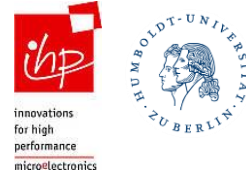


Drahtlose Breitbandkommunikation - Entzerrung



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

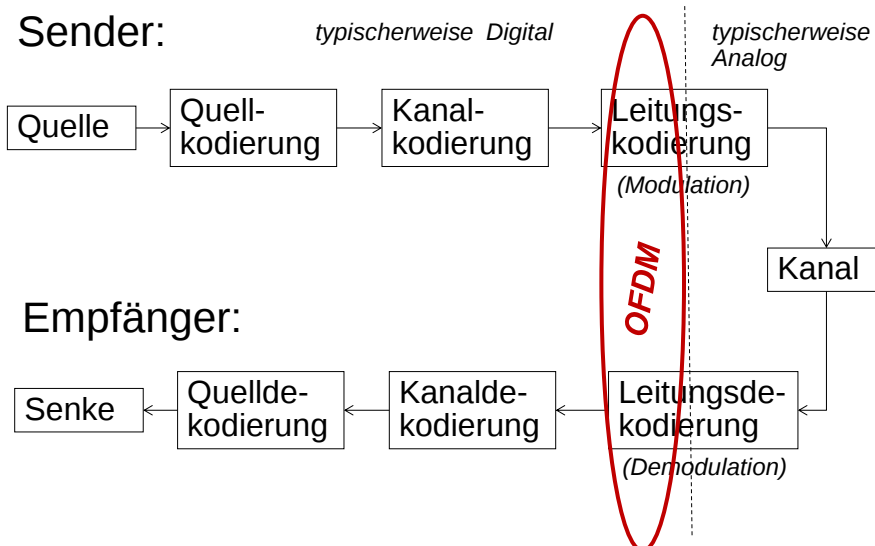
<http://www.informatik.hu-berlin.de/~grass/bbk>

1

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Breitbandkommunikation (PHY-Modell)



2

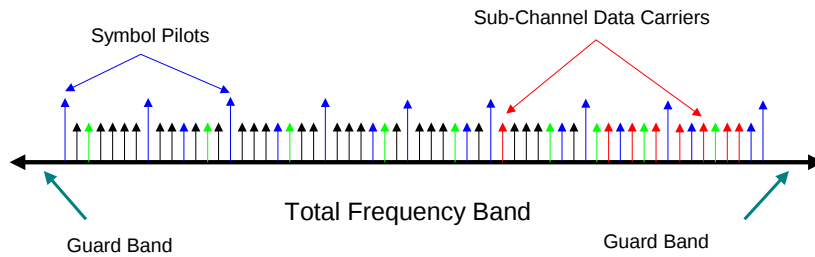
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OFDM-Nachlese: OFDM-A

OFDMA:

1. Strictly speaking OFDMA is not a modulation but an access scheme
2. Is used in LTE
3. Every user has a certain number of subcarriers allocated
4. Downlink is very efficient
5. Uplink is very difficult

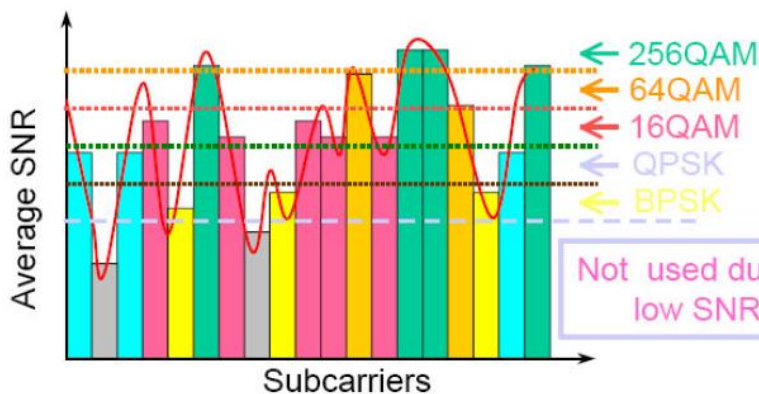


Source: E. Sofer and Y. Segal, Doc. IEEE802.22-05-0005r1, Jan. 2005

OFDM-Nachlese: Adaptive Modulation („Water filling“)

