Modified Concatenated LDGM codes

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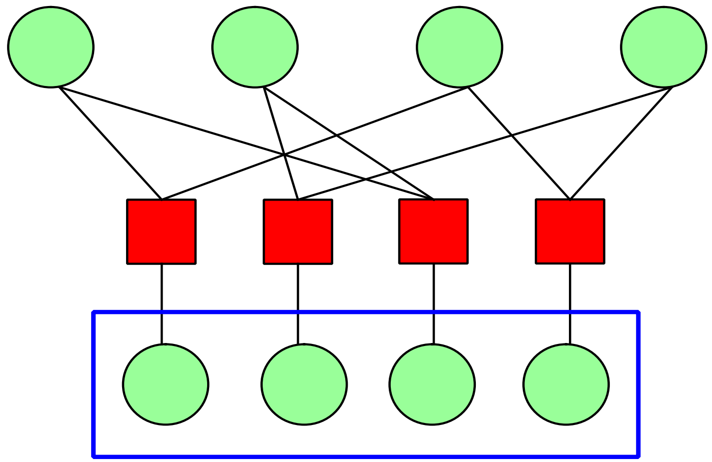
Contents

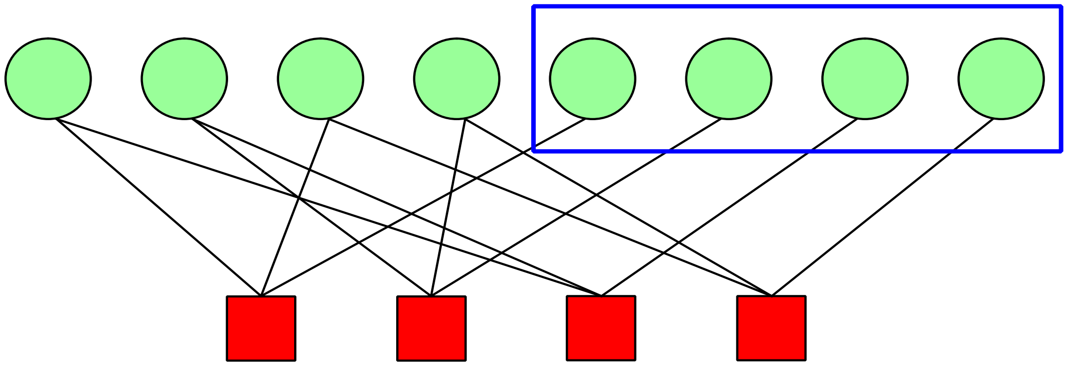
Introduction

- LDGM Codes
  - Systematic linear block codes
  - Subset of LDPC codes

$$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 \end{bmatrix}$$



$$H = \begin{bmatrix} 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

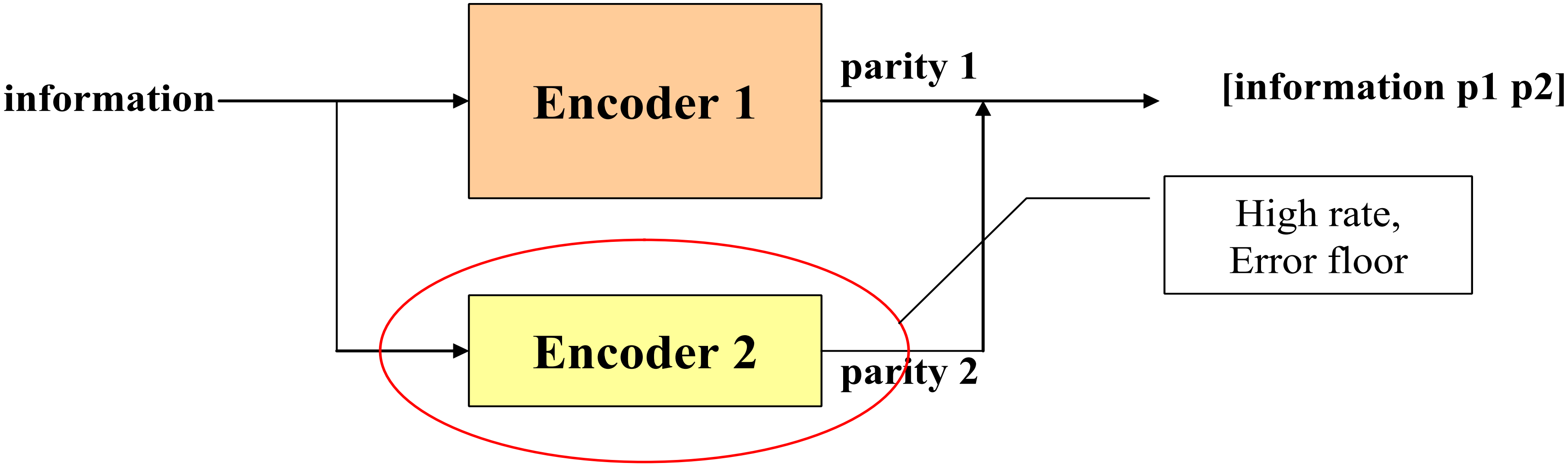


Introduction

- Characteristics of LDGM Codes
  - Low encoding complexity compared to LDPC codes
  - Serious error floor
    - solution: concatenated scheme
- Serial concatenated LDGM Codes
  - Require double decoder
  - Increase the hardware complexity
- Proposed LDGM codes
  - Reduce decoder complexity about 24% without performance degradation

