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LDPC Codes, Application to Next Generation Communication Systems

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Evolution of Error Coding Technology

- 1st Generation Wireless – FM no coding, 10-11 dB C/N threshold
- 2nd Generation Wireless - Convolutional codes with Viterbi decoding 5-7 dB C/N threshold, depending on code rate, and constraint length, 10^{-4} or better BER
- DVB-S – Concatentated Convolutional codes with Reed-Solomon codes, 5-7 dB C/N threshold, depending on code rate, 10^{-9} or better BER
- 3rd Generation Wireless – Turbo Codes, 0-1 dB E_b/N_o threshold at very low code rate (1/4, or 1/3), depending on block length 10^{-2} Packet Error Rate
- DVB-S2 – Low Density Parity Check Codes (LDPC), thresholds at 1 dB, 10^{-7} MPEG Packet Error Rate

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Highlights of LDPC Codes

- LDPC codes are discovered by R. Gallager in the mid 60s
  - Random Coding theory states that almost all randomly designed codes are good, as long as they are sufficiently long
  - Fewer ones in the parity check bits makes decoder simple to implement
  - Still too complex to implement in the 60s, or even 80s
- Due to the performance of turbo codes, whose performance is built upon
  - Large random interleaver
  - Iterative decoding
- Neal and McKay "rediscovered" LDPC codes recently employing iterative decoding to achieve turbo-like performance
- To design a good LDPC code, efficient use of modern Random Access Memory (RAM) architecture is the key. Design of the codes that has sufficient structure to allow efficient read/write, but still preserve sufficient "randomness" to retain coding gain are necessary
- LDPC codes are selected as the DVB-S2 standard over 7 other turbo code based candidates because of its more efficient implementation as well as better performance

Eb/No vs Throughput Performance in AWGN

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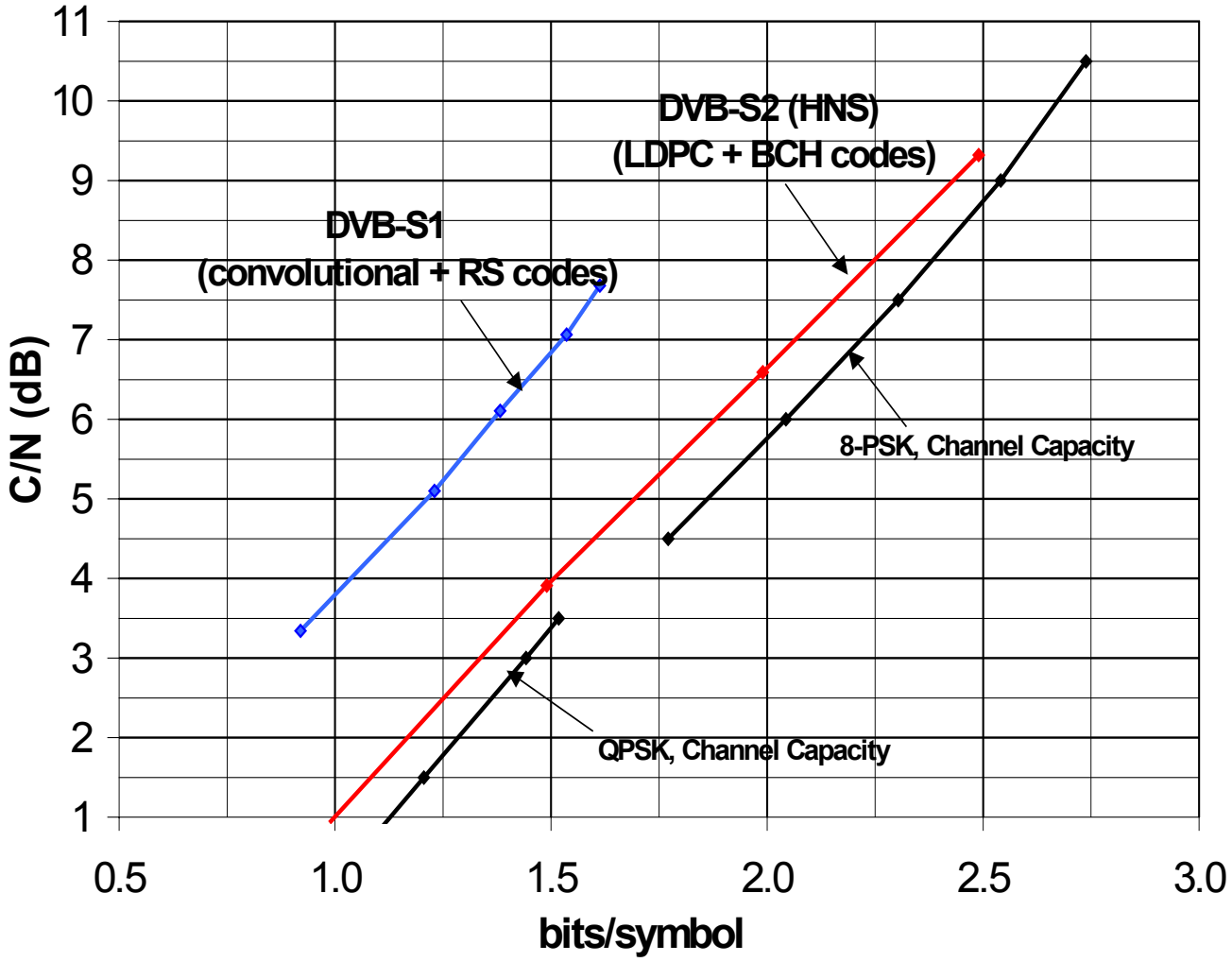

