Variable-to-Check Residual Belief Propagation for Informed Dynamic Scheduling of LDPC Codes

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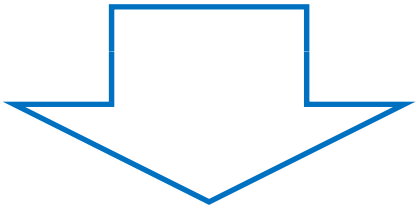
INTORDUCTION

- Future system requires higher data throughput
  - Fast and accurate decoder (fast convergence, high performance)

Standard BP (simultaneous scheduling)

Layered / Shuffled BP (serial scheduling)

Non-dynamic scheduling

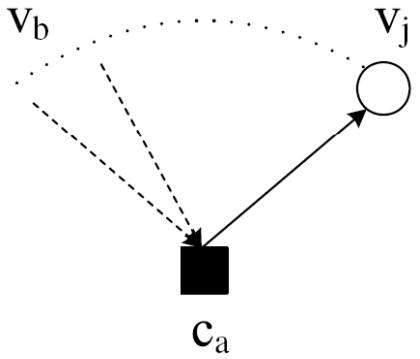


Residual BP (Informed Dynamic Scheduling)

RBP FOR LDPC CODES

- Residual Belief Propagation [3], [4]

$$r\left(m_{n_i \to n_j}\right) = \left\| m^{\text{new}}_{n_i \to n_j} - m^{\text{old}}_{n_i \to n_j} \right\|$$



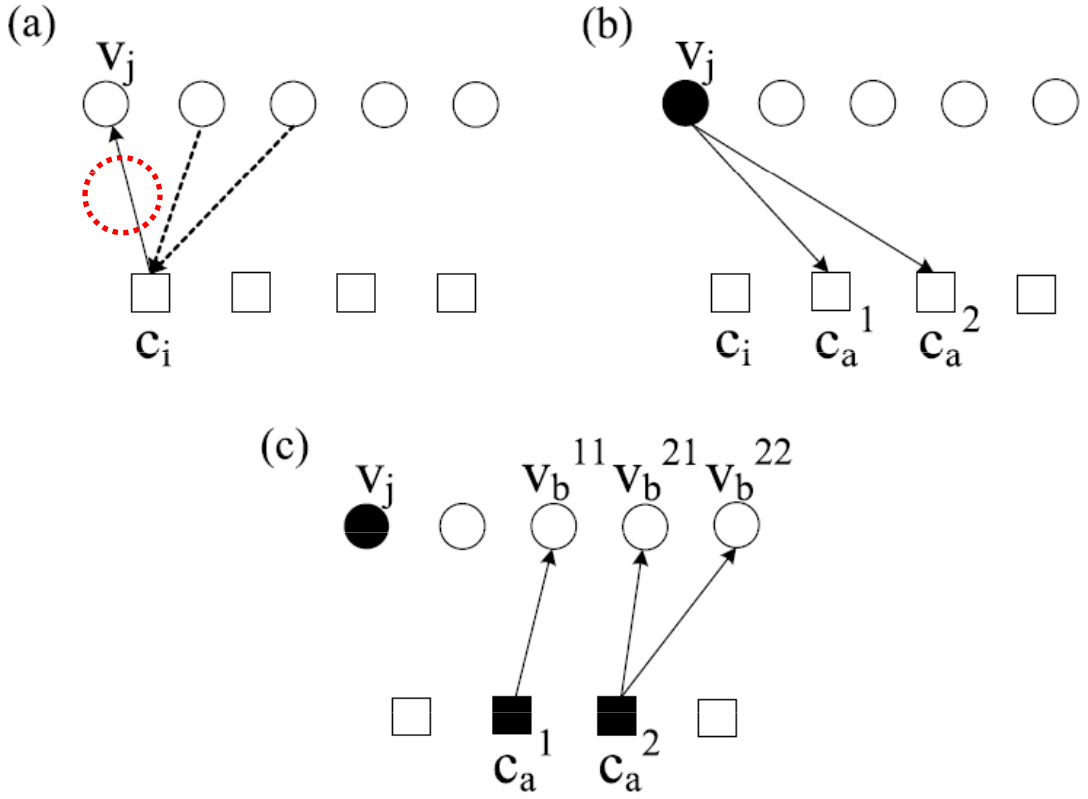
$$m_{c_a \to v_j} = \log \frac{P(E_{c_a} = 0 | v_j = 0, \mathbf{r})}{P(E_{c_a} = 0 | v_j = 1, \mathbf{r})}$$