Concatenated LDGM codes

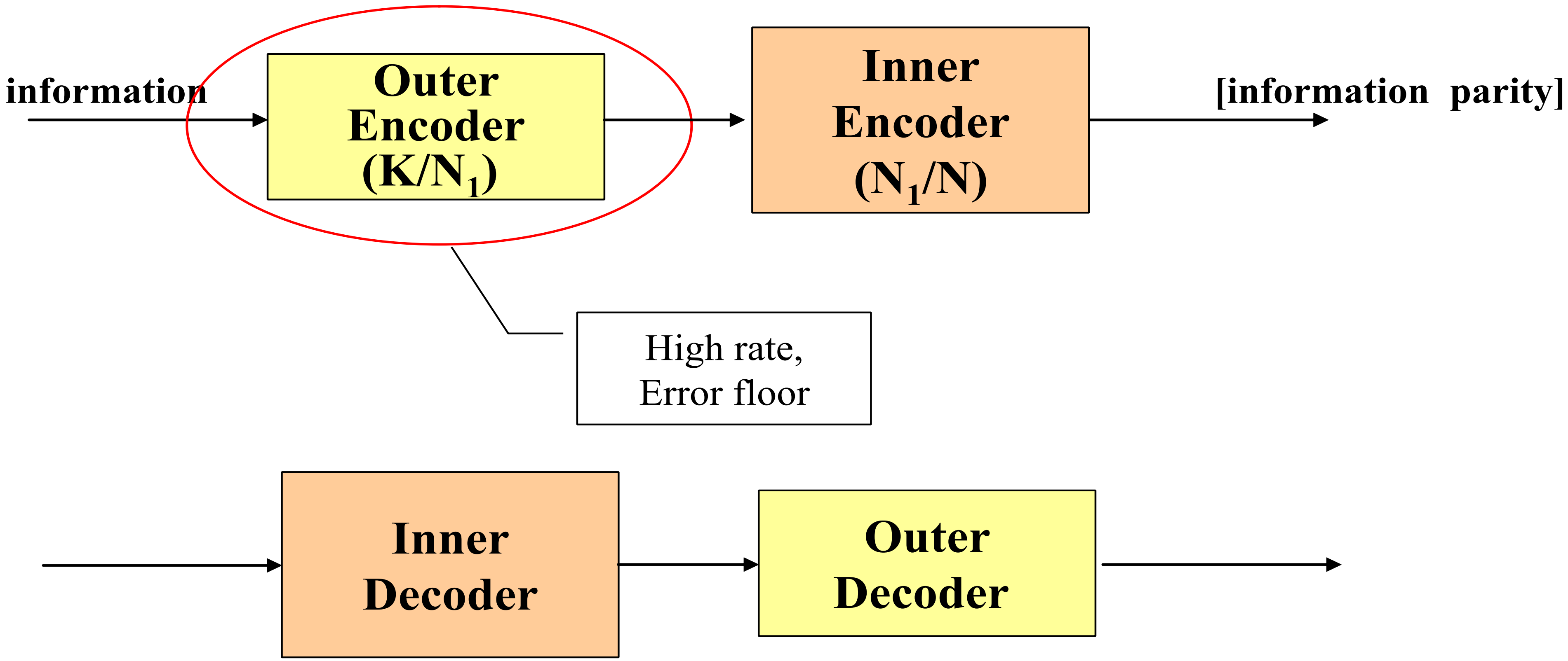
Parallel Concatenated LDGM Codes



$$G = \left[\begin{array}{c|c|c} \mathbf{I} & \mathbf{P}_1 & \mathbf{P}_2 \end{array}\right] \Rightarrow H = \left[\begin{array}{c|c} \mathbf{P}_1^{\mathrm{T}} & \\ \hline \mathbf{P}_2^{\mathrm{T}} & \mathbf{I} \end{array}\right]$$

Concatenated LDGM codes

- Serial Concatenated LDGM Codes



Concatenated LDGM codes

❑ Serial Concatenated LDGM Codes

G_{OUT} : Generator matrix for outer encoder

