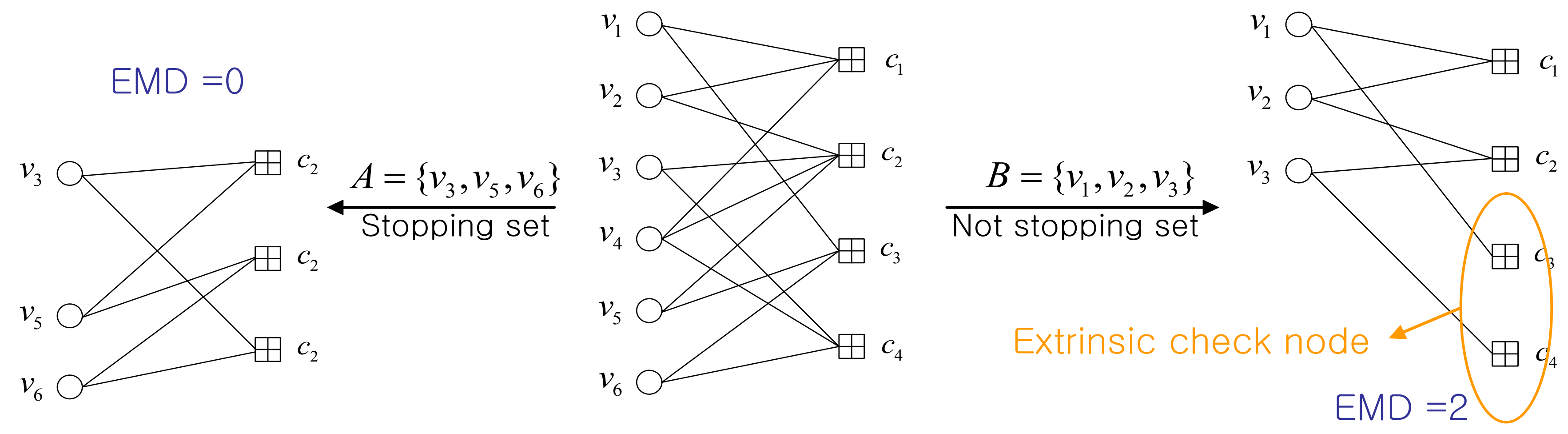
Introduction

- LDPC codes with finite block length
  - Parameter related to performance :
    - ✓ girth (the shortest cycle)
    - ✓ connectivity of graph
  - Construction algorithms
    - ✓ ACE algorithm : connectivity of graph
    - ✓ PEG algorithm : local girth
    - ✓ Improved PEG algorithm (IPEG) algorithm : PEG + ACE
      - One of the best known methods for constructing LDPC codes.
- IPEG Algorithm
  - A lot of random selection for new edges
    - ✓ About 40~50% of total edges.

→ IPEG algorithm needs **more specific criterion** for selection!!

Connectivity of variable nodes (1)

- Stopping sets and EMD (extrinsic message degree)



$$
\overset{v_3}{\begin{bmatrix}0\\1\\0\\1\end{bmatrix}} + \overset{v_5}{\begin{bmatrix}0\\1\\1\\0\end{bmatrix}} + \overset{v_6}{\begin{bmatrix}0\\0\\1\\1\end{bmatrix}} = \begin{bmatrix}0\\2\\2\\2\end{bmatrix}
$$

$$
\textit{The number of } 1's = 0
$$

$$
\begin{array}{c|cccccc} & v_1 & v_2 & v_3 & v_4 & v_5 & v_6 \\ \hline c_1 & 1 & 1 & 0 & 1 & 0 & 0 \\ c_2 & 0 & 1 & 1 & 1 & 1 & 0 \\ c_3 & 1 & 0 & 0 & 0 & 1 & 1 \\ c_4 & 0 & 0 & 1 & 1 & 0 & 1 \end{array}
$$

