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TITLE: G.gen: G.dmt.bis: G.lite.bis: Further results on the performance of LDPC coded modulation for AWGN channels.

ABSTRACT

We present further simulation results on the performance of LDPC coded modulation over an additive white Gaussian noise channel. Modulation types cover the range from 4-QAM up to 16384-QAM. The performance of LDPC codes of various lengths is illustrated in the spectral-efficiency versus power-efficiency plane. The results show that the proposed multilevel LDPC coding scheme exhibits uniform efficiency over all constellation sizes in terms of gap to capacity.

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1. Introduction

The performance of LDPC coded modulation for ADSL has been addressed in a number of contributions [1], [2], [3]. Here, we present some new sets of results that complement the ones given earlier and address some of the requirements in [4] and [5] that have not yet been considered for our LDPC coding proposal. The performance of LDPC coding under coding-latency constraints is discussed in the companion contribution [6].

We focus on system performance for LDPC coded modulation over an additive white Gaussian noise (AWGN) channel. The modulation types considered are 4-QAM, 16-QAM, 64-QAM, 256-QAM, 1024-QAM, 4096-QAM, and 16384-QAM. Performance is established for LDPC codes of length ~ 500, ~ 1K, ~ 2K, and ~ 4K.

The main result of this contribution can be summarized as follows. The proposed multilevel LDPC coding scheme is equally efficient for all constellation sizes: for a chosen binary LDPC code, the gap to capacity is essentially independent of spectral efficiency. This is an important property for DMT modulation where the signal sets used across the different tones can have different sizes.

2. Performance in AWGN with no latency constraints

We study the performance achieved by LDPC coded modulation over an AWGN channel using QAM constellations of size 4, 16, 64, 256, 1024, 4096, and 16384. LDPC codes of length ~ 500, ~ 1K, ~ 2K, and ~ 4K are considered. The code parameters are more precisely:

a. (N = 529, K = 462) rate = 0.8733,
b. (N = 1369, K = 1260) rate = 0.9204,
c. (N = 2209, K = 2024) rate = 0.9163,
d. (N = 4489, K = 4158) rate = 0.9263.

These codes were introduced in [2], where their “deterministic” construction was also explained.

The simulation results are summarized in Figs. 1 to 4, which show the performance of the various codes in the spectral-efficiency versus power-efficiency plane, at a bit-error rate (BER) of 10^{-7} (triangles). The figures incorporate the capacity of the employed signal sets (squares), shedding light to the effectiveness of the proposed LDPC coding scheme. We see that the gap between the capacity limit and power efficiency of the LDPC schemes remains fairly constant, nearly independently of the spectral efficiency.

It is also interesting to note that the gap-to-capacity is essentially maintained when going from binary to non-binary modulation. For example, the (529,462) code and the (2209,2024) code achieve, for binary transmission, a gap-to-capacity of ~ 3 dB and ~1.7 dB, respectively, at a BER of 10^{-7} (see Figs. 5 and 6). Hence, binary LDPC codes, which are known to be good for binary transmission, are equally good for non-binary transmission in terms of approaching capacity.

