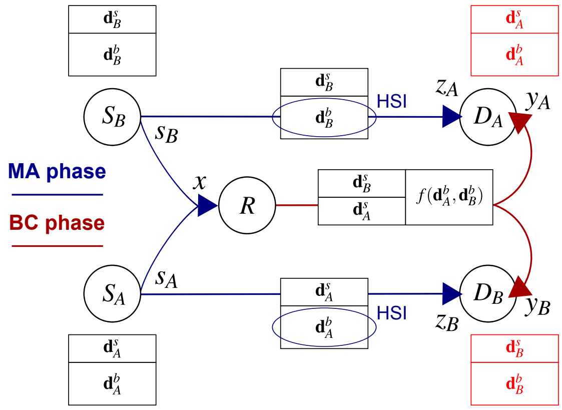


Figure 1: Symmetric WBN model with half-duplex constraint and 2-phase communication.

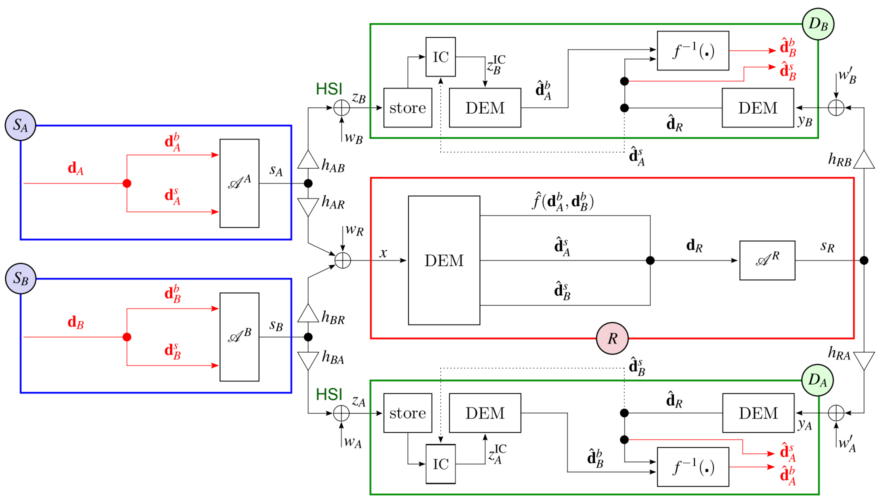


Figure 2: Relaying scheme for the uncoded WBN system. DEM stands for a hard decision demodulator, IC is the interference canceler.

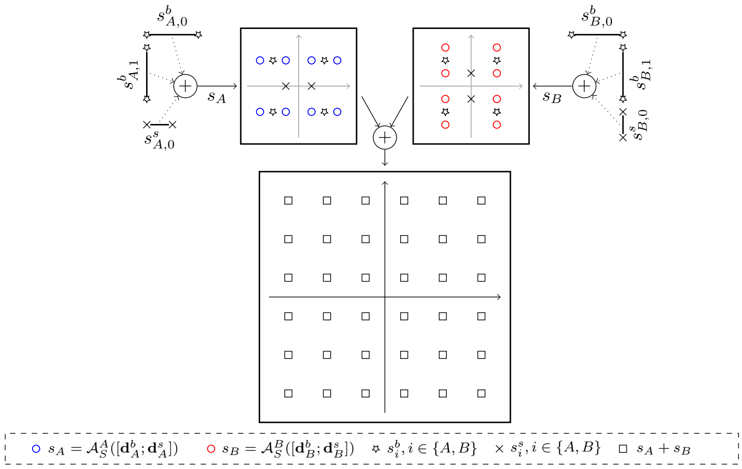


Figure 3: Source constellation design example for $N_b = 2$, $N_s = 1$. Resulting constellations are depicted as blue circles (S_A output constellation), red circles (S_B output constellation) and squares (received superimposed constellation at R). Hierarchical function is $f\left(\mathbf{d}_A^b, \mathbf{d}_B^b\right) = \mathbf{d}_A^b \oplus \mathbf{d}_B^b$.