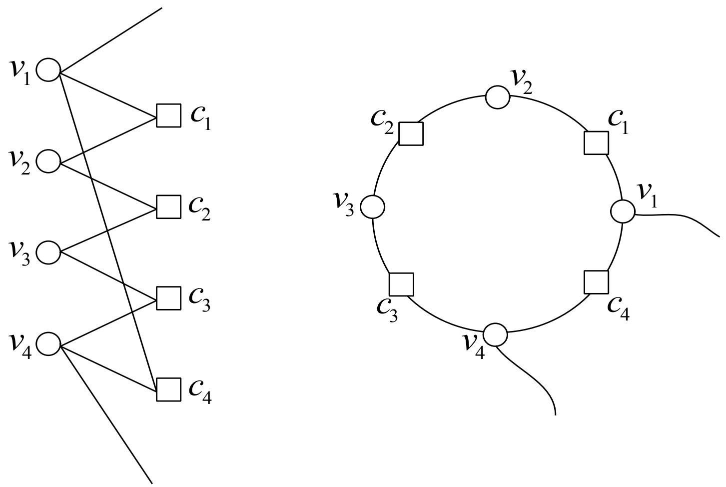
$$
\overset{v_1}{\begin{bmatrix}1\\0\\1\\0\end{bmatrix}} + \overset{v_2}{\begin{bmatrix}1\\1\\0\\0\end{bmatrix}} + \overset{v_3}{\begin{bmatrix}0\\1\\0\\1\end{bmatrix}} = \begin{bmatrix}2\\2\\1\\1\end{bmatrix}
$$

$$
\textit{The number of } 1's = 2
$$

Connectivity of variable nodes (3)

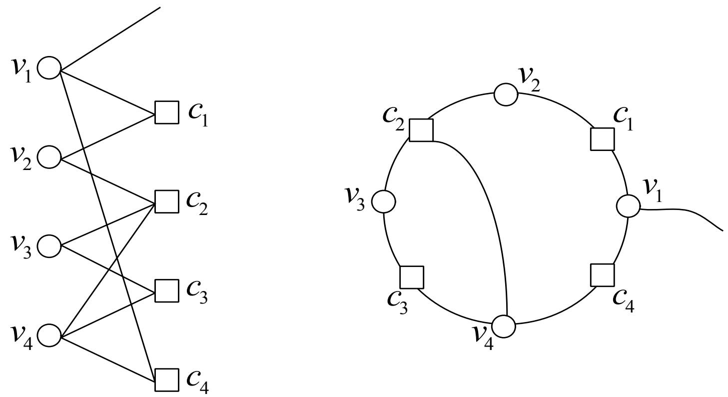
- ACE (Approximate cycle EMD)
  - ACE of variable node : (degree -2),   ACE of check node : 0
  - ACE = ∑ (ACE of each node)

- EMD and ACE



* ACE = 2 = (3-2)+(2-2)+(2-2)+(3-2)
* EMD = 2
* ACE = EMD

(a) No subcycle



* ACE = 2 =(3-2)+(2-2)+(2-2)+(3-2)
* EMD = 1
* ACE ≠ EMD

(b) Subcycles

PEG algorithm and IPEG algorithm

- Given parameter
  - the number of variable node (n), the number of check node (m)
  - variable node degree sequence : density evolution.
- Basic idea
  - make local girth as large as possible whenever placing a new edge.

