

## Abstract

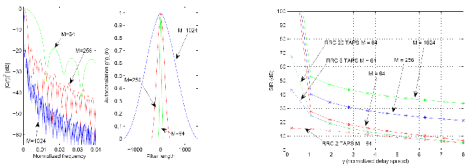
The University of Udine is contributing on radio technology advances looking at spectral efficient multicarrier architectures. In particular, we focus on MIMO multiuser filter bank schemes, cross layer optimization, filter bank orthogonal design, hardware impairments analysis. The results obtained show that significant performance improvements are attainable over WLAN channels using FMT modulation.

### Orthogonal FMT



M Filter bank channels  
N Interpolation factor

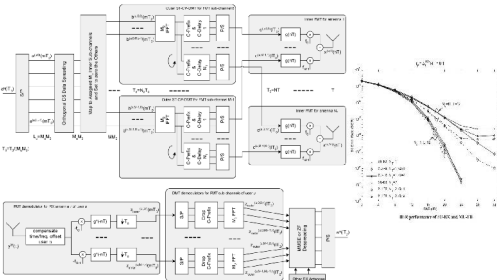
- The IDFT output coefficients and DFT input coefficients must be identical to have perfect reconstruction (PR)
 
$$\sum_{b=0}^{L-1} g_{Mb+a-Ni}^* h_{N\beta-a-Mb}(M, n) = \delta_a \delta_{a-\beta} \quad a = \{0, \dots, M-1\}$$
- This leads to a matrix representation in the Z-Domain of the PR conditions
 
$$H_{-a}(z)G_a(z) = I_{M_a} \quad a = \{0, \dots, M-1\}$$
- Submatrices  $G_a(z)$  and  $H_{-a}(z)$  have coefficients equal to the polyphase components of the pulse with delays
- The FB has perfect reconstruction if every sub-block is the identity matrix
- Parameterize the pulse coefficients via trigonometric functions of angles
- Search for pulses that fulfill the orthogonal relations with the goal of **maximizing the in-band energy**



N. Moret and A. Tonello, "Similarities and Differences among Filtered Multitone Modulation Realization and Orthogonal Filter Bank Design," EUSIPCO 2009, Glasgow, Scotland, Aug. 2009.

### Concatenated Scheme

- The users are multiplexed in a frequency division fashion. The transmitter of each user comprises three stages:
  - DS data spreading stage
  - Cyclically prefixed DMT modulator
  - Inner (with respect to the physical media) FMT modulation stage with transmission over  $N_f$  antennas



A. M. Tonello, M. Bellin, "Low Complexity Realization of a Concatenated DMT-FMT Multiuser Uplink System with Transmit Diversity," IEEE Trans. on Vehicular Technology, vol. 58, no. 7, Sep. 2009, pp. 3844-3850.

### Adaptive FMT and OFDM over WLAN Channels

- For each channel realization, the **optimal overhead factor (OH)**, namely  $\beta = N - M$ , **maximizes the achievable rate**, i.e.,

$$\beta_{opt} = \arg \max_{\beta \in \{0, \dots, N-M\}} \{C(\beta)\}$$

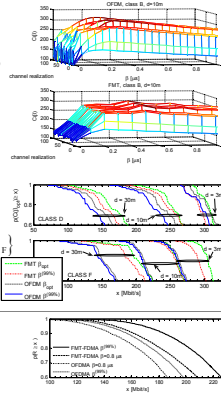
- To diminish the computational complexity we adapt the OH over a small set of values, i.e.,

$$P_{OFDM} = \{\beta_{CLASS B}^{99\%}, \beta_{CLASS C}^{99\%}, \beta_{CLASS D}^{99\%}, \beta_{CLASS E}^{99\%}, \beta_{CLASS F}^{99\%}\}$$

$$P_{FMT} = \{\beta_{3m}^{99\%}, \beta_{10m}^{99\%}, \beta_{30m}^{99\%}, \beta_{60m}^{99\%}\}$$

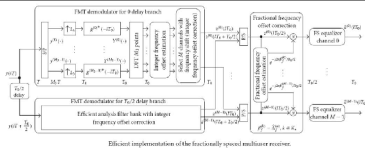
#### Improvements via FDMA

- Joint sub-channels and OH allocation
- FMT-FDMA outperforms OFDMA



S. D'Alessandro, A. M. Tonello, L. Lampe, "Improving WLAN Capacity via OFDMA and Cyclo Prefix Adaptation" in Proc. of IEEE IPSP Wireless Days 2009, Paris, Dec. 2009.

### Efficient realization and Synchronization Algorithm for FMT systems



- Efficient Implementation parameters:**
  - $M_2 = L_c M_1(M, N) = L_2 N$  order polyphase decomposition of the signals
  - $M$  point IDFT and Cyclic extension to
  - Pulses:** PF components of order  $N_i g^{(i)}(LN+i) = g(LN+i) \quad i = \{0, 1, \dots, M_2-1\}$
  - Sample / Interpolation period  $L_2$
  - Synthesis / Analysis bank complexity  $(M \log_2 + 2L_f - 1) / N$  (prototype pulse with length  $L_f$ )
- Synchronization Metrics:**
  - Metrics for the Conventional Receivers:**
    - It implements an analysis filter bank with precompensation of the subchannel time and frequency offsets followed by recursive least square linear subchannel equalization.
  - Metric for the Fractionally Spaced Multiuser Receiver:**
    - We consider a system that comprises two efficiently implemented fractionally spaced analysis filter banks.
    - In this receiver, time/frequency compensation can be jointly done for all the users.

Andrea M. Tonello and Francesco Picile, "Synchronization Algorithms and Receiver Structure for Multiuser Filter Bank Uplink Systems," EURASIP Journal on Wireless Communications and Networking, Volume 2009 (2009), Article ID 387520.