

LDPC Codes, Application to Next Generation Communication Systems

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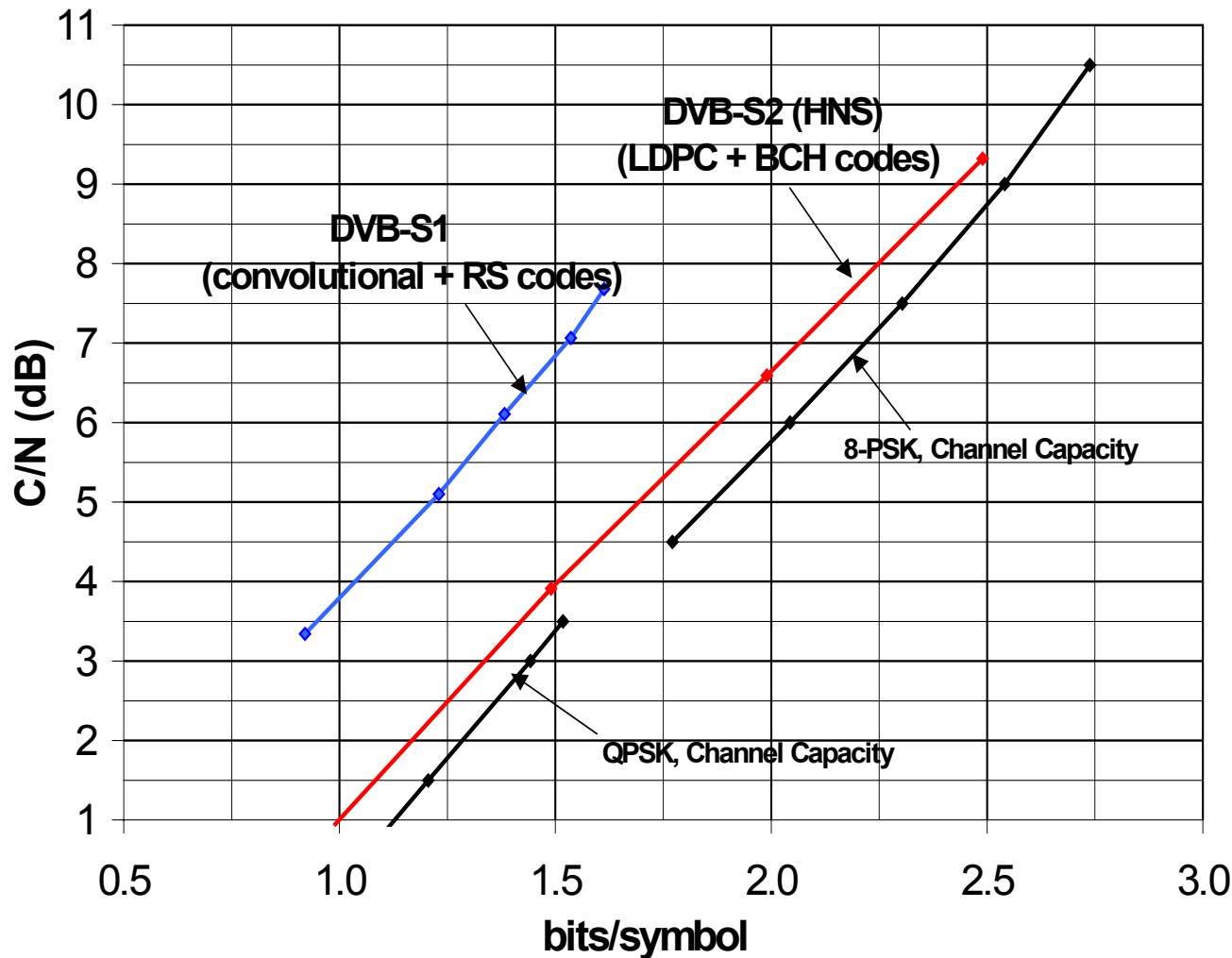
Evolution of Error Coding Technology

- ◆ **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 – Concatenated 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**

