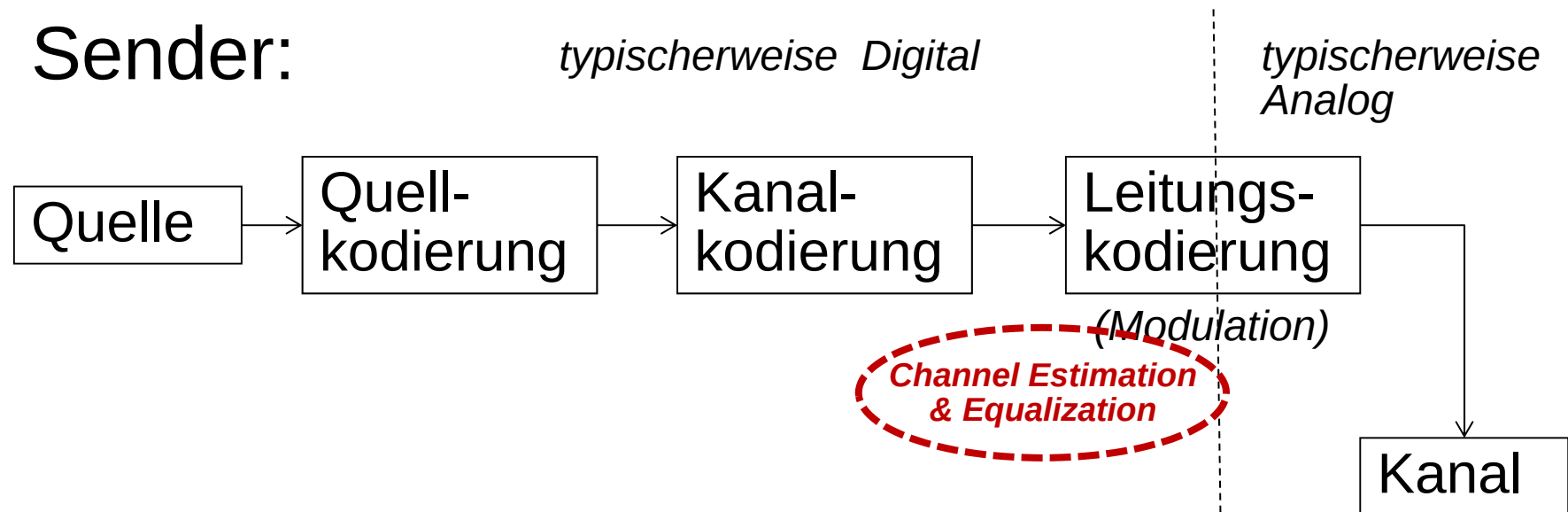
Breitbandkommunikation (PHY-Modell)

Sender:

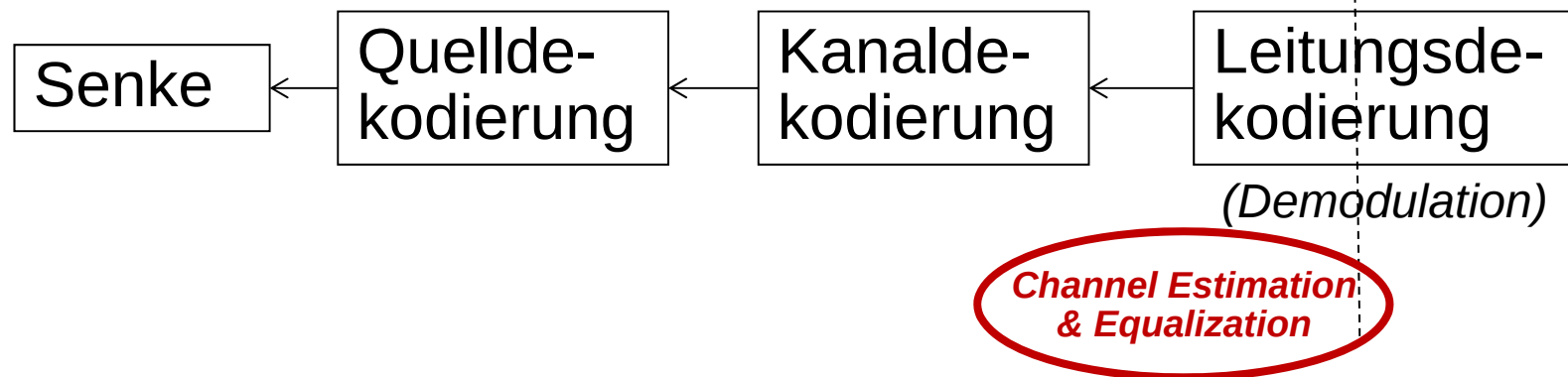


Breitbandkommunikation (PHY-Modell)

Sender:

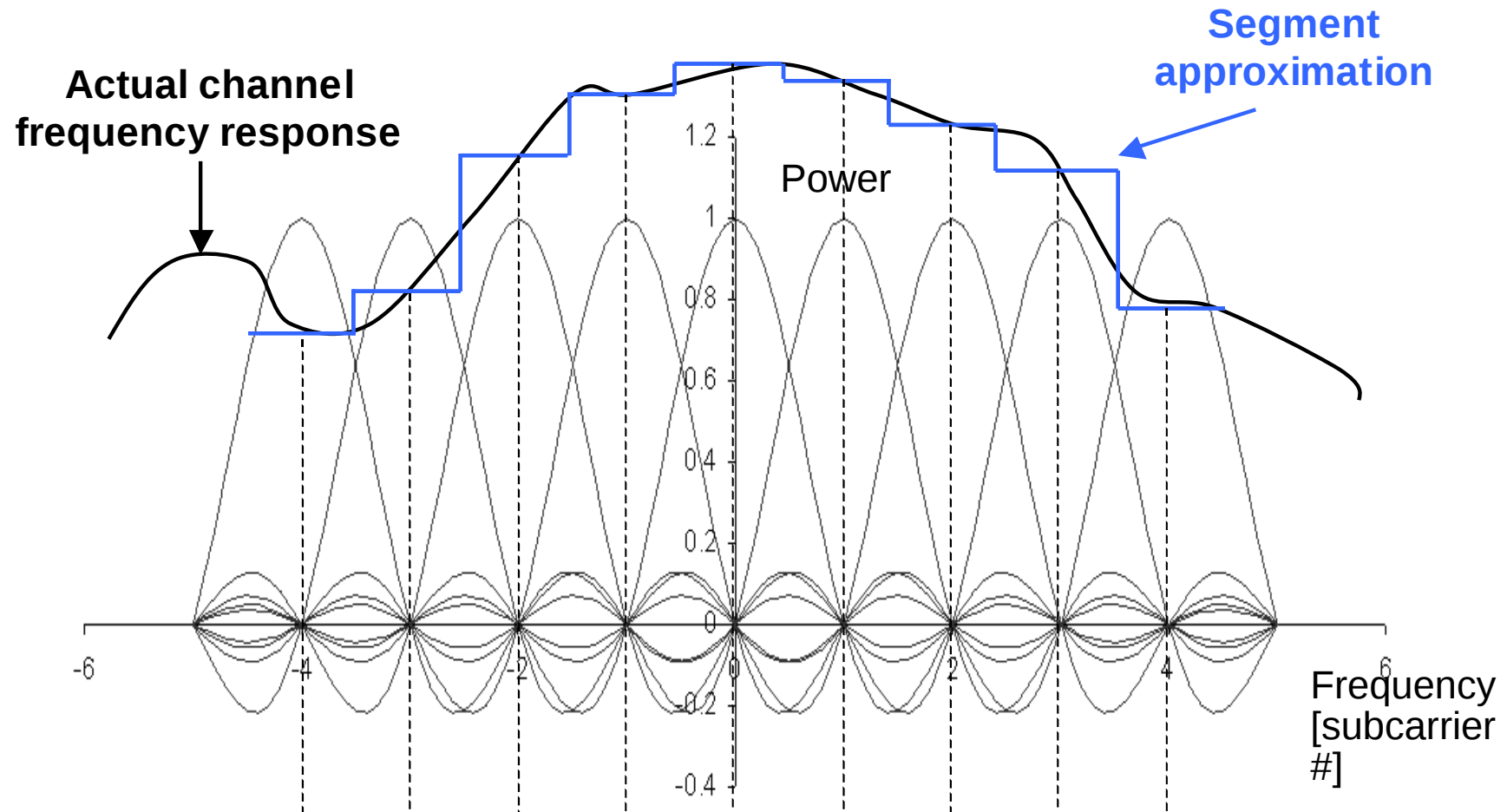


Empfänger:



OFDM: Effects of fading channels

- CHANNEL'S PIECEWISE APPROXIMATION



Channel Estimation and Equalization

Reference signal
(Preamble) based
channel estimation

Blind channel estimation
(data aided channel
estimation ...
Decision-feedback channel
estimation/equalization)

