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Performance analysis for a two-way relaying power line network with analog network coding

Key words: Power line communication, Outage probability, Symbol error rate, Signal attenuation

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Introduction

- Severe signal fading and impulsive impose many unsolved challenges on reliable communications over long-distance power lines.
- To resolve the problem, we study a two-way relaying PLC system, where two sources exchange information with the help of an intermediate relay implementing analogue network coding.
- We derive the outage probability, symbol error rate, and average capacity performance of the relaying PLC system.

The system mode of an in-home PLC network

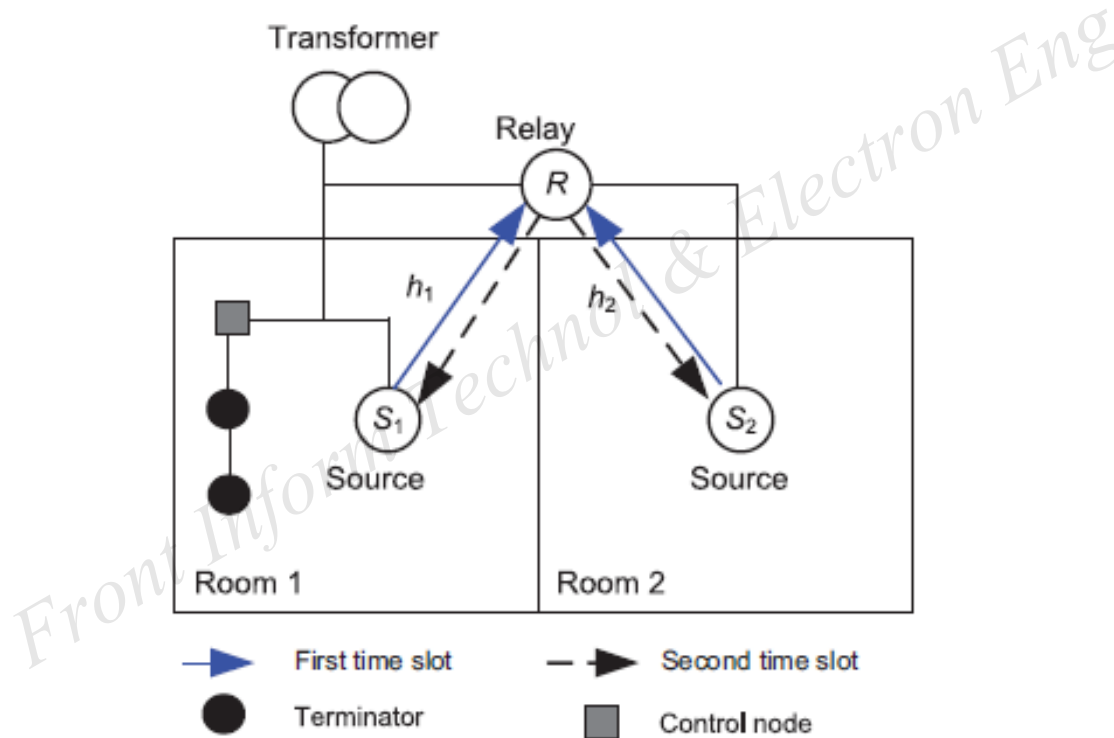


Fig. 1 In-home PLC amplify-and-forward relay system

Performance analysis

- Outage: $P(\gamma \leq \gamma_{\text{th}}) \cong 1/2 + \Psi_{\gamma_{\text{eq}}}(\gamma_{\text{th}})$

- SER:
$$P_{\text{SER}} \approx \frac{m}{2\pi} \frac{1}{2\sqrt{\pi}} \sum_{j=1}^l H_j \left(\frac{1}{2} + \sum_{i=1}^l H_i \right. \\ \left. \cdot \text{erf} \left(\frac{\ln q_j^2 \cdot \frac{bne^{2\sigma\sqrt{2}s_i+2\mu} + nc}{ne^{2\sigma\sqrt{2}s_i+2\mu} - aq_j^2} - 2\mu}{2\sqrt{2}\sigma} \right) \right)$$