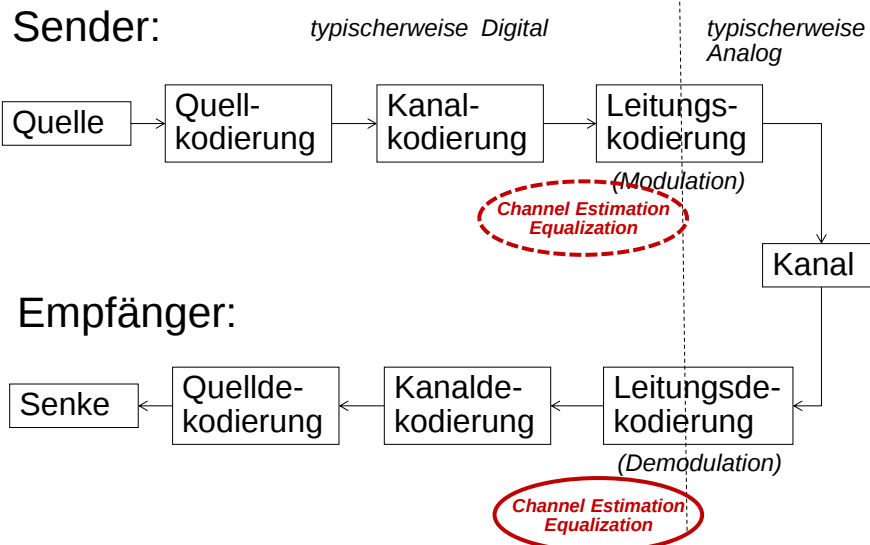
Adaptive Modulation:

1. Special version of OFDM where, depending on the SNR-level, the modulation scheme for every subcarrier is adapted optimally
2. High SNR -> High modulation scheme (i.e. 64 QAM)
3. Low SNR -> low modulation scheme (i.e. BPSK) or subcarrier not used
4. Advantage: Optimal use of channel
5. Disadvantage: Signaling overhead
(Receiver needs to know modulation scheme for each subcarrier.)



Source: M. Essam Khedr, "Adaptive Modulation in OFDM", Fall 2007

Breitbandkommunikation (PHY-Modell)



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Channel Estimation and Equalization

Reference signal
(Preamble) based
channel estimation

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

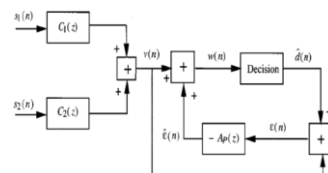


Fig. 3. MLDPE (Bellare and Park).

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

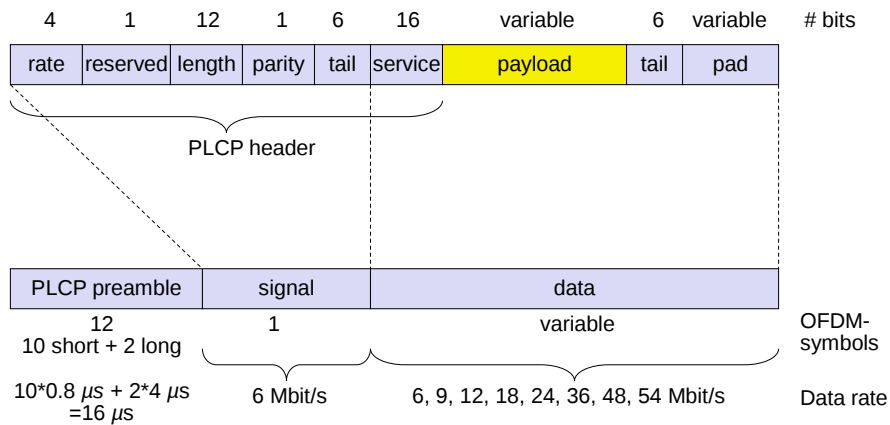
6

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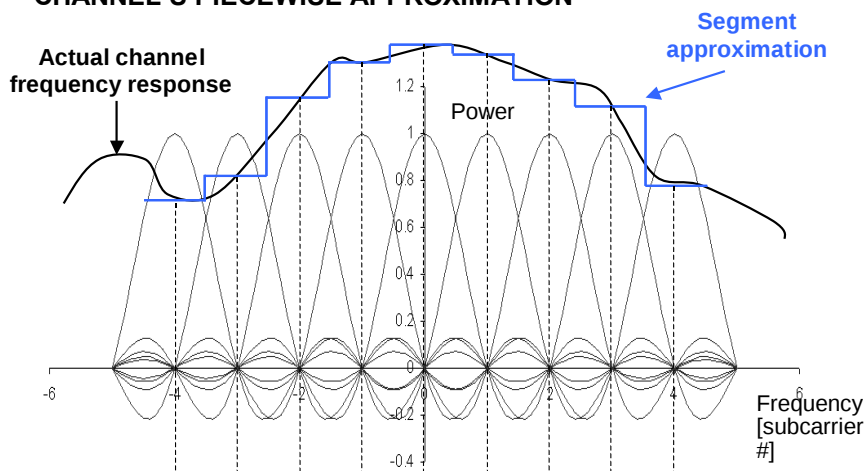
IEEE 802.11a – PHY Frame Format

