On the Baseband Algorithms for OFDM Systems

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Outlines

◆ OFDM systems
◆ Implementation impairments
◆ Baseband Algorithms
  ➢ Windowing/pulse shaping
  ➢ Time/Frequency synchronization
  ➢ Channel estimation
  ➢ CTC
  ➢ MIMO
OFDM systems

- ADSL
- 802.11a/g/n
- ETSI DAB
- ETSI DVB-T
- IEEE802.16e/m/WiMAX
- ETSI DVB-H
- LTE, LTE-advanced
Implementation impairments

- Carrier frequency offset
  - Oscillator
  - Doppler drift
- Timing offset
- Sampling clock frequency offset
- Phase noise
- I-Q channel mismatch
- Nonlinear distortion
  - Peak-to-Average-Power-Ratio (PAPR)
Baseband Algorithms: Windowing/pulse shaping

- **Bandwidth limiting**
  - Out-of-band suppression

- **Zero crossing at integer multiples of symbol time**
  - Reduce intersymbol interference (ISI)

- **Reduce Secondary lobes**
  - Reduce intersymbol interference (ISI)
  - Reduce main lobe leak

- **Maintain orthogonality condition**
  - Basic OFDM principle
Baseband Algorithms: Time/Frequency synchronization

◆ Decision-directed/Data-aided synchronization
  - Pseudo-random preamble/pilot
  - Frame/Symbol timing and carrier frequency offset

◆ Two-stage synchronizer
  - Coarse estimation: acquisition stage
  - Fine estimation: tracking stage
Baseband Algorithms: Channel estimation

23-April-2008

WOCC 2008, Taichung, Taiwan
◆ Pilot-assisted channel estimation

➢ 2-D interpolation filter
  ✩ Limited number of pilot in practice
  ✩ Edge effect
  ✩ Susceptibility to noise

➢ 2-D Wiener filter (MMSE)
  ✩ Limited number of pilot in practice
  ✩ Power delay profile & Doppler power spectrum

➢ 2 1-D filter
Baseband Algorithms : CTC

◆ BCJR algorithm
  ➢ Symbol-by-symbol MAP algorithm
◆ Map, Log-Map and Max Log-Map
◆ Binary vs Duo-binary
◆ Tail biting
  ➢ Circular Recursive Systematic Convolutional code
CTC, binary vs duo-binary

QPSK/CTC Rate 1/2, 60-byte

BER: AWGN, duo-binary CTC
--- BER: AWGN, binary CTC
--- FEC BLER: AWGN, duo-binary CTC
--- FEC BLER: AWGN, binary CTC
Baseband Algorithms : MIMO

◆ Space Time Coding (STC)
  ➢ Alamouti Coding

◆ Spatial Multiplexing (SM)
  ➢ ML receiver
  ➢ MMSE receiver with successive interference cancellation (SIC)