On Multiple Slice Turbo Codes

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How to avoid memory duplication for high throughput turbo decoders ?

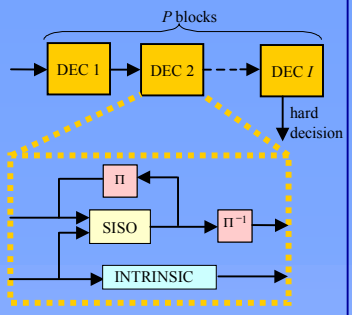
- constituent code split into slices
- parallel decoding of slices
- adequate interleaver with good performance

Results:

- parallelism introduce no degradation in performance
- interleaver gain of 0.4 dB compared to DVB-RCS interleaver at BER 10^{-7}
- 50 % overall complexity reduction for a 100 Mbits/s turbo decoder
- well suited for analog turbo decoders

Note: Slice Turbo Codes has been proposed for DVBS2

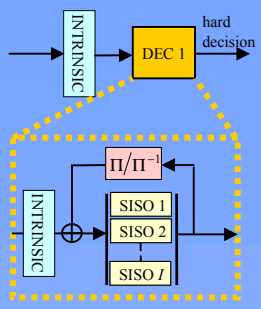
Classical serial architecture



$$A_{TD}^{S} = P \cdot \left[A_{SISO} + Mem_E + Mem_I \right]$$

- Memories are duplicated P times.

Parallel architecture

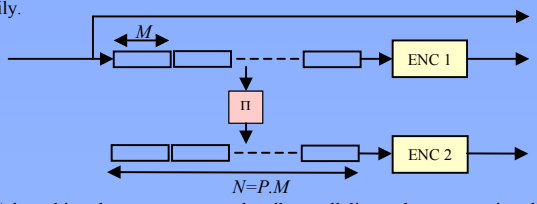


$$A_{TD}^{P} = 2.Mem_I + Mem_E + P \cdot A_{SISO}$$

- Key idea : use I SISOs in parallel
  ⇒ No memory duplicated

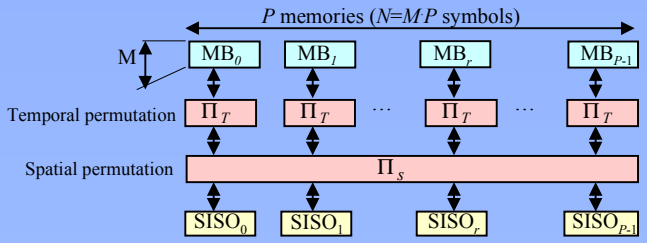
Solution: Slice Turbo Codes

✓ Frame is divided into P independent Circular Recursive Systematic Convolutional Codes of size M to handle side-effects at the end of the SISOs easily.



✓Adapted interleaver structure to handle parallelism : the memory is split into P blocks.

✓Appropriate memory organization suited for the interleaver and parallel decoding.



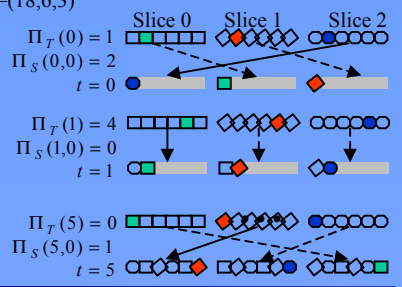
$$\Pi(k) = \Pi(t,r) = \Pi_S(t,r) \cdot M + \Pi_T(t,r)$$

Example: Code (N,M,P) =(18,6,3)

$\Pi_T(t) = \{1,4,3,2,5,0\}$

$\Pi_S(t,r) = (A(t \bmod 3) + r) \bmod 3$

$A(t \bmod 3) = \{2,0,1\}$

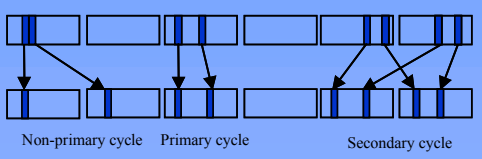


Interleaver optimization: simplicity and perfomance.

Performance criteria:

- high minimum distance (asymptotic performance)
- no short cycles (fast convergence)

Study of Primary and Secondary Error Patterns (PEP and SEP).



Influence of PEPs is measured by the spread:

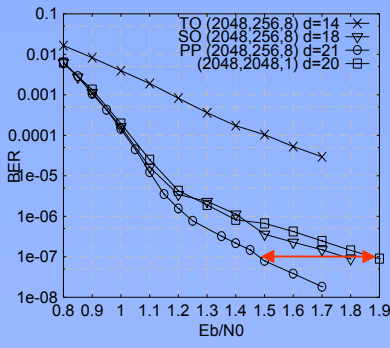
$$S(k_1,k_2) = \left\| k_1 - k_2 \right\| + \left\| \Pi(k_1) - \Pi(k_2) \right\|$$

Choice of the permutations :

- temporal permutation : maximizes the overall minimum spread
- spatial permutation : rotation with irregular amplitude to minimize influence of SEPs
- post-processing to further increase the minimum distance d

Results:

Performance of the (2048,256,8) and (2048,2048,1) 8-states duo-binary codes for 8 iterations of the LogMAP algorithm.



Gain of 0.4dB at BER 10-7

	0.3 mm² A_{SISO}	0.25 mm² Mem_I	0.2 mm² Mem_E	in mm² A_{TD}
Serial	8→2.4mm²	8→2.0mm²	8→1.6mm²	6
Parallel	8→2.4mm²	1→0.25mm²	2→0.4mm²	3.05

50 % complexity reduction

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