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

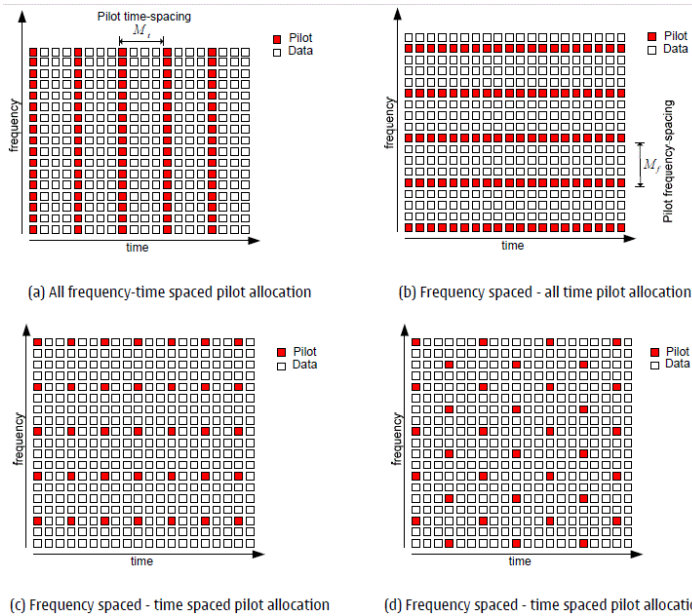


OFDM: Effects of fading channels

• CHANNEL'S PIECEWISE APPROXIMATION



OFDM Channel Estimation using „Pilot Carriers“



[From Akram (Nokia)]

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OFDM Channel Estimation

Interpolation in Time- and Frequency Domain

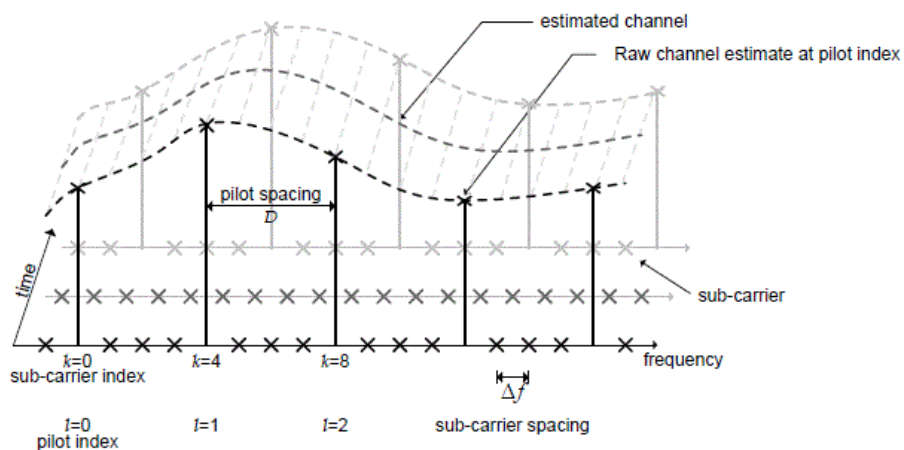


Figure 4-6. Channel estimation in time-frequency domain

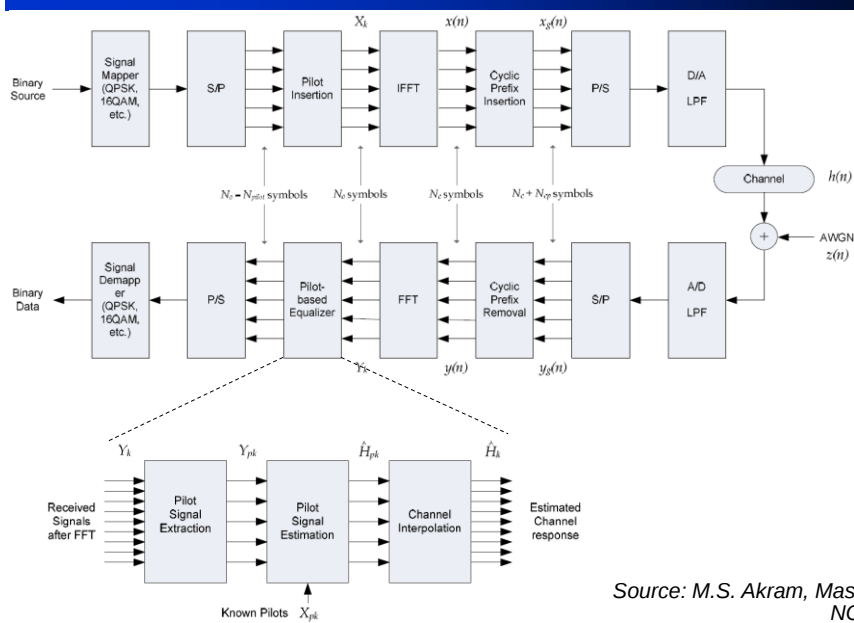
[From Akram (Nokia)]