Highlights of LDPC Codes

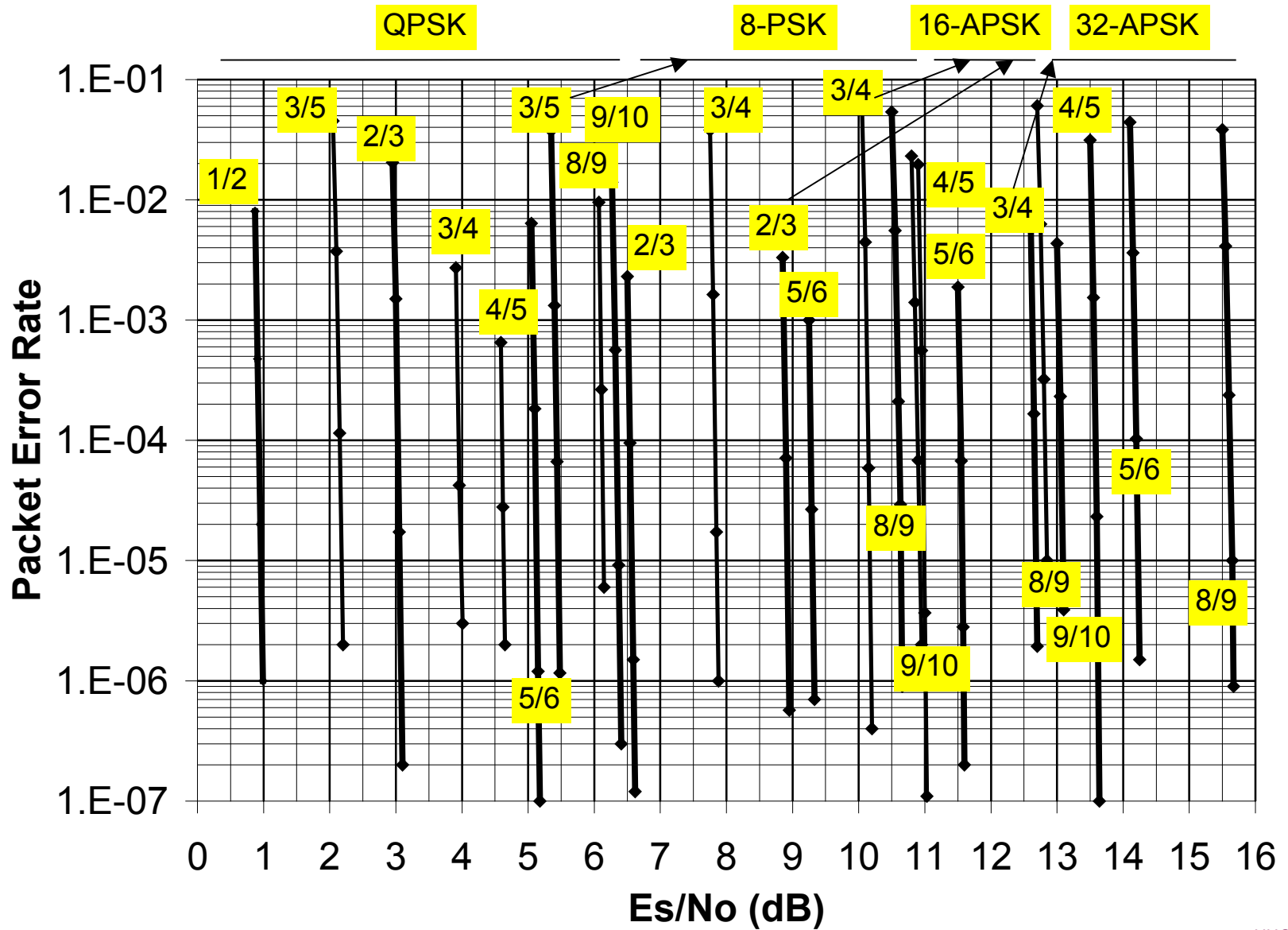
- ◆ **LDPC codes are discovered by R. Gallager in the mid 60s**
 - **Random Coding theory states that almost all randomly designed codes are good, as long as they are sufficiently long**
 - **Fewer ones in the parity check bits makes decoder simple to implement**
 - **Still too complex to implement in 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



- ◆ 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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