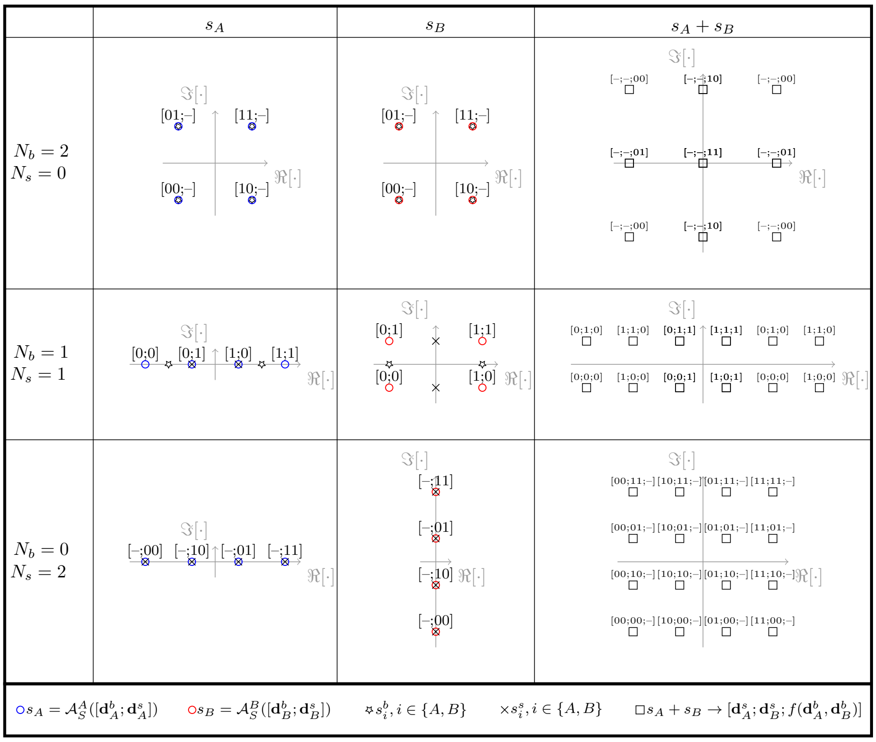


Figure 4: Proposed constellation design for $(N_b, N_s) = \{(2,0);(1,1);(0,2)\}$.

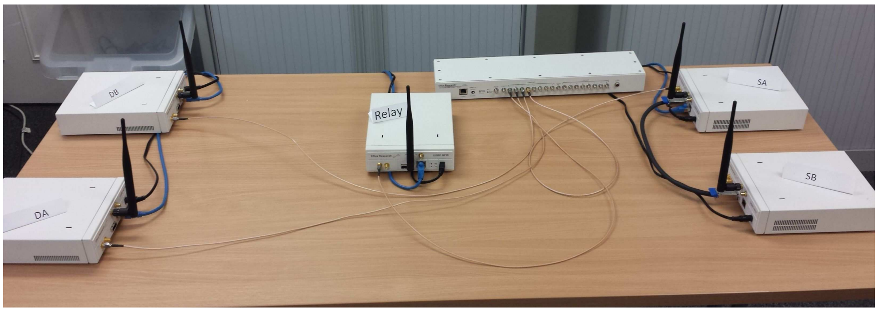


Figure 5: Setup for HW evaluation (Ettus Research USRPs). Source transmissions are prerotated [?, ?, ?] to imitate the AWGN channel conditions (as used in the numerical evaluation). To allow a strict control of HSI channels SNR in the HW setup, the HSI channels are emulated by adding a Gaussian noise to the respective source signal and the resulting emulated HSI is passed to destinations via UDP. This also avoids the problem of node visibility where direct links $S_A \to D_A$ and $S_B \to D_B$ exist in the laboratory environment.

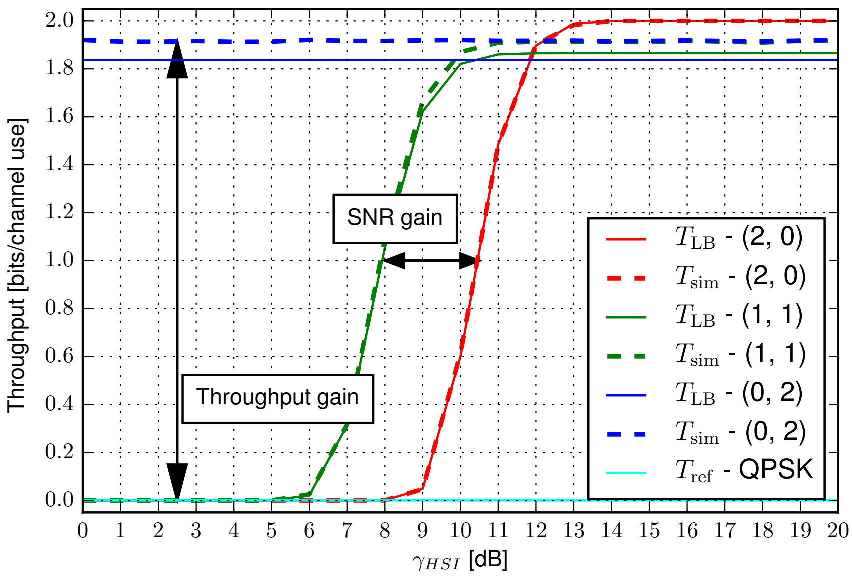


Figure 6: Comparison of throughput as a function of γ_{HSI} for $\gamma_{\mathrm{MAC}} = 16\,\mathrm{dB}$, $\gamma_{\mathrm{BC}} = 20\,\mathrm{dB}$ and given (N_b, N_s).