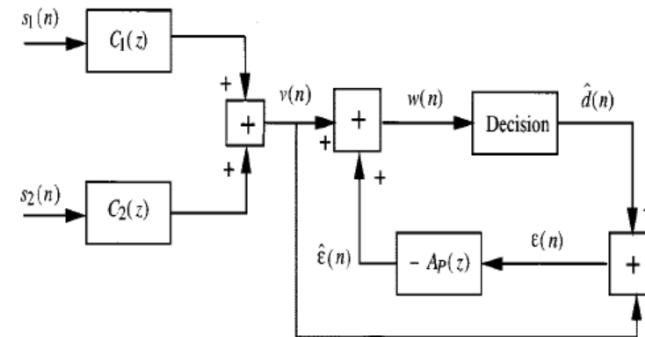
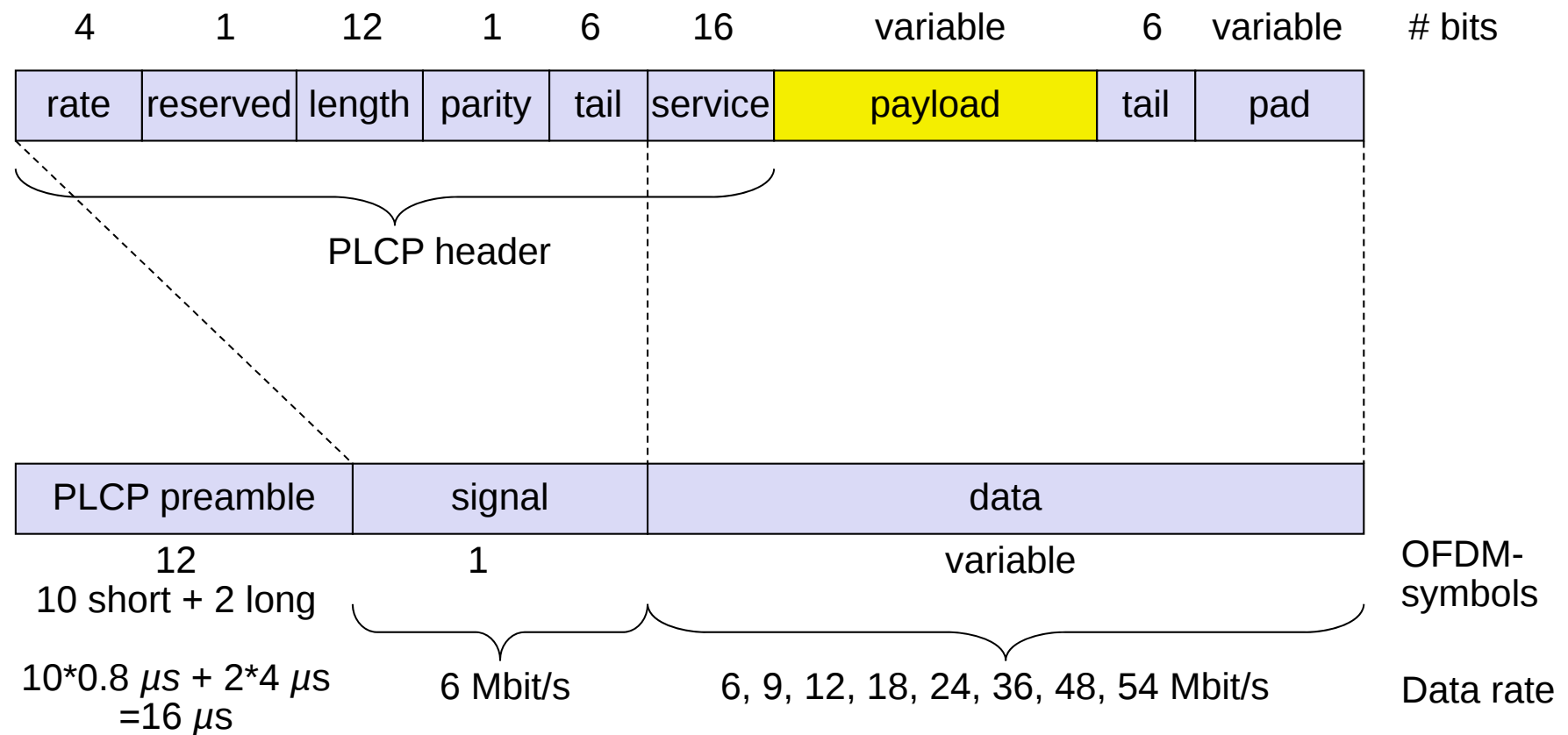


Fig. 3. MI-DFE (Belfiore and Park).

Source: Joel Labat and Christophe Laot, *IEEE Tr Comms*. 2001.

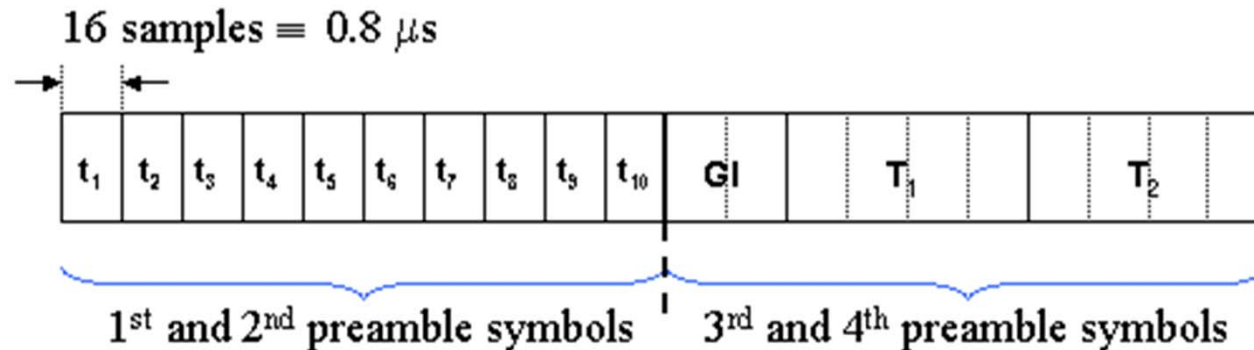
IEEE 802.11a – PHY Frame Format

One OFDM-Symbol: $0.8 \mu\text{s}$ (guard interval) + $3.2 \mu\text{s}$ (data) = $4 \mu\text{s}$

