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MacKay-Neal Codes for High-Speed Wireless

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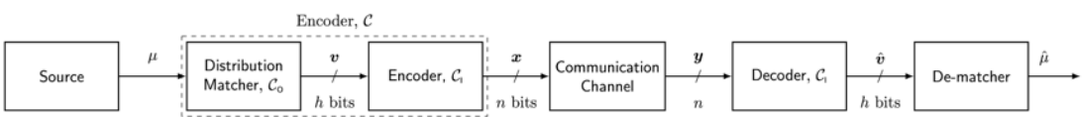
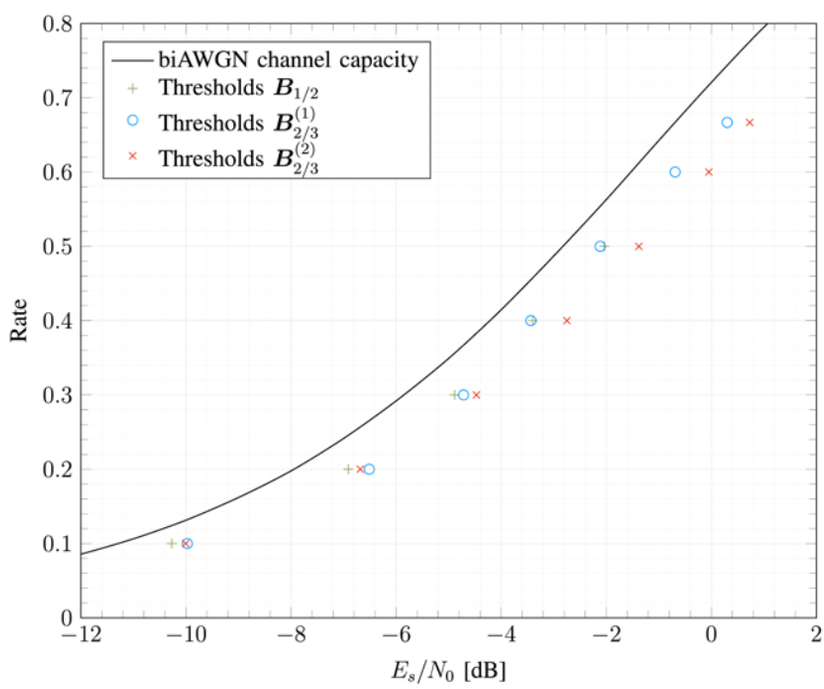
Next-generation wireless systems will introduce short-reach communications in high frequency bands, with data rates exceeding 10 Gbps. To keep signal processing simple, it is essential to (a) employ low-order modulations (PSK/QPSK or OOK), (b) use a regular framing structure, and (c) resort to pipeline decoder architectures. Under these constraints, how should forward error correcting be designed, providing the necessary rate adaptive capability?





The picture shows the capacity limit of the AWGN channel with BPSK modulation, as a function of the channel signal-to-noise ratio. On the same chart, we provide the operation points (decoding thresholds) of the developed rate-adaptive scheme. Note that the points are provided only for some representative rates, i.e., a finer granularity of rates is achieved by the proposed approach. Above the chart, the architecture of the rate-adaptive scheme, with the concatenation of the distribution matcher (responsible of rate adaptation) and of the inner LDPC encoder.

KEY FINDINGS

We introduced a class of rate-adaptive error correcting codes, based on the MacKay-Neal (MN) LDPC code construction. The design satisfies the requirements above, achieving rate flexibility with a single (inner) LDPC code. The result is achieved by tuning the code rate via an outer distribution matcher. The results show that it is possible to operate within 1 dB from the binary input AWGN channel capacity over a wide rate of rates / signal-to-noise ratios.

A. Zahr, B. Matuz and G. Liva, "Rate-Adaptive Protograph MacKay-Neal Codes", in Proc. IEEE Information Theory Workshop (ITW). Saint Malo, France, April, 2023.

A. Zahr, E. Ben Yacoub, B. Matuz, and G. Liva, "Rate-Adaptive Protograph-Based MacKay-Neal Codes," submitted to IEEE Trans. Inf. Theory, 2024