Abstract — We propose a new algorithm for Turbo code interleaver design, which is based on the conventional s-random approach and whose complexity grows only linearly with the interleaver length.

Designing the interleaver \( \pi = (\pi_1; \ldots; \pi_K) \) of length \( K \) of a Turbo code serves to increase the code’s minimum distance \( \delta_{\text{min}} \) and hence to lower the error floor of the Word and Bit Error Rates (WER/BER). An efficient method was presented in [1]. Examinations show that for so-designed interleavers, Error Rates (WER/BER) are spread to distant positions in the Turbo encoder input \( u \) and can be ignored, since we consider and try to avoid only error patterns. Otherwise the associated codeword has large weight. We must thus discard \( i-3 \) from \( A_l \), which prevents the assignment \( \pi_l = i-3 \), which would otherwise complete the unlucky mapping in Fig. 1. When all unfavourable values have been discarded from \( A_l \), then \( \pi_l \) is randomly chosen from the remaining values. The backtracking algorithm works also for error patterns of weight \( > 2 \). The complexity of a complete interleaver design grows linearly with \( K \).

We verified the proposed algorithm by designing an interleaver of length \( K = 290 \) for a Turbo code of rate 1/2 employing \( M = 2 \) component codes (generator polynomials: \((1;5/7)\)). In the design, we used \( s = 8 \) and considered all error patterns of weight \( \leq 3 \). For a termination of both component trellises, this Turbo code attains \( \delta_{\text{min}} = 14 \). Fig. 2 shows the WER (upper curves) and BER (lower curves) for varying \( E_b/N_0 \) (received energy per information bit over the one-sided noise power spectral density) for a simulated transmission using coded BPSK over an AWGN channel. The performance is compared to using a pure \( s \)-random interleaver [1] with \( s = 10 \) (expected \( \delta_{\text{min}} \leq 12 \) and a uniform interleaver [2] (mean \( \delta_{\text{min}} \leq 6 \)) of the same length. We can clearly see the improved BER and particularly WER for higher \( E_b/N_0 \).

### References