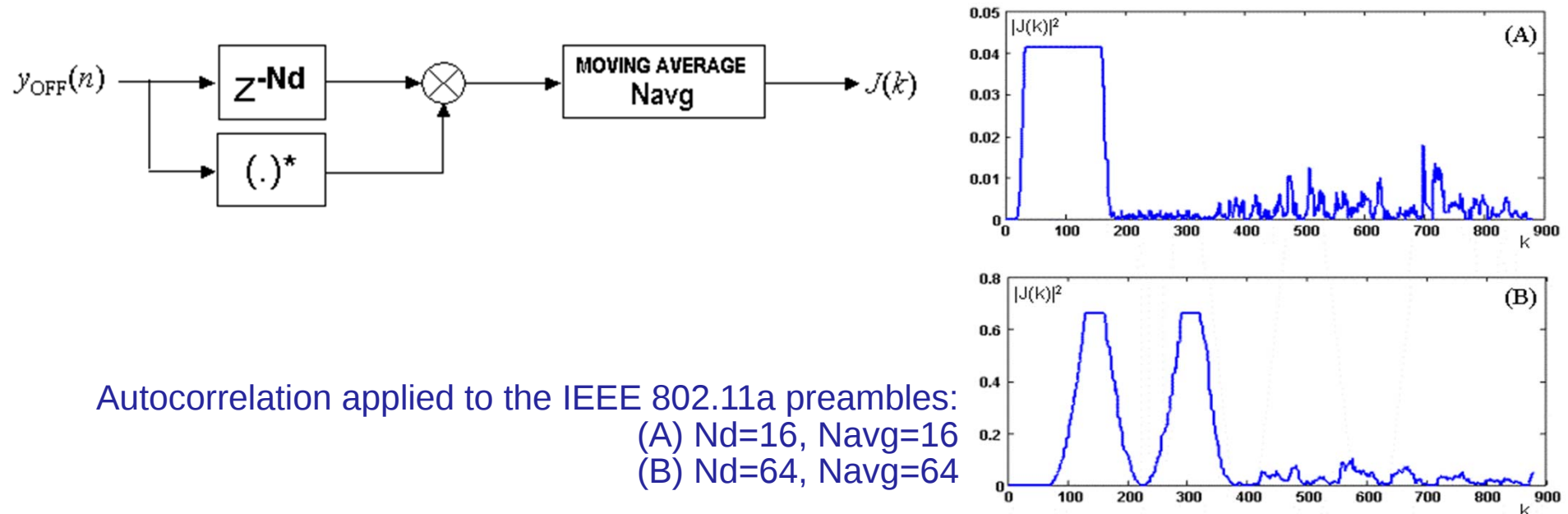


Timing Synchronisation using Preamble

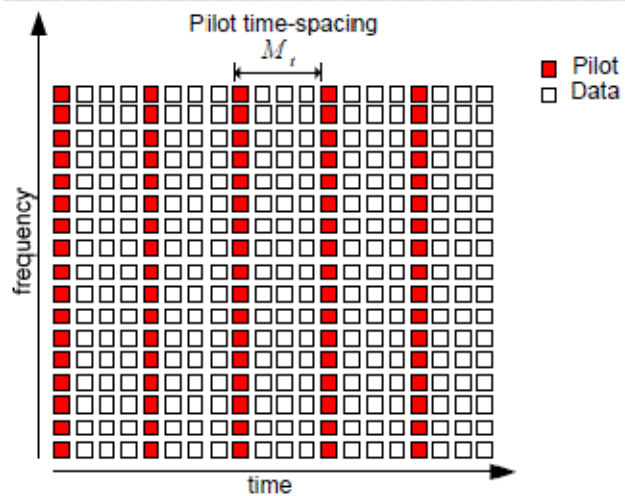
IEEE802.11a Preamble structure:



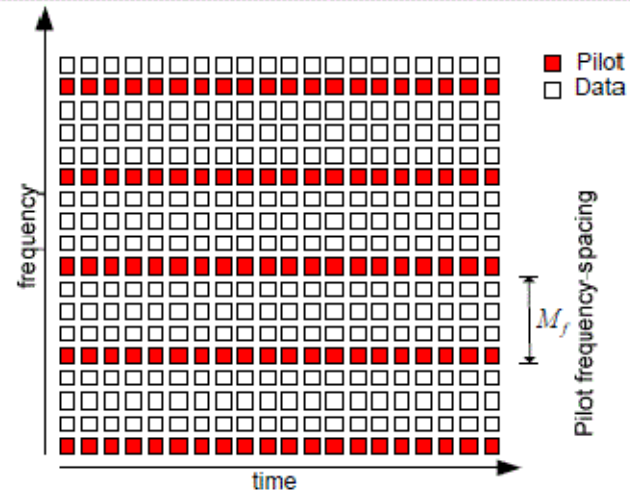
General autocorrelator architecture:



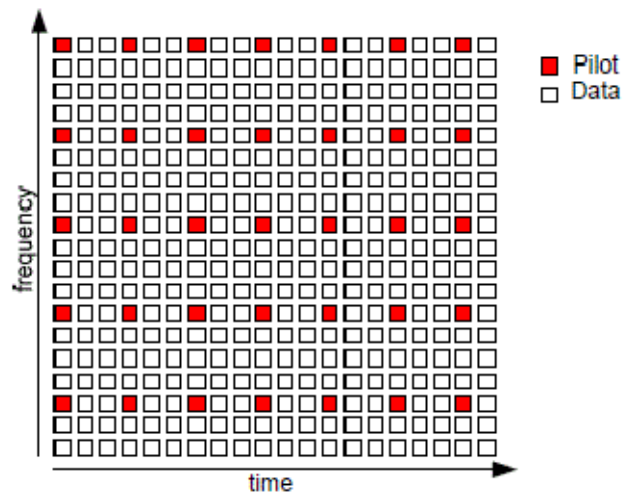
OFDM Channel Estimation using „Pilot Carriers“