G_{IN} : Generator matrix for inner encoder

G : Generator matrix for overall encoder

$$G = G_{OUT} \times G_{IN} = [I \quad P]$$

H : Party check matrix for decoder

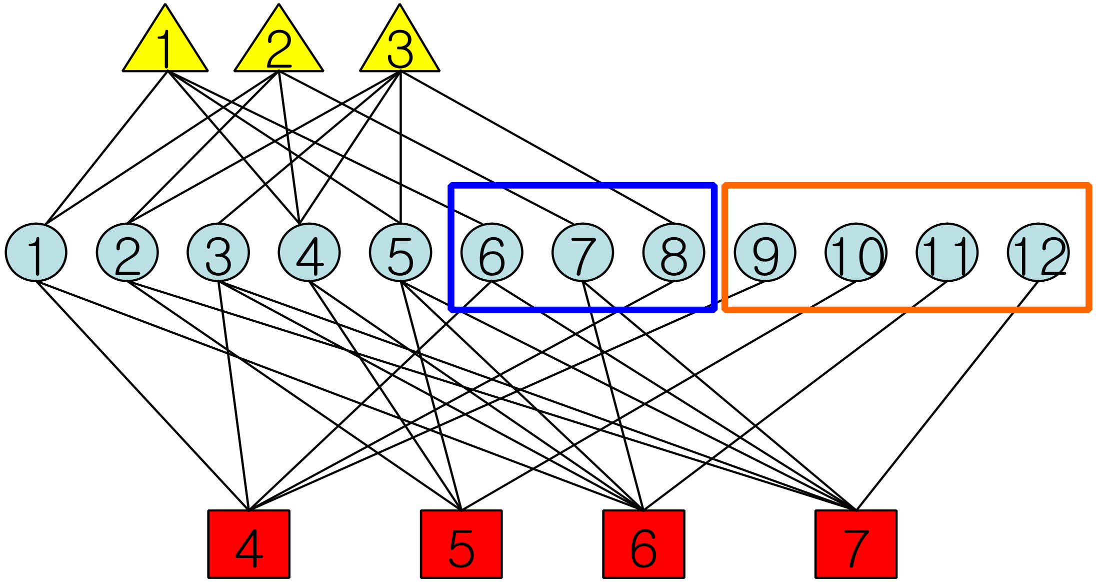
$$H = [P^T \quad I]$$

- Single decoder
- Cannot be used for decoding
- Due to too many short cycles

Concatenated LDGM codes

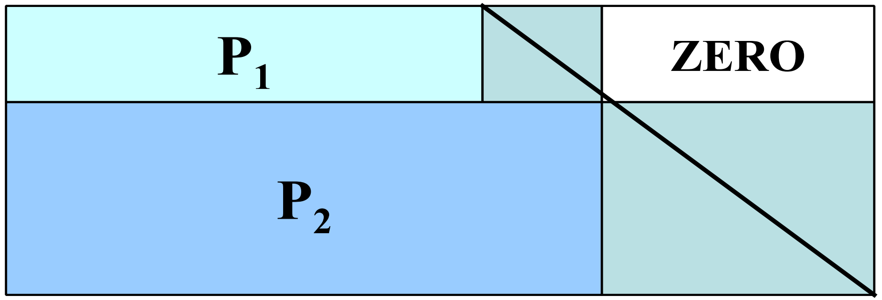
Serial Concatenated LDGM Codes

$$G_1 = \left[\begin{array}{ccccc|ccc} 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \end{array}\right]$$