[3] G. Elidan, I. McGraw, and D. Koller, "Residual belief propagation: informed scheduling for asynchronous message passing," *In Proc. 22nd Conference on Uncertainty in Artificial Intelligence*, MIT, Cambridge, MA, July, 2006.

[4] A. I. Vila Casado, M. Griot, and R. D. Wesel, "Informed Dynamic Scheduling for Belief-Propagation Decoding of LDPC Codes," *In Proc. IEEE ICC 2007*, Glasgow, Scotland, June, 2007.

RBP FOR LDPC CODES [4]

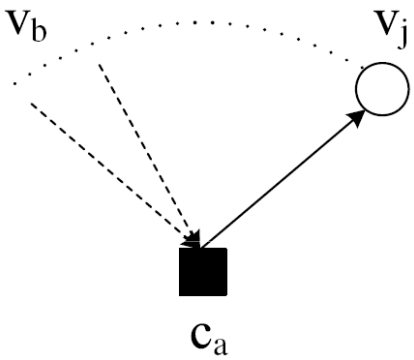
- The procedure of RBP decoding for LDPC codes



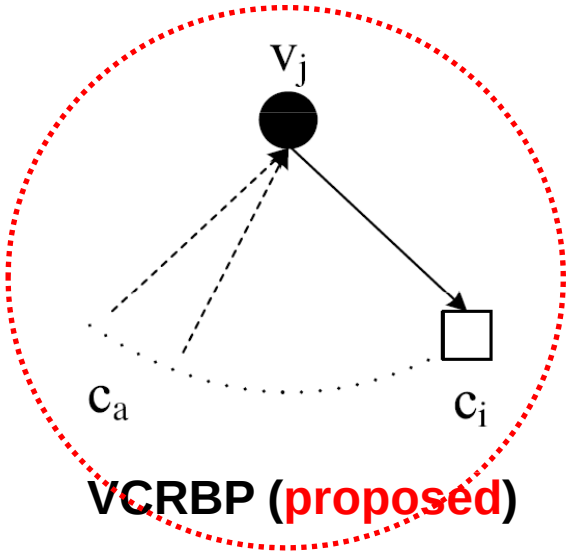
[4] A. I. Vila Casado, M. Griot, and R. D. Wesel, "Informed Dynamic Scheduling for Belief-Propagation Decoding of LDPC Codes," *In Proc. IEEE ICC 2007*, Glasgow, Scotland, June, 2007.

VCRBP FOR LDPC CODES (proposed)

- The Residual of RBP and VCRBP



RBP [4]



VCRBP (proposed)