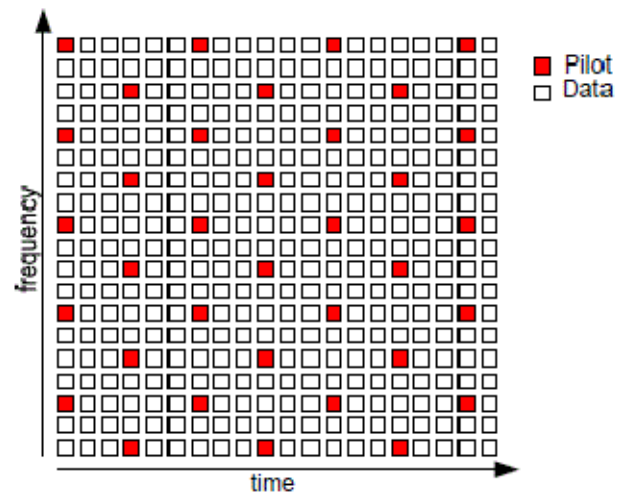
(a) All frequency-time spaced pilot allocation



(b) Frequency spaced - all time pilot allocation



(c) Frequency spaced - time spaced pilot allocation



(d) Frequency spaced - time spaced pilot allocation

[From Akram (Nokia)]

OFDM Channel Estimation

Interpolation in Time- and Frequency Domain

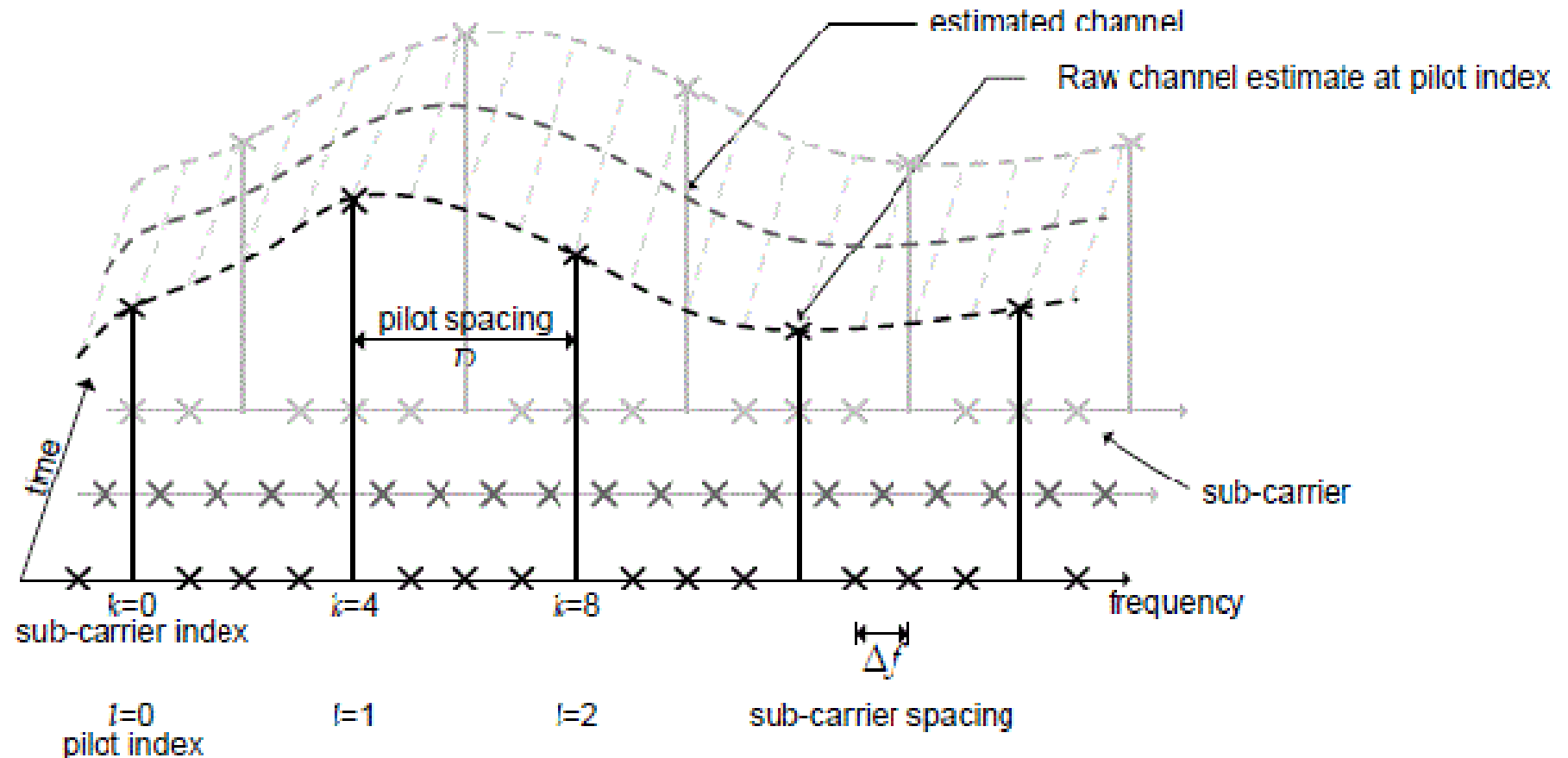
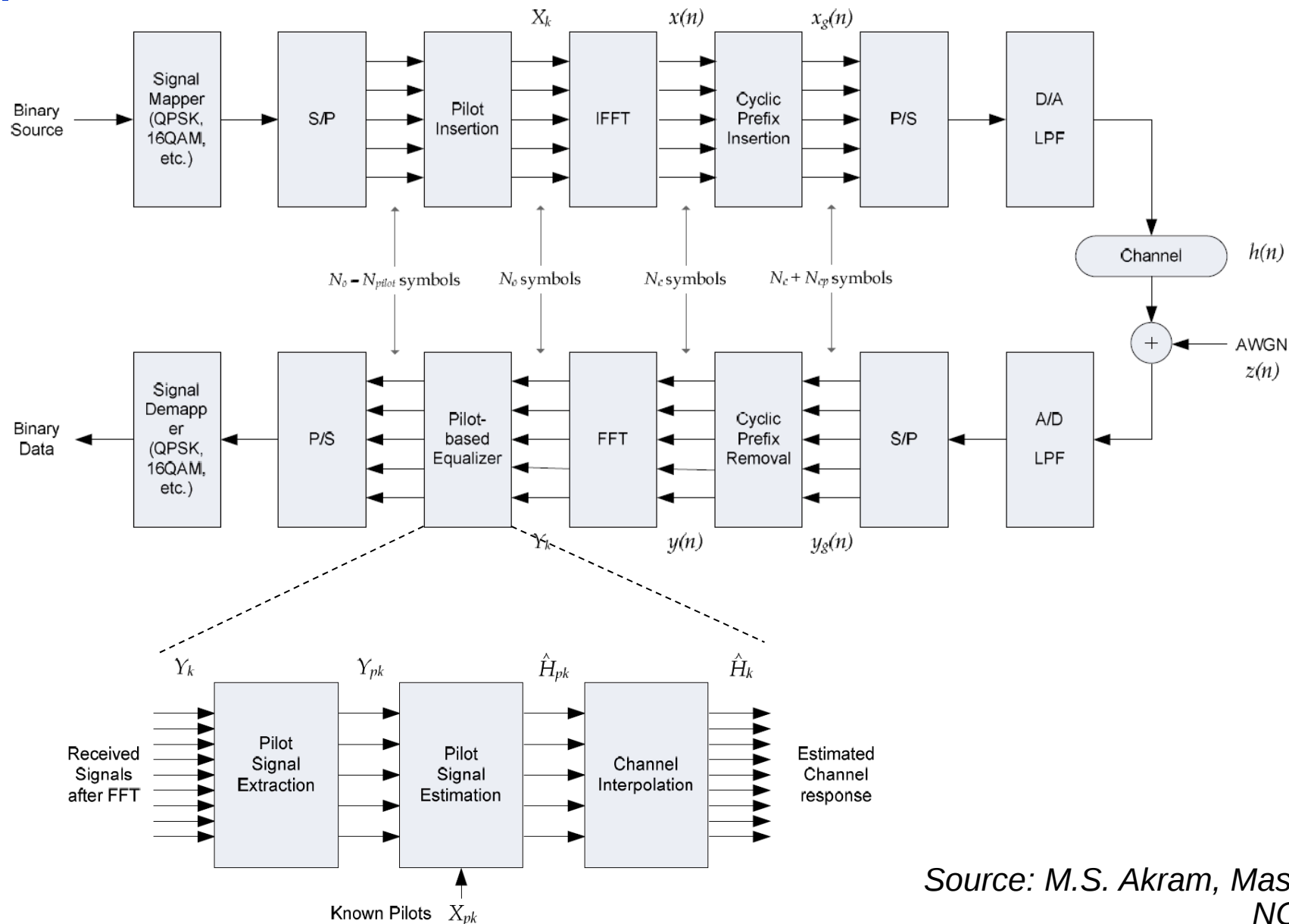