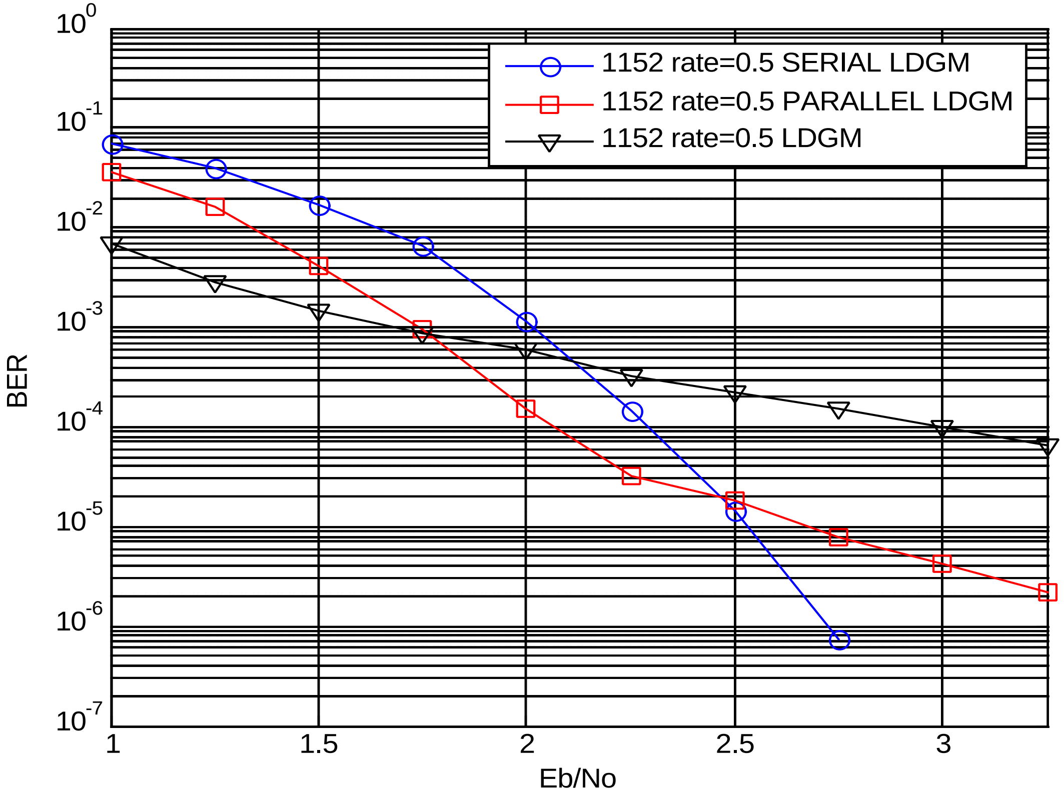
$$G_2 = \left[\begin{array}{cccccccc|cccc} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \end{array}\right]$$