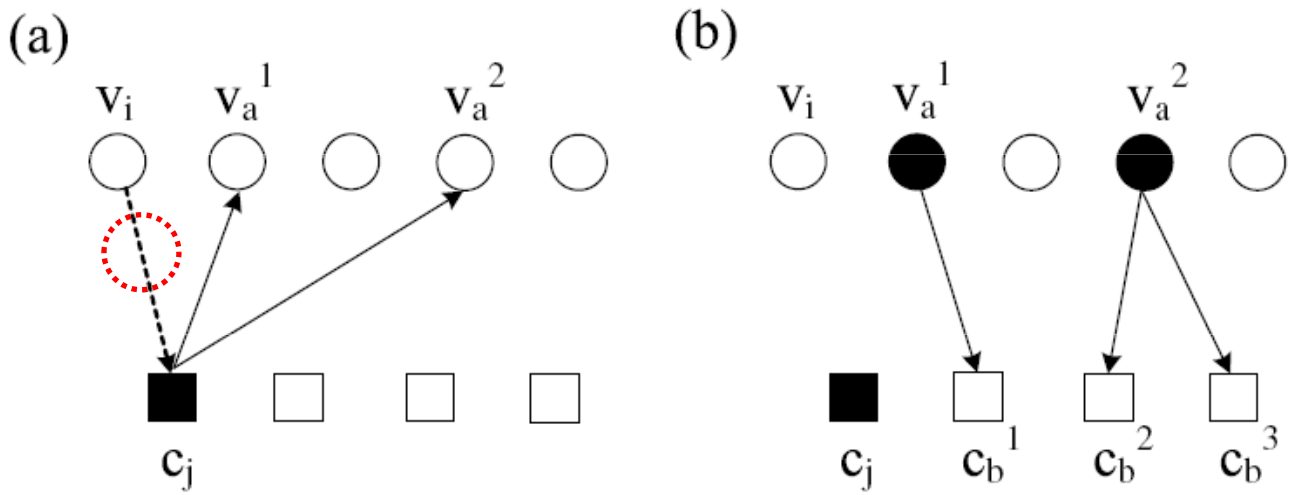
$$m_{c_a \to v_j} = \log \frac{P(E_{c_a} = 0 | v_j = 0, \mathbf{r})}{P(E_{c_a} = 0 | v_j = 1, \mathbf{r})}$$

$$m_{v_j \to c_i} = \log \frac{P(v_j = 0 | \mathbf{r}, \{E_{c_a} = 0, c_a \in N(v_j) \backslash c_i\})}{P(v_j = 1 | \mathbf{r}, \{E_{c_a} = 0, c_a \in N(v_j) \backslash c_i\})}$$

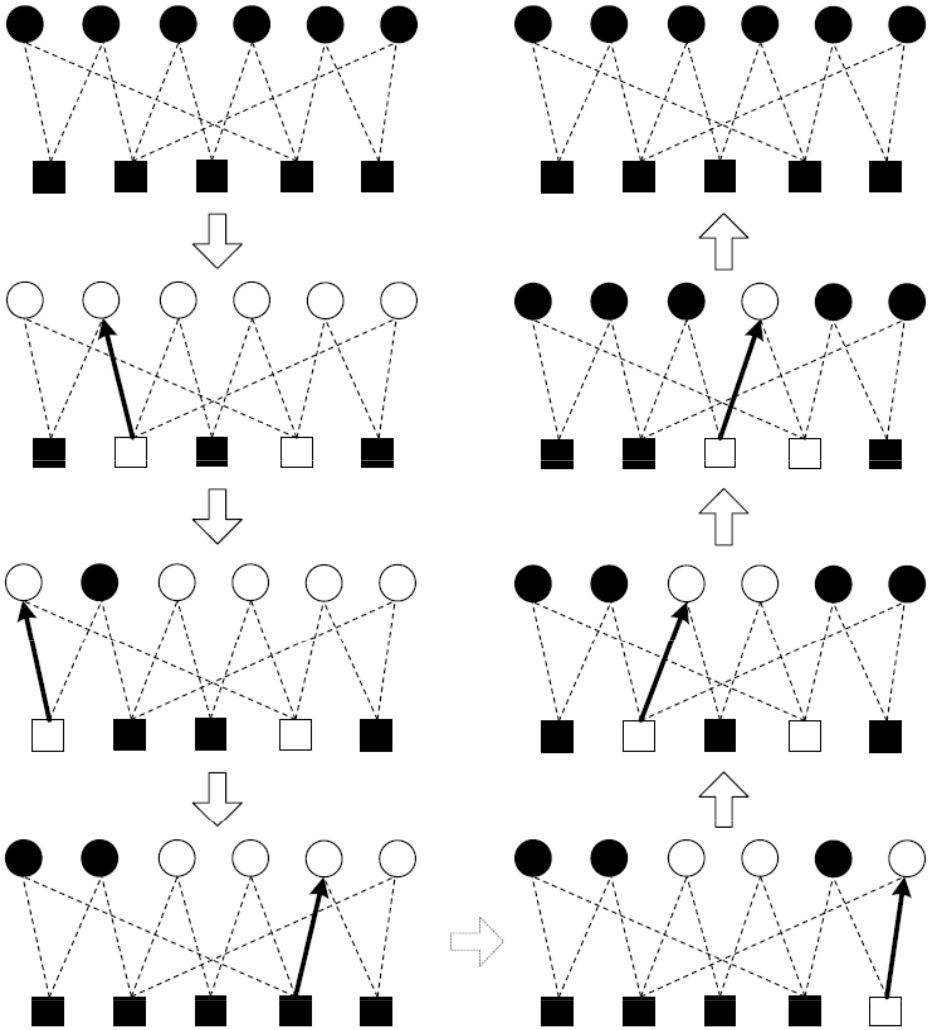
[4] A. I. Vila Casado, M. Griot, and R. D. Wesel, "Informed Dynamic Scheduling for Belief-Propagation Decoding of LDPC Codes," *In Proc. IEEE ICC 2007*, Glasgow, Scotland, June, 2007.