Figure 4-6. Channel estimation in time-frequency domain

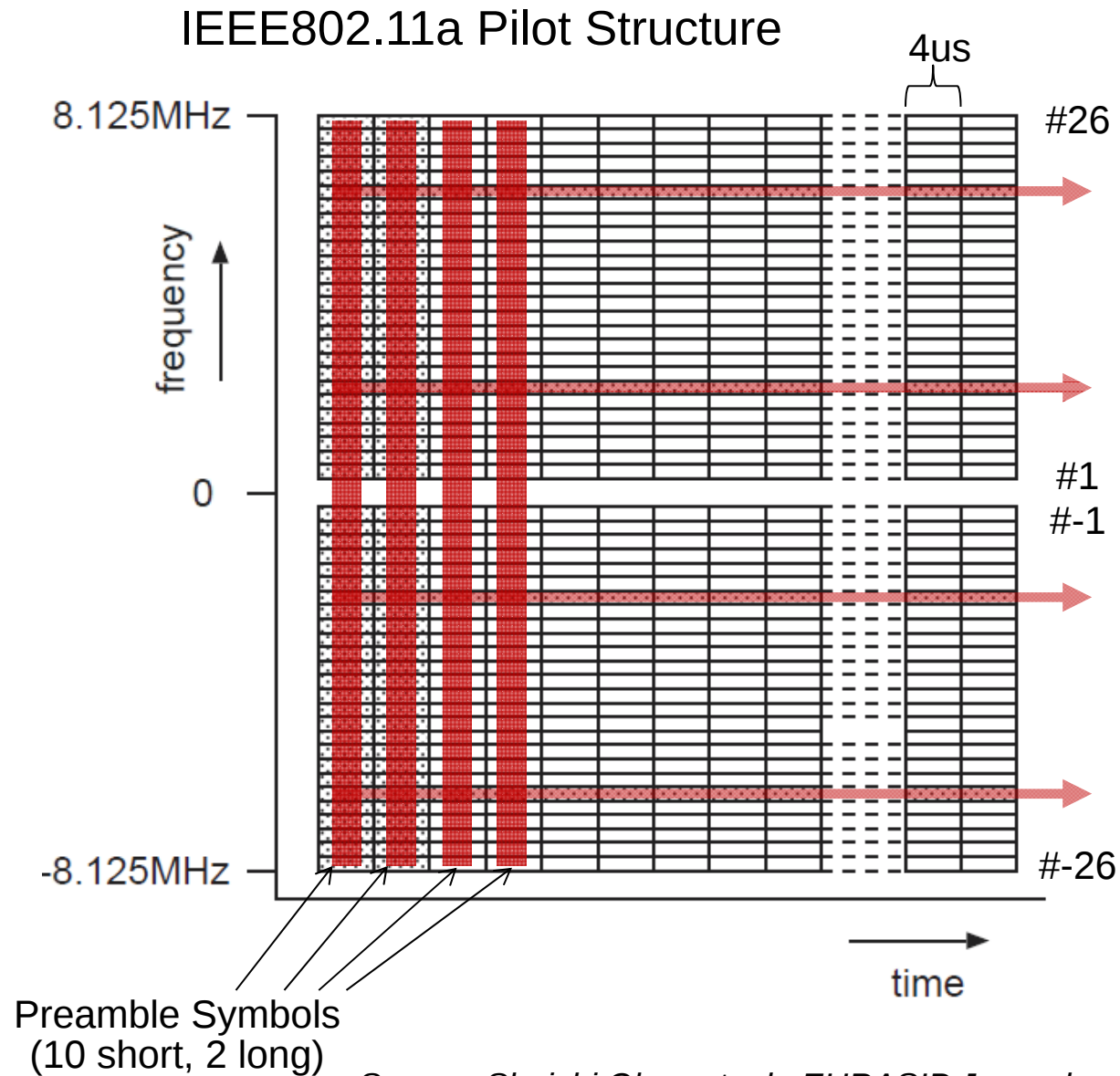
[From Akram (Nokia)]

OFDM: Pilot Based Equalization



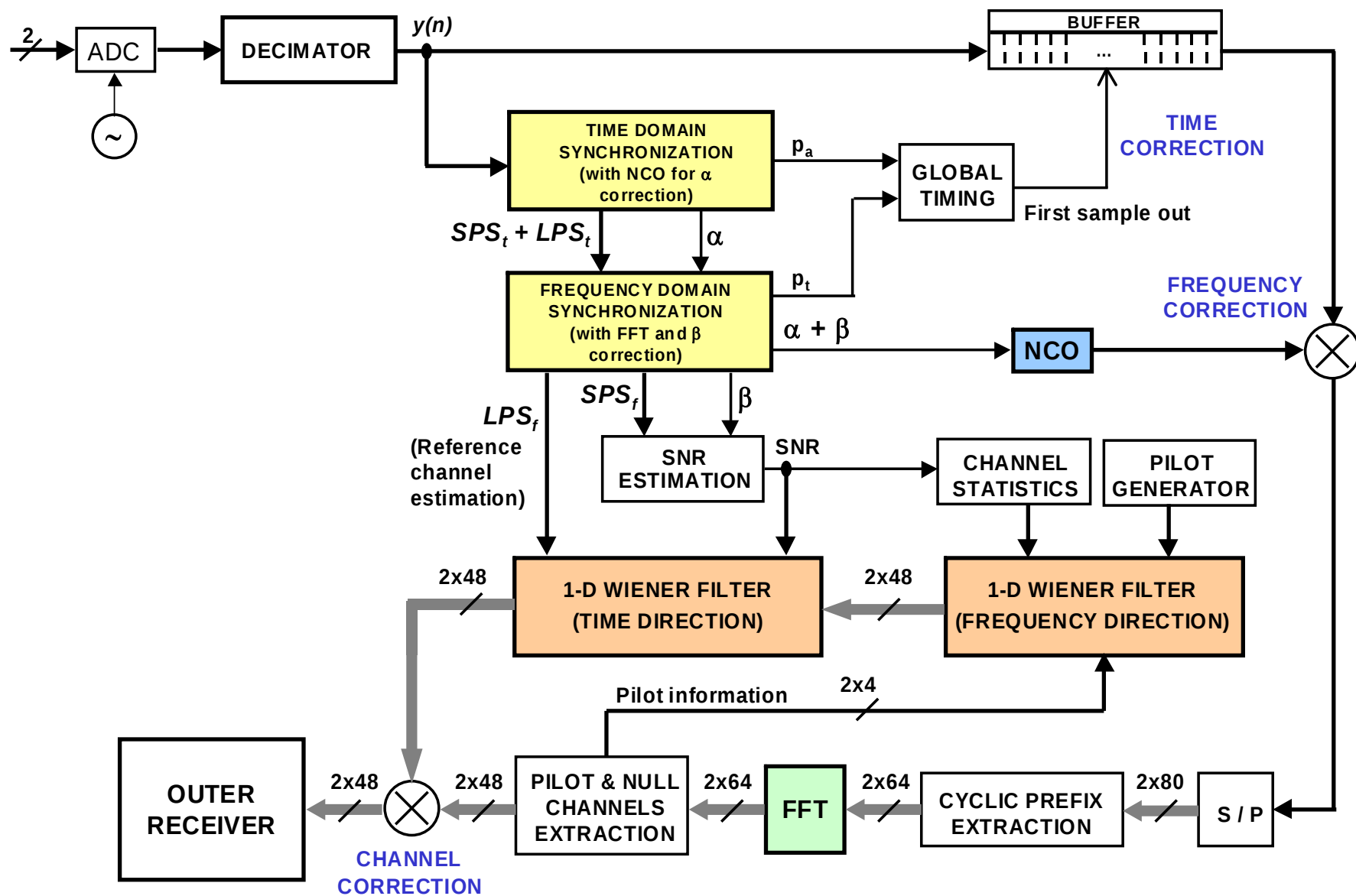
Source: M.S. Akram, Master Thesis, NOKIA, 2007