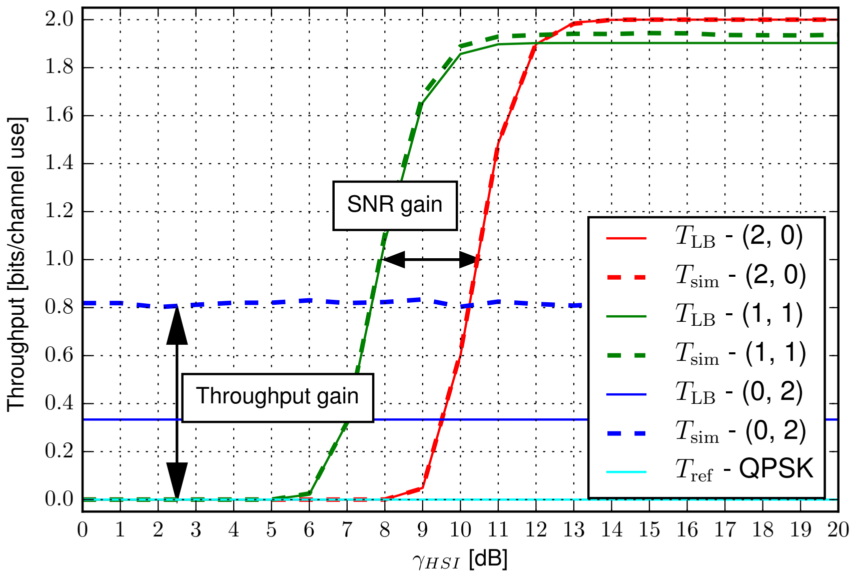


Figure 7: Comparison of throughput as a function of γ_{HSI} for $\gamma_{\mathrm{MAC}} = 17\,\mathrm{dB}$, $\gamma_{\mathrm{BC}} = 17\,\mathrm{dB}$ and given (N_b, N_s).

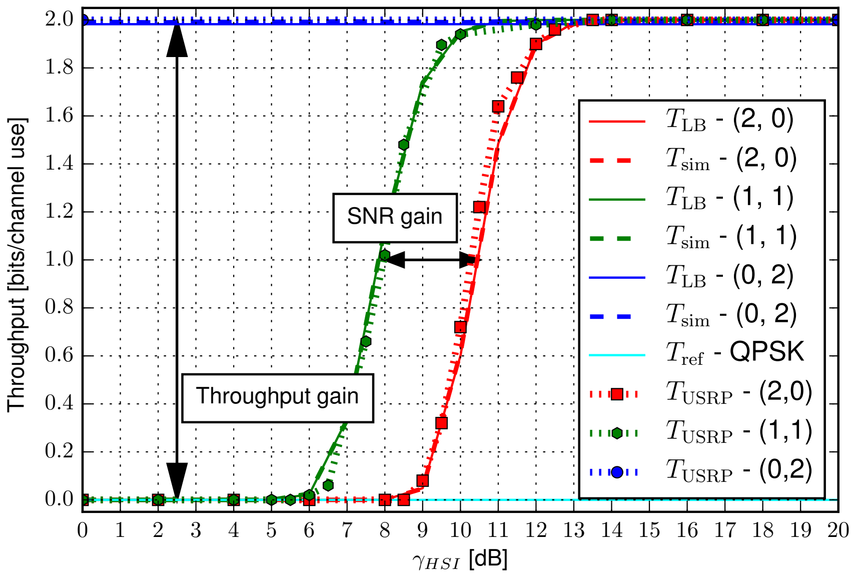


Figure 8: Comparison of throughput as a function of γ_{HSI} for $\gamma_{\mathrm{MAC}} = 20\,\mathrm{dB}$, $\gamma_{\mathrm{BC}} = 20\,\mathrm{dB}$ and given (N_b, N_s).