- Average capacity:

$$\bar{C} = \sum_{i=1}^l \sum_{j=1}^l H_i H_j \log_2 \left(1 + \frac{p_S}{\sigma^2} \frac{e^{2\mu+2\sigma v_j} e^{2\sqrt{2}\sigma s_i+2\mu}}{be^{2\sqrt{2}\sigma s_i+2\mu} + c + ae^{2\mu+2\sigma v_j}} \right) \frac{e^{2\sqrt{2}\sigma s_i+2\mu} \left(1 - \frac{ae^{2\mu+2\sigma v_j}}{be^{2\sqrt{2}\sigma s_i+2\mu} + c + ae^{2\mu+2\sigma v_j}} \right)}{be^{2\sqrt{2}\sigma s_i+2\mu} + c} \\ \cdot \frac{2a\sigma e^{2\mu+2\sigma v_j} (be^{2\sqrt{2}\sigma s_i+2\mu} + c + ae^{2\mu+2\sigma v_j}) - 2\sigma e^{2\mu+2\sigma v_j}}{(bs_i + c + ae^{2\mu+2\sigma v_j})^2}.$$

Simulation results

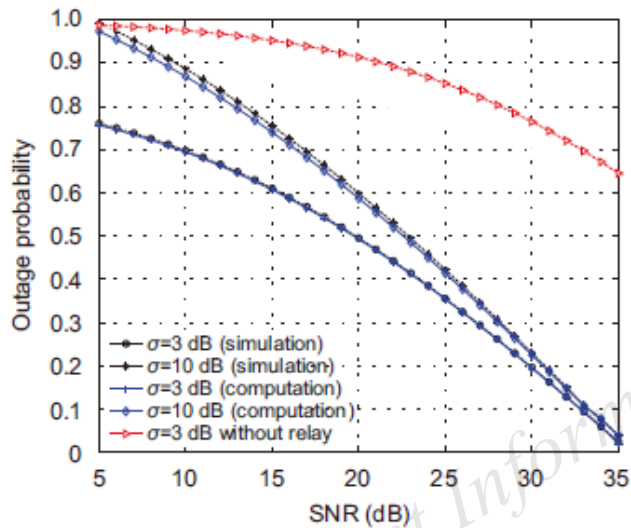


Fig. 2 Average outage probability against average received SNR with $\sigma=3$ dB and $\sigma=10$ dB

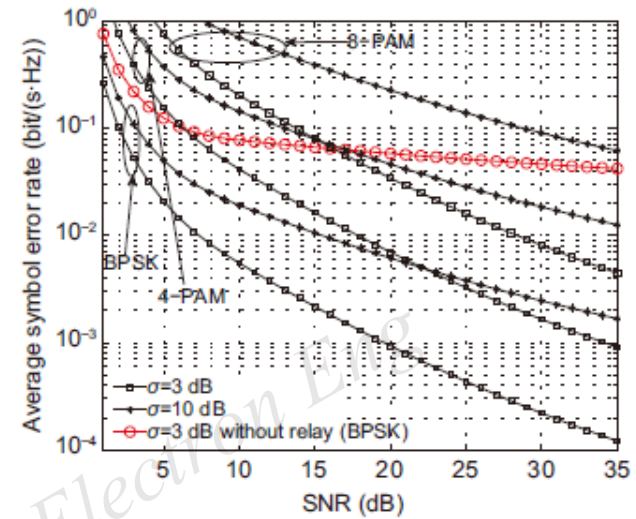


Fig. 3 Symbol error rate against average received SNR with $\sigma=3$ dB and $\sigma=10$ dB

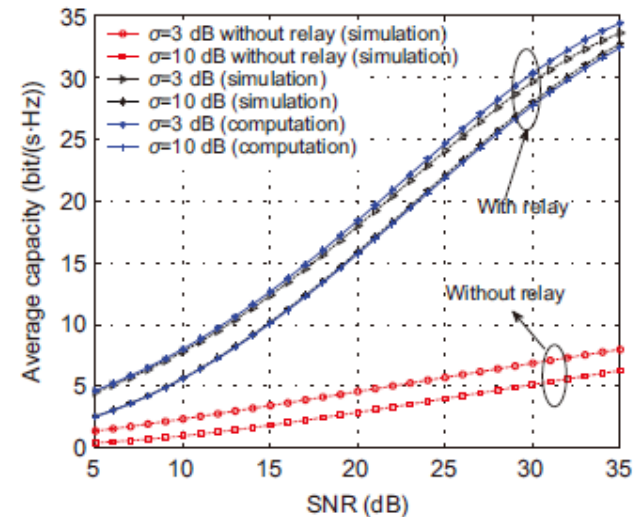


Fig. 4 Average system capacity against SNR with $\sigma=3$ dB and $\sigma=10$ dB

Conclusions

- In this paper, the performance of the relaying PLC system based on analog networking is presented.
- The formula of the PDF of received SNR is derived.
- We have also found that introducing a two-way relay can significantly improve the performance of a PLC system.