OFDM and Turbo coding: 
the perfect marriage

Liesbet Van der Perre, on behalf of the T@MPO team
OFDM and turbo codes are complementary

OFDM mitigates multipath

Turbo codes approach capacity limit

But: a good effort is needed to make it work!
OFDM modulates on parallel carriers by (I)FFT operations

Transmitter                Channel                  Receiver
But: Uncoded performance is bad in frequency selective fading
OFDM needs good error correction

bad carriers dominate the performance
Forward error correction is performed over the carriers.
The performances on AWGN and flat fast fading channels are excellent.
Never trust a wireless channel: What in frequency selective fading?
The bad carriers are still show breakers

BER statistic on ETSI Ch. A

Conv. code

Turbo code
Turbo trellis modulation may solve the problem

\[ C_1 \rightarrow \text{mapper} \rightarrow X(n) \]

\[ C_2 \rightarrow \text{mapper} \]
Turbo trellis modulation performs better indeed.
Trellis solution has nice statistics, but is less flexible.

Conv. Codes

Turbo Codes

Trellis Turbo Codes
OFDM naturally enables solutions to frequency selective problems.
Let the turbo decoder profit from OFDM

At transmitter:
adaptive loading

At receiver:
adaptive decoding
Adaptive loading avoids bad carriers

- QAM16
- QPSK

Channel Response
Adaptive decoding is (almost) for free

only DSP effort in receiver is needed
Also the ‘bad’ carriers have to surrender

BER statistic on ETSI Channel A

- Conv. code
- Adaptive turbo code
Performance is increased significantly

![Graph showing BER vs. Eb/No (dB)]

- Convolutional code
- Adaptive turbo code (N = 384)

ETSI: Channel A
We put the emphasis on ‘real’ bit-based turbo codes at the moment

? Why not product codes?
! Turbo codes achieve on the average better performance for different code rates

? Why not Trellis coded modulation?
! Turbo codes allow a flexible implementation towards different rates and modulation schemes

-> A good combination of performance and flexibility
We further investigate product codes and trellis coded modulation

- On a reconfigurable platform, the balance may tumble over
  - improved flexibility through code programmability
  - improved performances through code adaptation

- Implementation study was rather limited till now

- What about serial concatenating convolutional codes?
What are we waiting for?

! Appropriate turbo coding solution
Practical impediments need to be tackled

- Speed: 50-100 Mbps will be required
- Power consumption: a clear bottleneck due to memory accesses
- Latency: real-time communications
- Flexibility: adapt coding scheme to service and channel
IMEC’s effort should lead to T@MPO
(Turbo @ Minimum POwer)

Algorithmic exploration

Architectural exploration
Please spread the good news ...