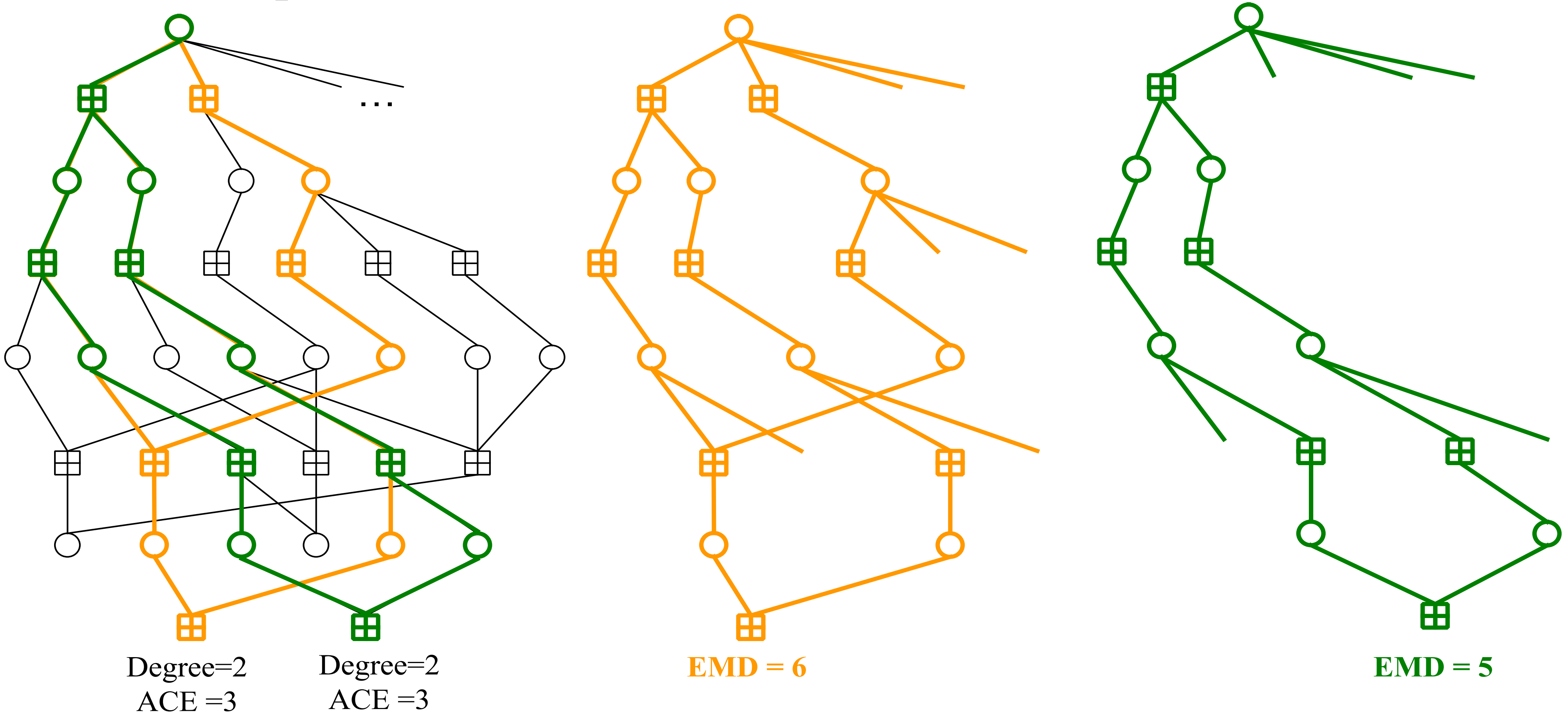
	PEG	IPEG
Construction method	Tree spreading	Tree spreading
Criterion for selection - 1st	Highest depth	Highest depth
Criterion for selection - 2nd	Lowest degree	Lowest degree
Criterion for selection - 3th	Random	ACE
Criterion for selection - 4th		Random

Modified IPEG algorithm (1)