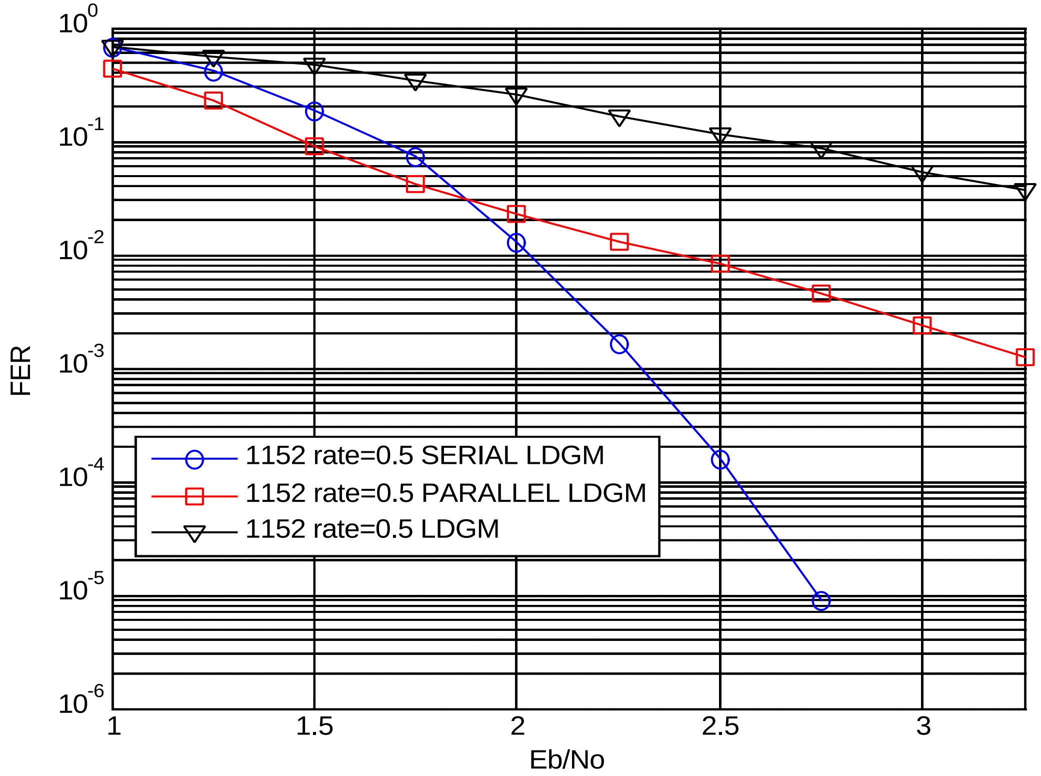
$H =$



Concatenated LDGM codes

❑ Simulation Results





Proposed LDGM codes

H matrix structure

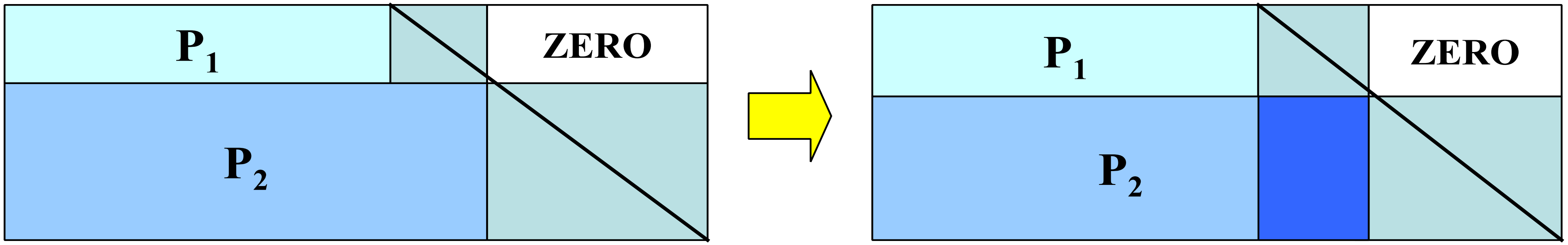


Figure 1: Parity check matrix for simply single LDGM codes.

Figure 2: Parity check matrix for proposed LDGM codes.

- **To decrease density of P_1, we lower coderate of outer encoder**
- **By decreasing the density, we reduce the number of short cycles**
- **In Figure 2, we only increase the degree of blue part to reduce the error floor**
- **By decreasing the overall degree, we reduce the complexities**