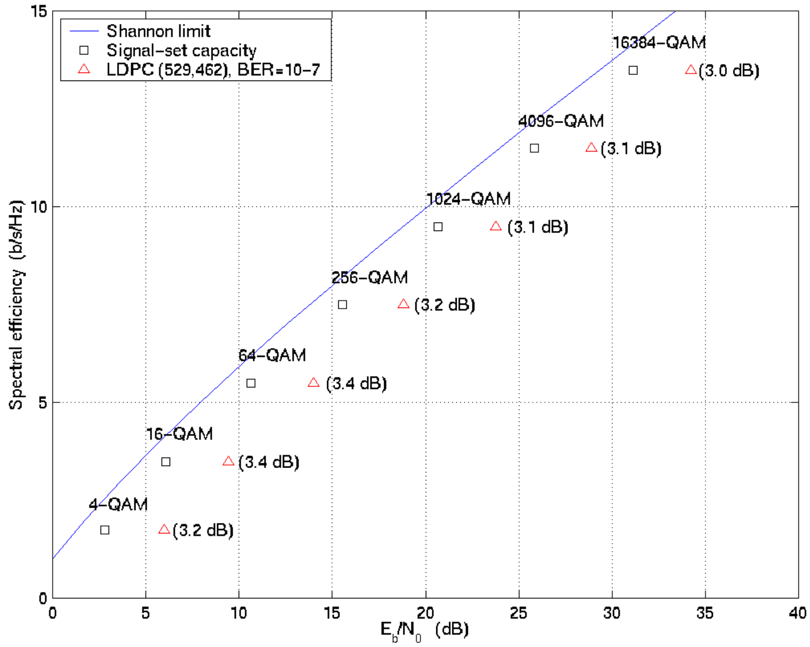

Fig. 1: Performance of LDPC code (529,462) for various spectral efficiencies. The numbers in parentheses indicate the gap in E_b/N_0 between the coded scheme and the signal-set capacity at a BER of 10^{-7}.

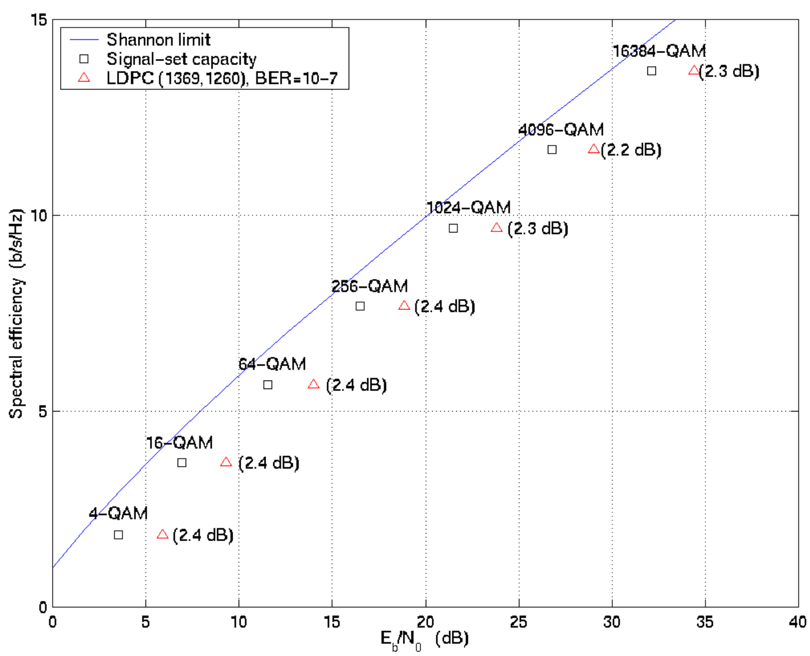

Fig. 2: Performance of LDPC code (1369,1260) for various spectral efficiencies. The numbers in parentheses indicate the gap in E_b/N_0 between the coded scheme and the signal-set capacity at a BER of 10^{-7}.

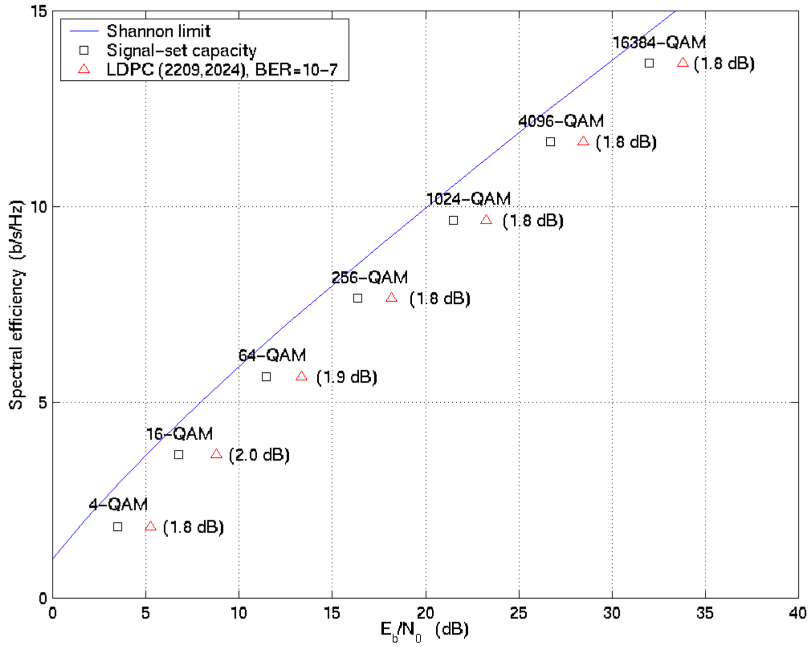

Fig. 3: Performance of LDPC code (2209,2024) for various spectral efficiencies. The numbers in parentheses indicate the gap in E_b/N_0 between the coded scheme and the signal-set capacity at a BER of 10^{-7}.