VCRBP FOR LDPC CODES (proposed)

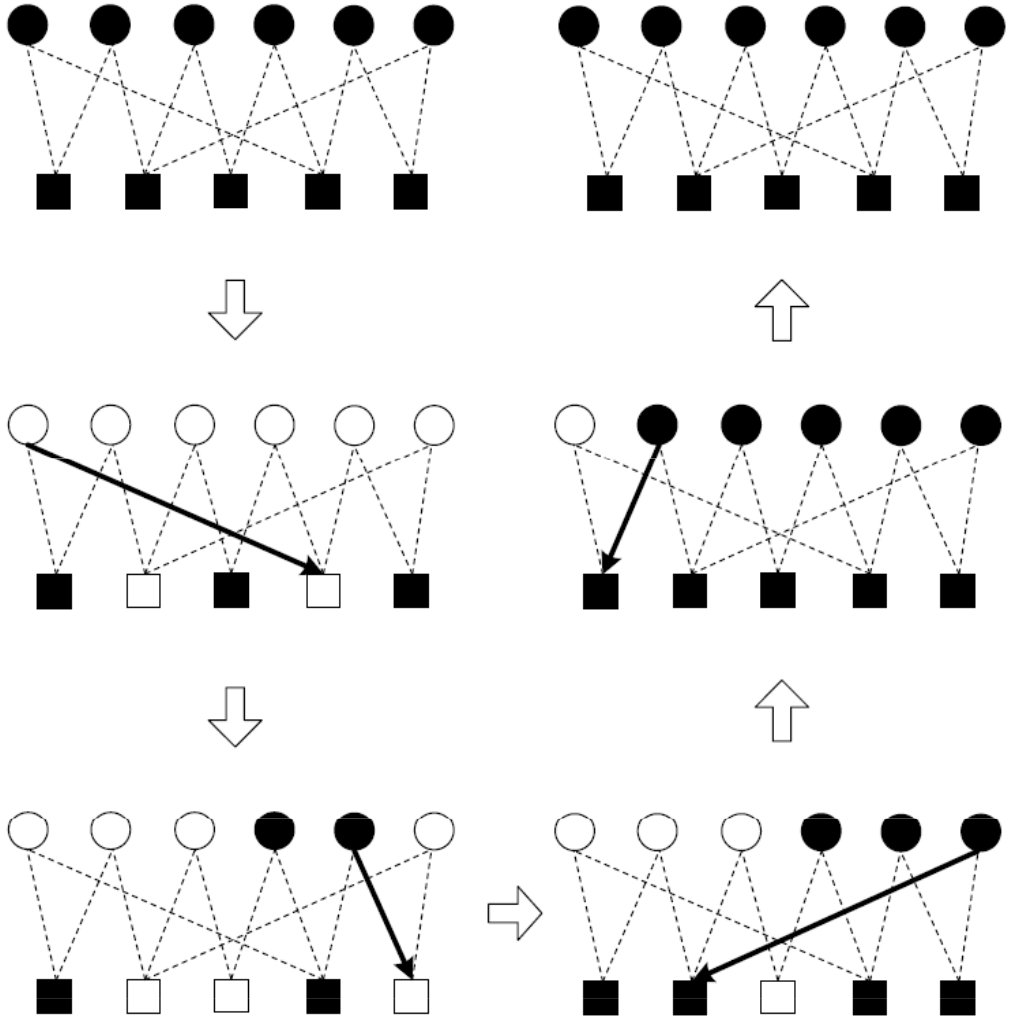
- The procedure of VCRBP decoding for LDPC codes