OFDM: Equalization Using Pilots

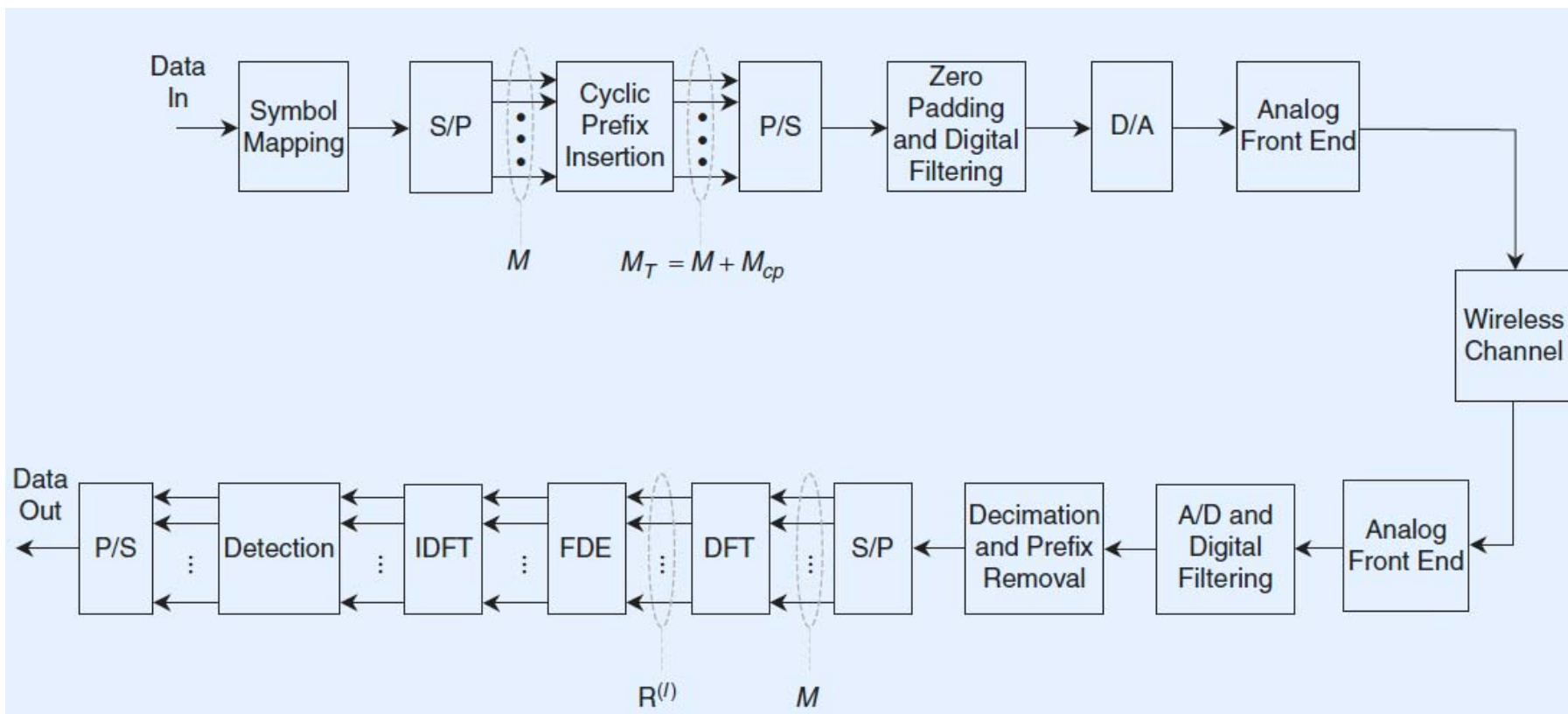


Source: Shuichi Ohno et. al., *EURASIP Journal on Wireless Comms.*, 2011.

Architecture of synchronisation and channel estimation blocks for the IEEE 802.11a Standard



Single Carrier Transmission with Frequency Domain Equalization (FDE)



Block diagram of communication system using Single Carrier transmission with FDE

Source: Fabricio Pancaldi et.al., SC-FDE, IEEE Signal Processing Mag. 2008

Processing Requirements IEEE802.11a TX & RX

Approximate gatecount of IEEE802.11n Transmitter and Receiver.

Transceiver Block	Gatecount
Synchronizer	334000
Demodulator	800
Deinterleaver	10000
Channel Equalizer	351000
Viterbi Decoder	20000
FCS (Frame Check Sequence)	35000
UCM (Unit Control Module)	30000
Encoder	20000
Modulator	1600
IFFT/FFT	30000

Source: VIJAYANT BHATNAGAR, M.Sc., New Jersey, 2008.