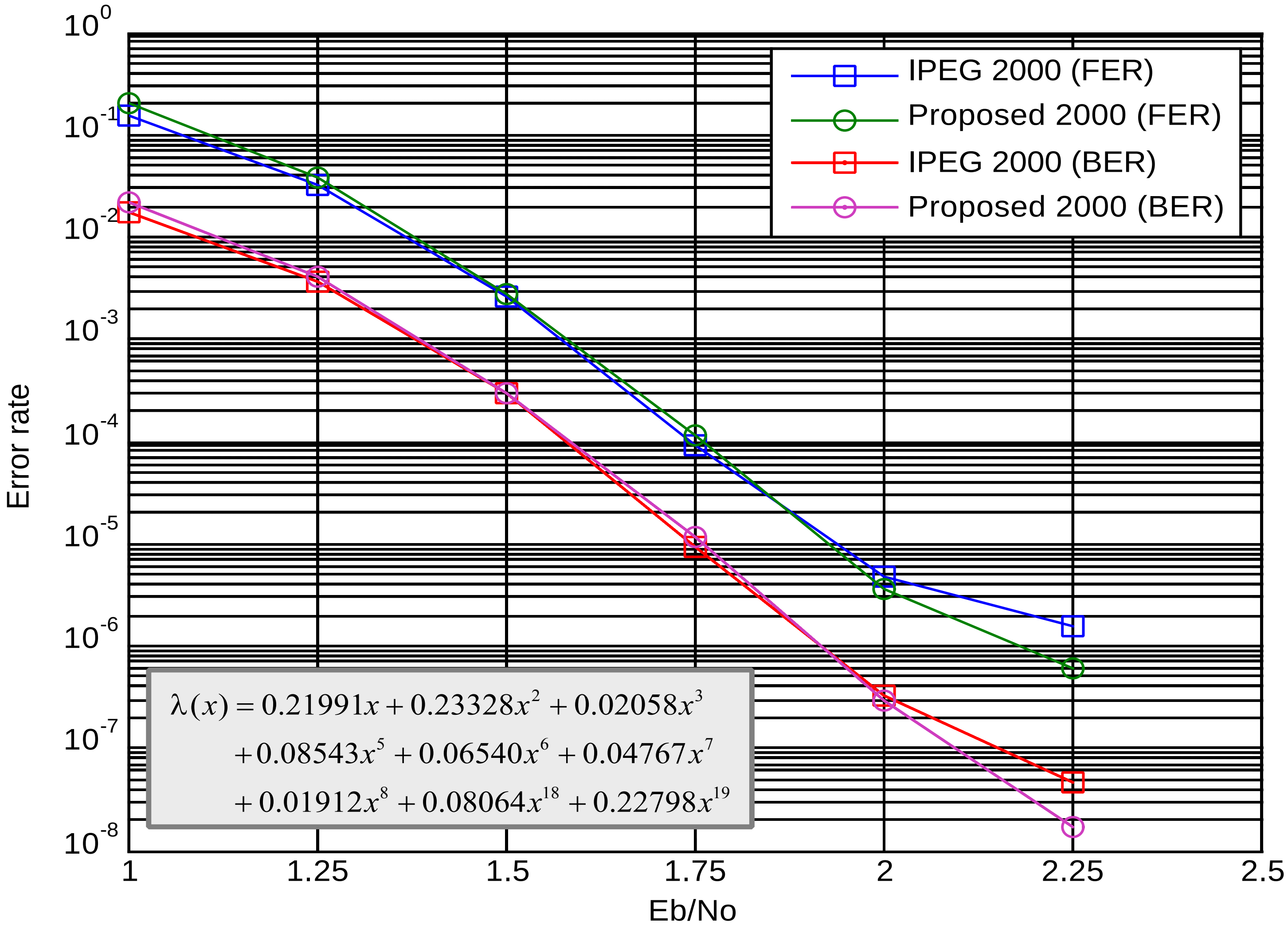
- Proposed algorithm
  - Φ : the candidate check node classified by IPEG algorithm
  - Select a check node in Φ by calculating the EMD of subgraph.
    - ✓ Extract subgraph for each check node in Φ
      - By back-tracking from the check node to root (variable) node.
    - ✓ Calculate the EMD of variable nodes in each subgraph
      - Counting the number of 1's in the column sum over the variable nodes in subgraphs
    - ✓ Select a check node that has the maximum EMD
  - If there are more than two check nodes that have the same EMD, select a check node that has more variable node in subgraph.