HOW TO SOLVE THE TRAPPING SET - RBP

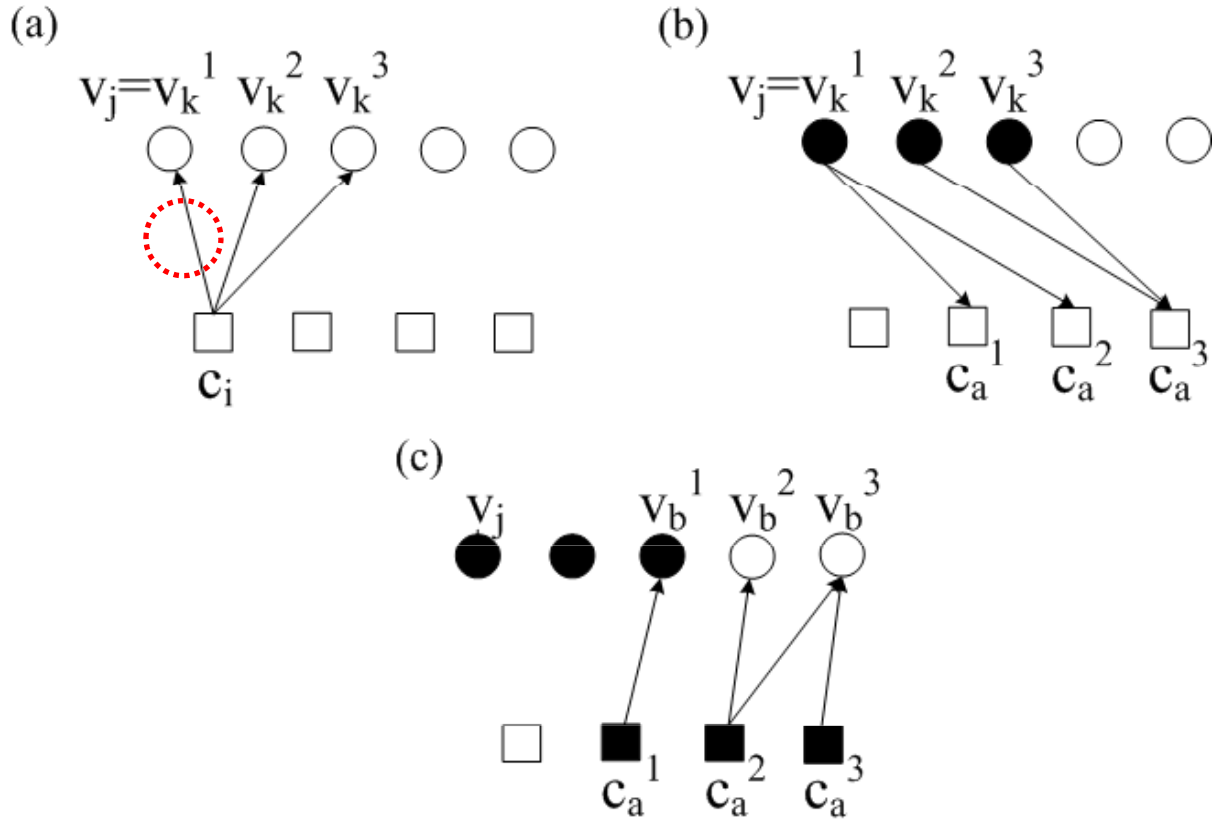


HOW TO SOLVE THE TRAPPING SET - VCRBP



N-RBP FOR LDPC CODES [4]