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OFDM: Pilot Based Equalization

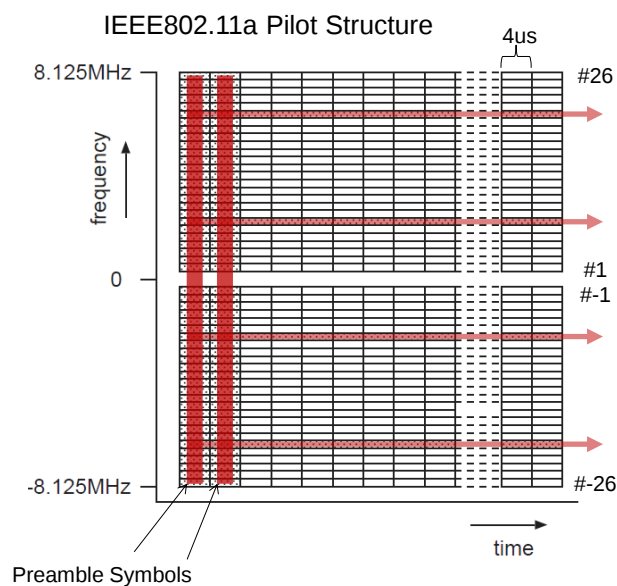


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OFDM: Equalization Using Pilots



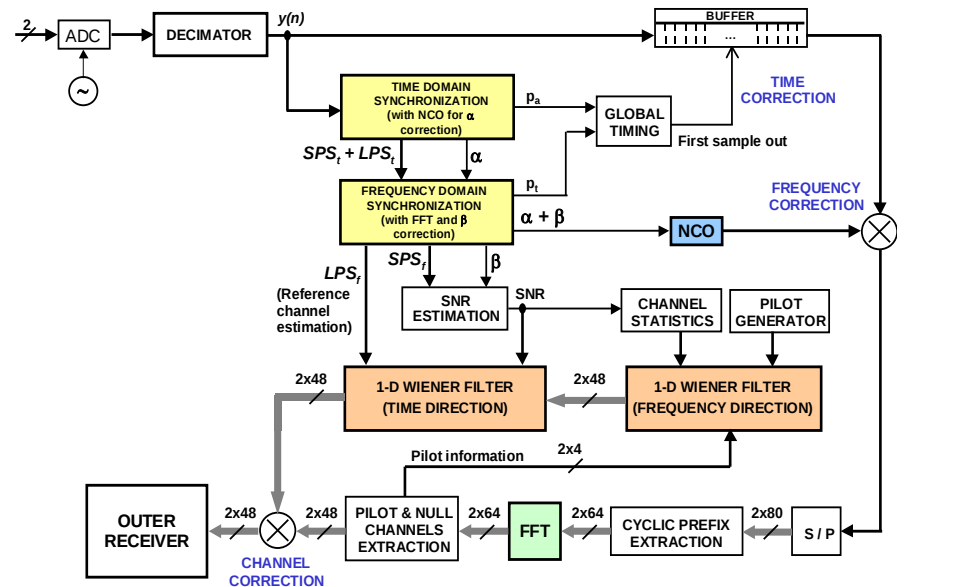
Source: Shuichi Ohno et. al., EURASIP Journal on Wireless Comms., 2011.

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

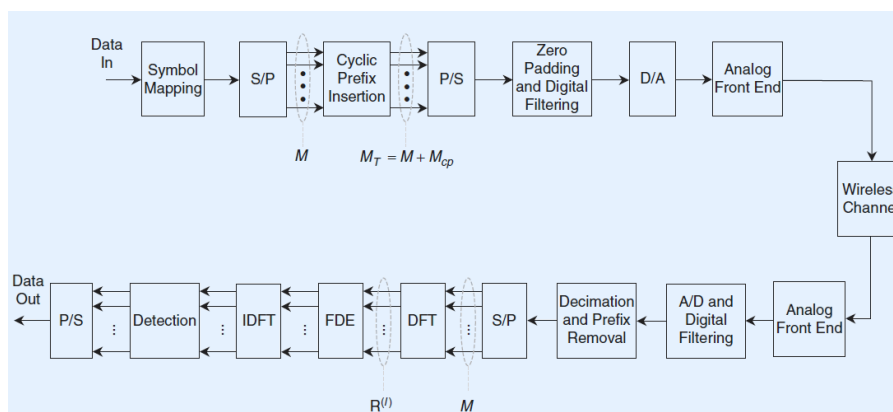


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Single Carrier Transmission with Frequency Domain Equalization (FDE)



Block diagram of communication system using Single Carrier transmission with FDE

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

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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.