Modified IPEG algorithm (2)

- Example



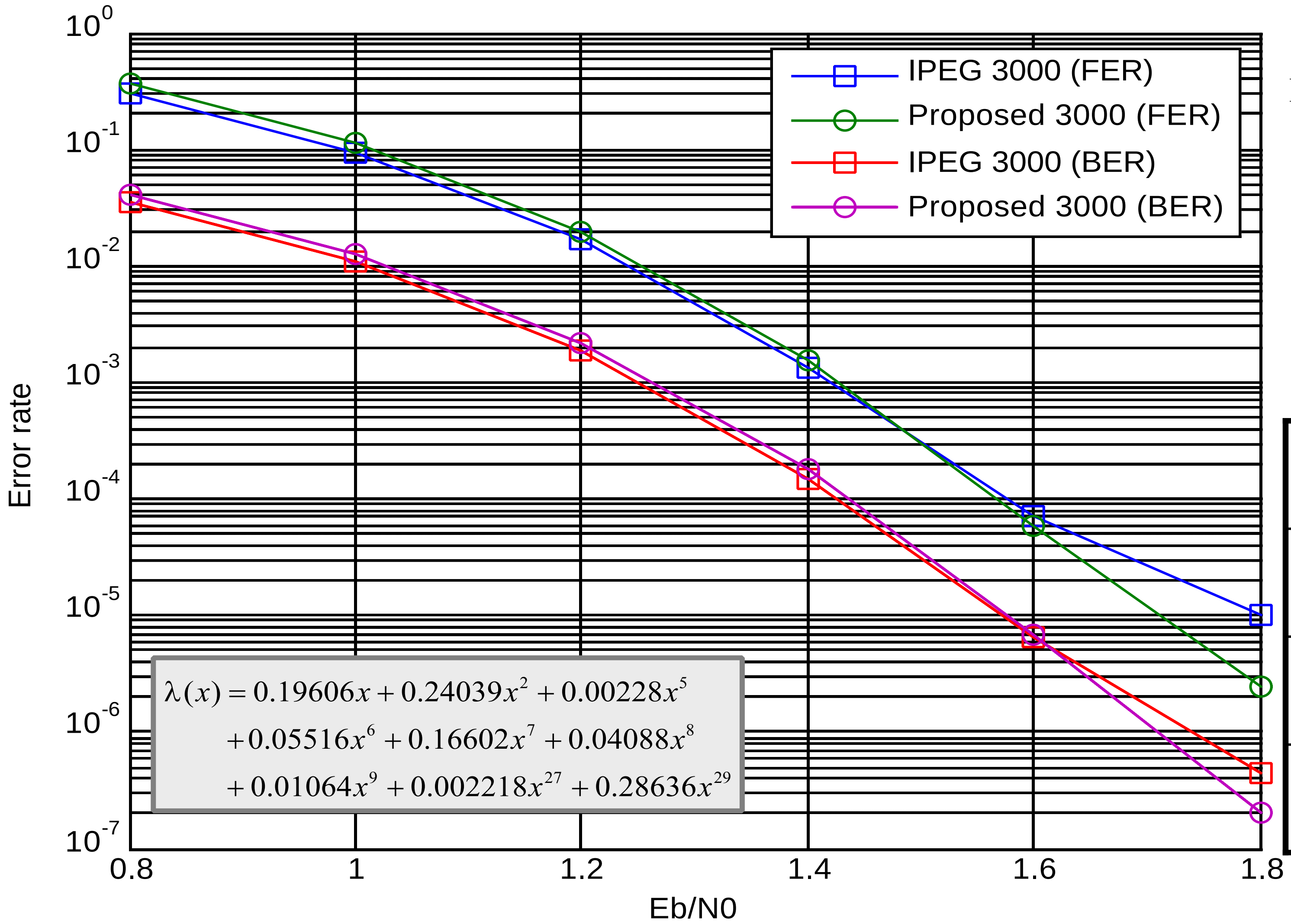
Simulation results (1)



Block length = 2000
Maximum variable node degree = 20
Coderate 1/2

Total edges (except first)	6326
Random selection after PEG	5327 (0.84208)
Random selection after IPEG	2476 (0.43408)
Random selection after proposed	77 (0.01217)

Simulation results (2)



Block length = 3000
Maximum variable node degree = 30
Coderate 1/2

Total edges (except first)	10496
Random selection after PEG	8997 (0.85718)
Random selection after IPEG	5260 (0.50114)
Random selection after proposed	148 (0.01410)