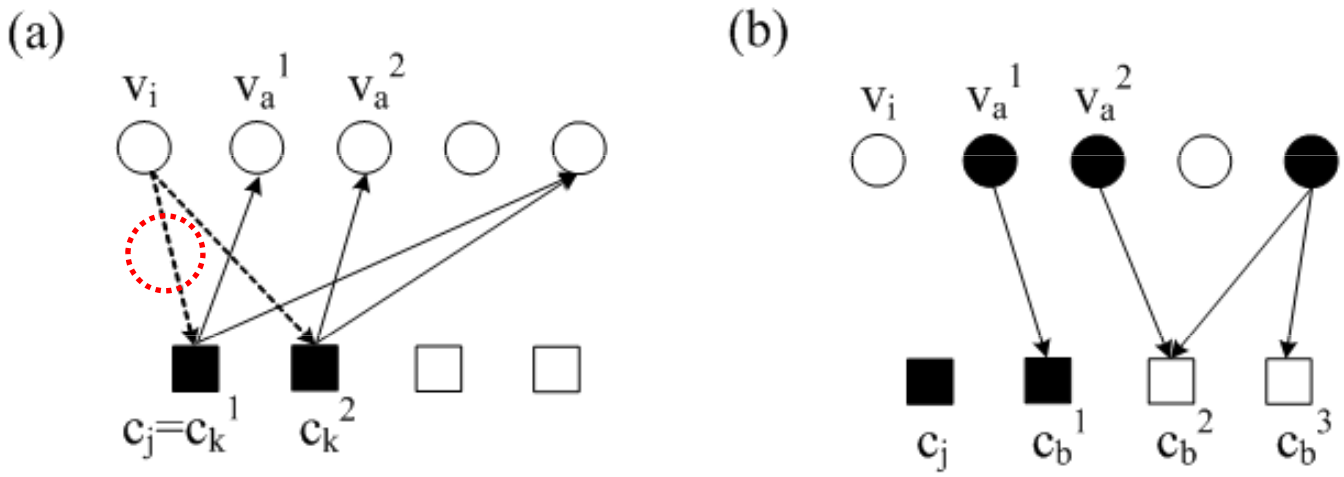
- The procedure of Node-wise RBP decoding for LDPC codes



[4] A. I. Vila Casado, M. Griot, and R. D. Wesel, "Informed Dynamic Scheduling for Belief-Propagation Decoding of LDPC Codes," *In Proc. IEEE ICC 2007*, Glasgow, Scotland, June, 2007.

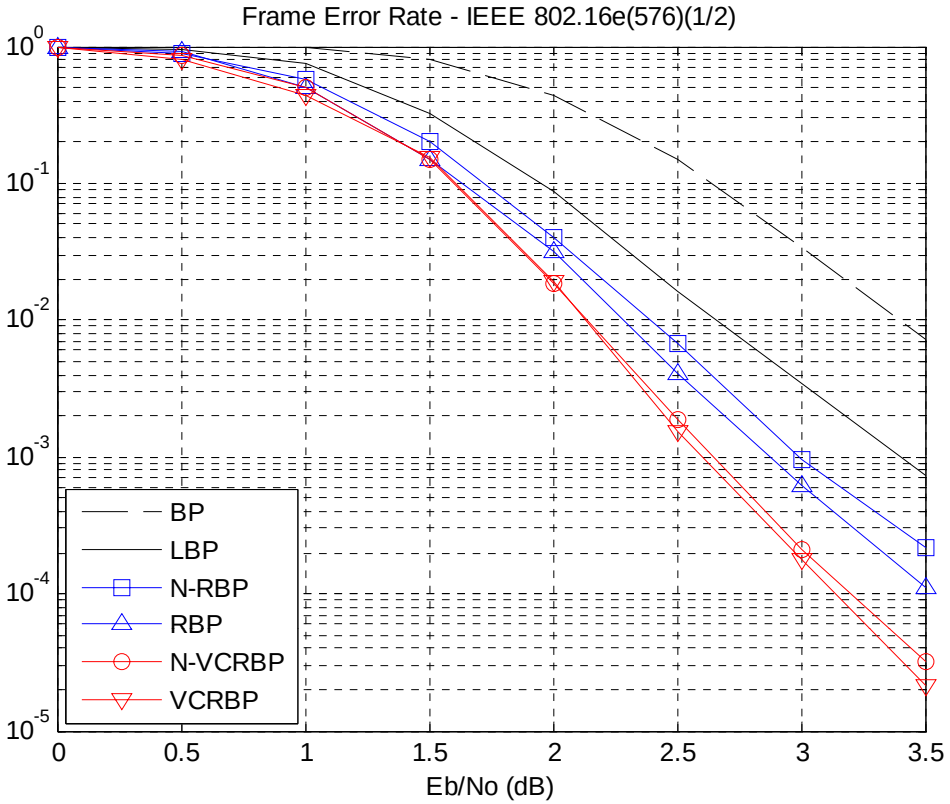
N-VCRBP FOR LDPC CODES (proposed)