- About 0.6-0.8 dB away from Shannon limit
- About 0.3 dB better than the best turbo code candidates in the DVB-S2
- About 0.7 dB better than turbo code based ASIC solutions we have tested
- About 2.5-3.0 dB power advantage, or up to 30 % through-put improvement over DVB-S
- Further performance improvement not expected for decades to come

...LDPC Performance in AWGN

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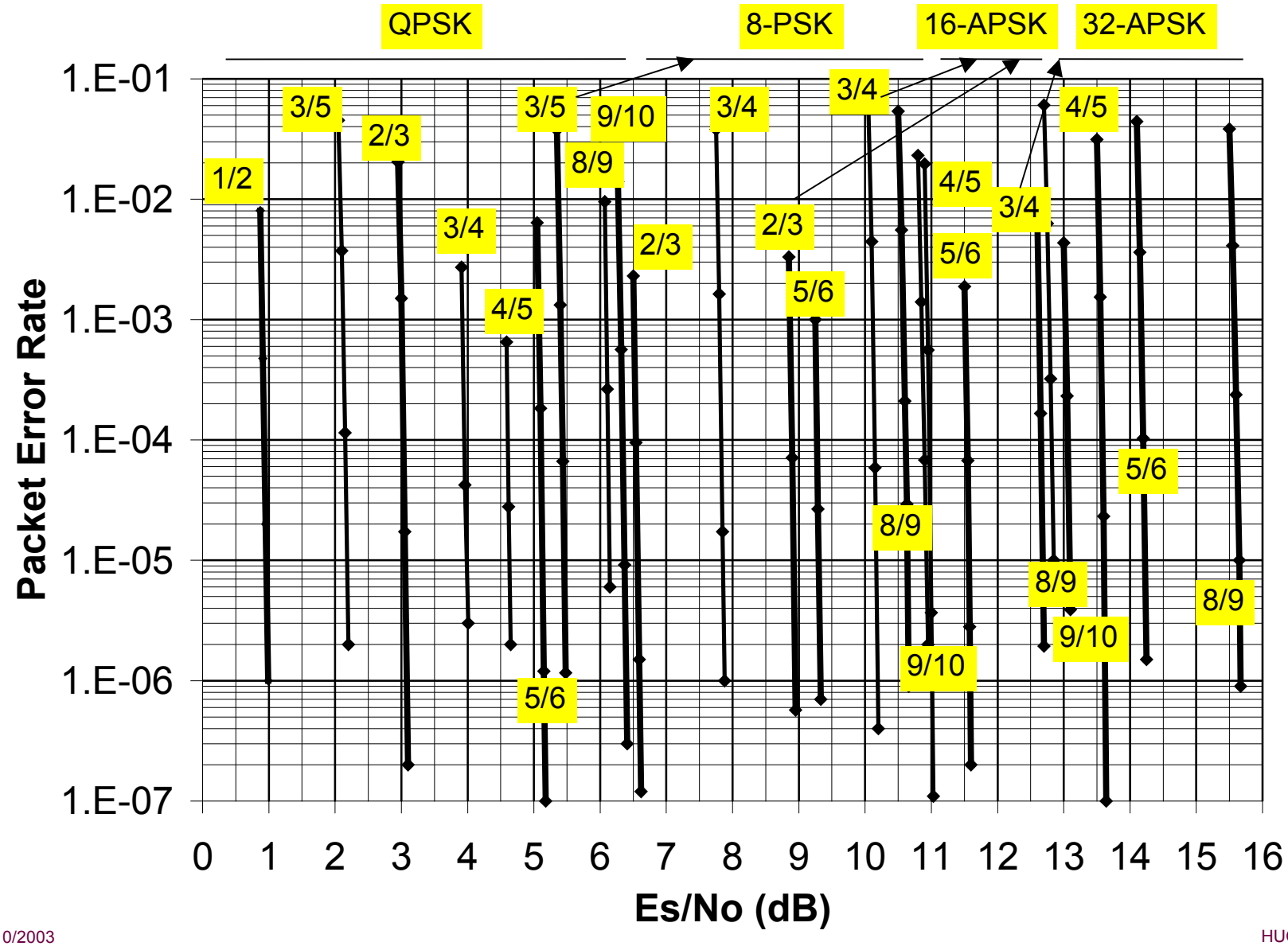

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