Simulation Results

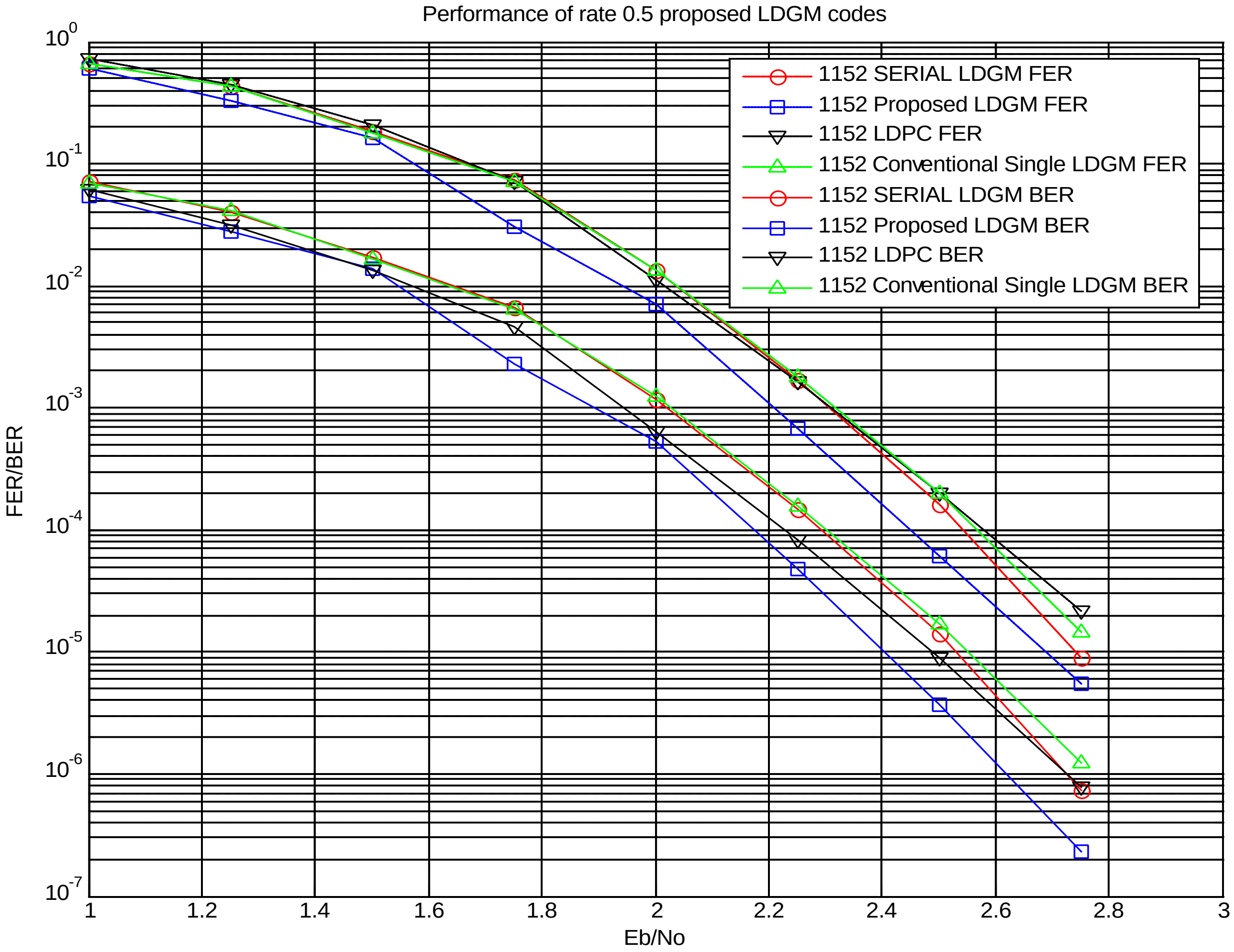


Figure 3: Performance of proposed LDGM codes.

- Block length=1152, Code rate=0.5
- Belief propagation decoding
- Maximum iteration number
  - SERIAL LDGM: 30, 50
  - Other codes: 50
- AWGN channel
- Code rate
  - SERIAL LDGM: 0.914, 0.547
  - Proposed LDGM: 0.8252, 0.6059
- PEG construction
- Number of 1's of parity check matrix

LDPC	SERIAL LDGM	Proposed LDGM
3456	6084	4642

Table 1: Number of 1's of parity check matrix.

Conclusion

- Conventional serial concatenated LDGM codes
  - Have performance similar to LDPC codes
  - Require double decoder
  - Increase decoder complexity for implementation
- Proposed LDGM codes
  - Reduce decoder complexity about 24% without performance degradation