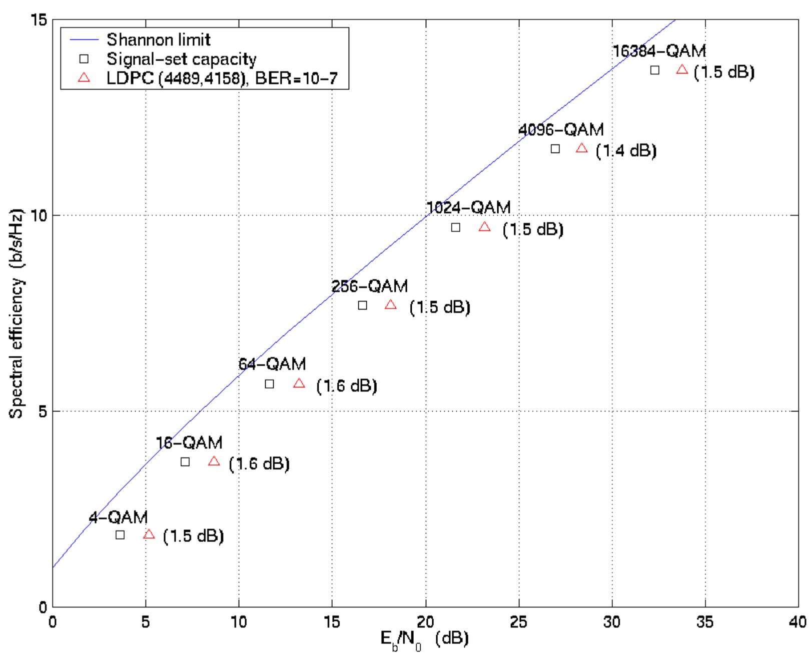

Fig. 4: Performance of LDPC code (4489,4158) for various spectral efficiencies. The numbers in parentheses indicate the gap in E_b/N_0 between the coded scheme and the signal-set capacity at a BER of 10^{-7}.

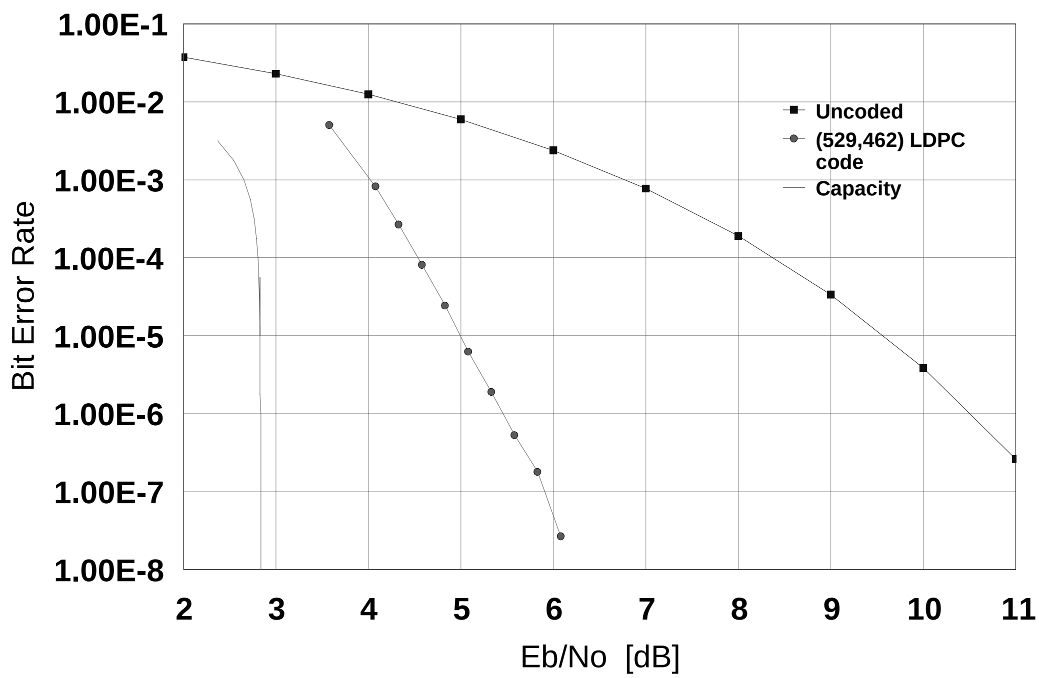

Fig. 5: Performance of LDPC code (529,462) for binary transmission.