- The procedure of Node-wise VCRBP decoding for LDPC codes



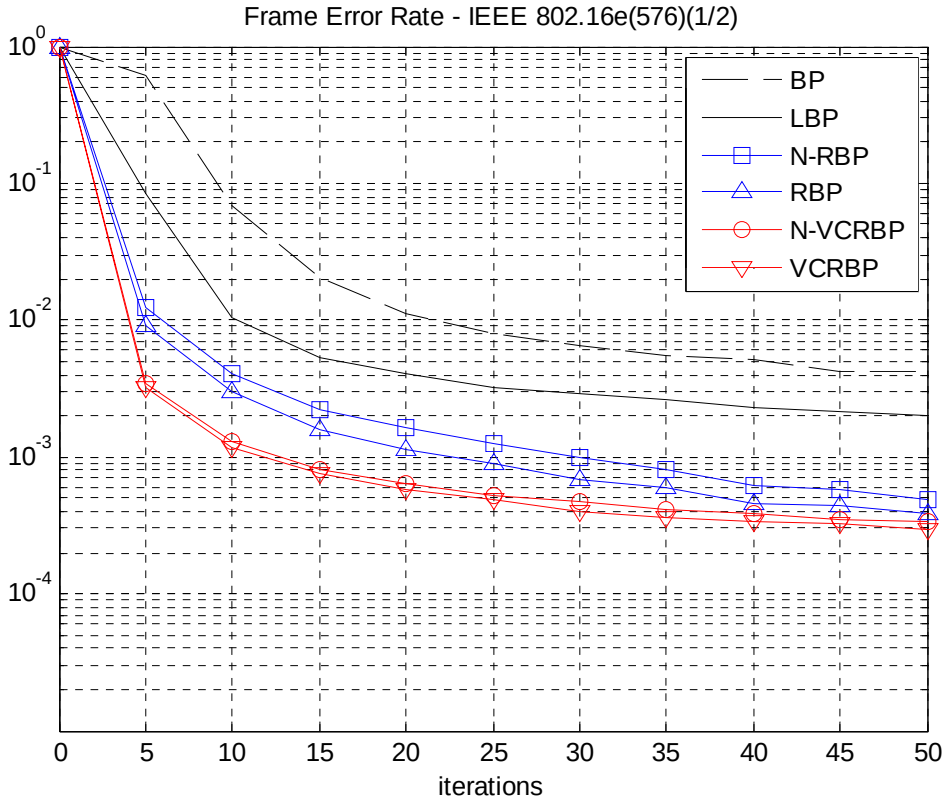
SIMULATION RESULTS

- FER performance with IEEE 802.16e block length-576, code rate-1/2, maximum 8 iterations



SIMULATION RESULTS

- FER performance with IEEE 802.16e block length-576, code rate-1/2, up to maximum 50 iterations at 2.5dB



CONCLUSION

(1) VC-RBP makes LDPC decoding converge very fast in terms of the number of iterations.

(2) It guarantees better performance with lower decoding complexity than RBP in only 8 iterations.

(3) It performs similarly better after sufficiently many iterations.

(4) N-VCRBP has very close performance to VCRBP with significantly lower decoding complexity.