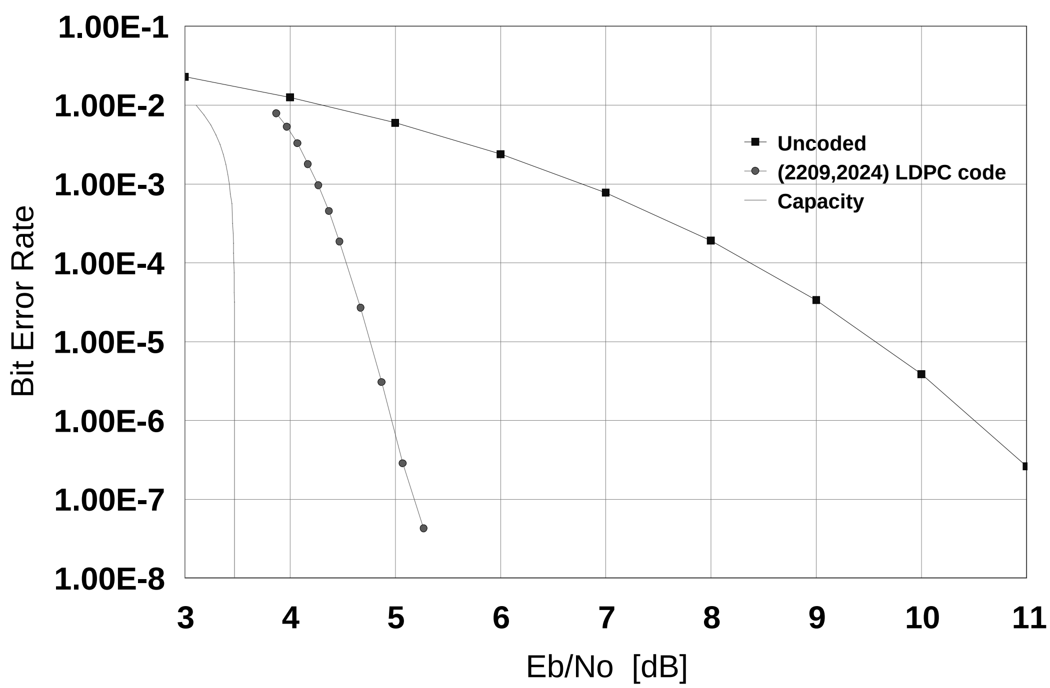

Fig. 6: Performance of LDPC code (2209,2024) for binary transmission.

3. Summary

We have provided further results on the performance of LDPC coding for G.dmt.bis and G.lite.bis by determining the gap to capacity for typical codes of size between ~500 and ~ 4K and for modulation formats from 4-QAM to 16834-QAM. Performance under coding-latency constraints is addressed in the companion contribution [6].

This contribution pertains to G.gen, G.dmt.bis, and G.lite.bis. It is provided for information only.

References

[1] "Low-density parity-check codes for DSL transmission," Temporary Document BI-095, Study Group 15/4, Goa, India, 23-27 Oct. 2000.

[2] "LDPC codes for G.dmt.bis and G.lite.bis," Temporary Document CF-060, Study Group 15/4, Clearwater, FL, 8-12 Jan. 2001.

[3] "LDPC coding proposal for G.dmt.bis and G.lite.bis," Temporary Document CF-061, Study Group 15/4, Clearwater, FL, 8-12 Jan. 2001.

[4] "Coding ad hoc report," Temporary Document BA-108, Study Group 15/4, Antwerp, Belgium, 19–23 June 2000.

[5] "Report of the ad hoc on improved coding gain," Temporary Document BI-110, Study Group 15/4, Goa, India, 23–27 October 2000.

[6] "Performance of LDPC coded modulation for ADSLbis under latency constraints ," Temporary Document RN-073, Study Group 15/4, Red Bank, New Jersey, 21–25 May 2001.