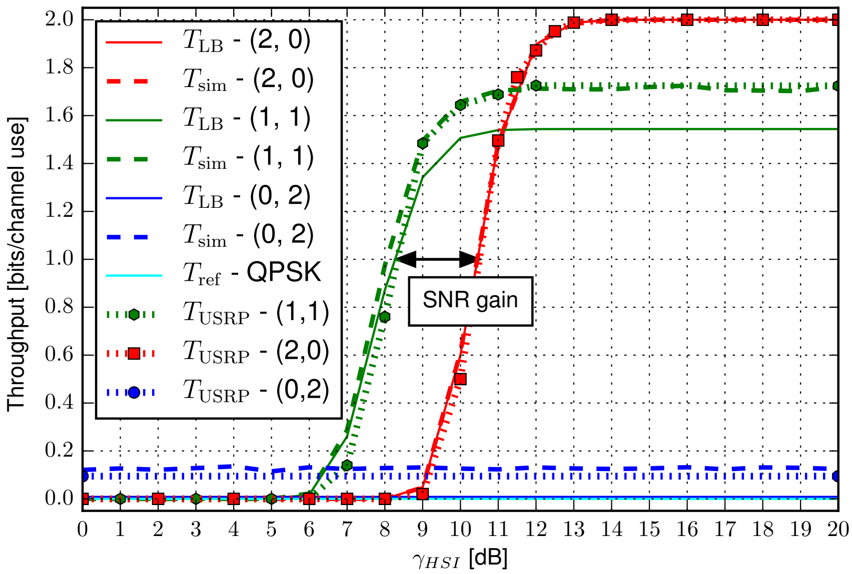


Figure 9: Comparison of throughput as a function of γ_{HSI} for $\gamma_{\mathrm{MAC}} = 20\,\mathrm{dB}$, $\gamma_{\mathrm{BC}} = 16\,\mathrm{dB}$ and given (N_b, N_s).

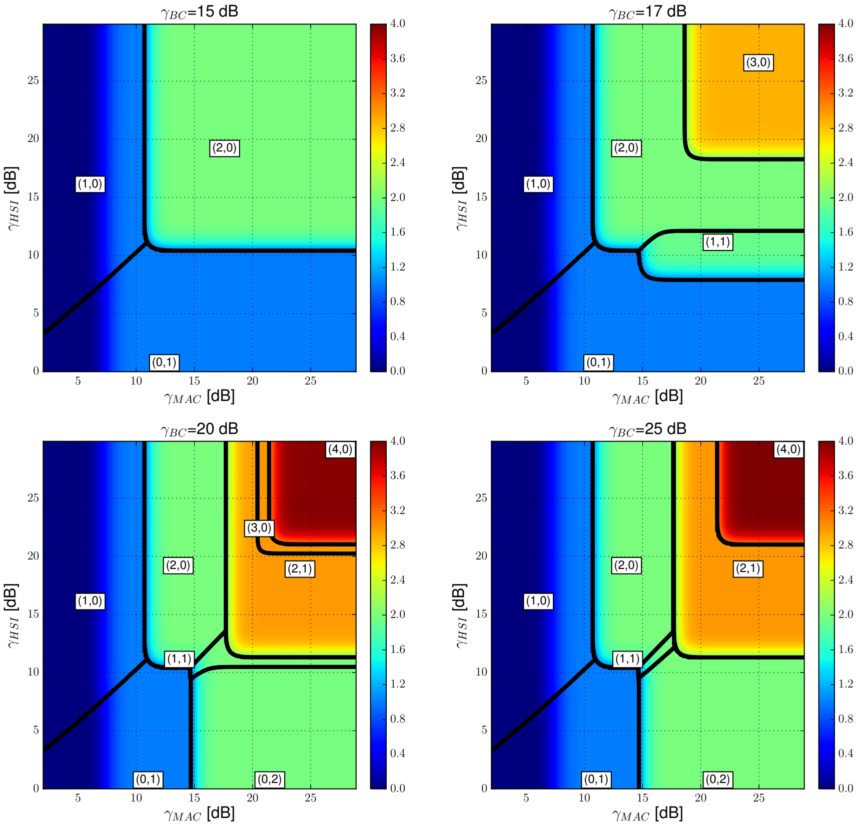


Figure 10: Throughput performance T_{LB} and SNR mapping regions (including the optimal const. parameters $(N_b^{\mathrm{I}}, N_s^{\mathrm{I}})$) for $\gamma_{\mathrm{BC}} \in \{15\,\mathrm{dB}, 17\,\mathrm{dB}, 20\,\mathrm{dB}, 25\,\mathrm{dB}\}$.

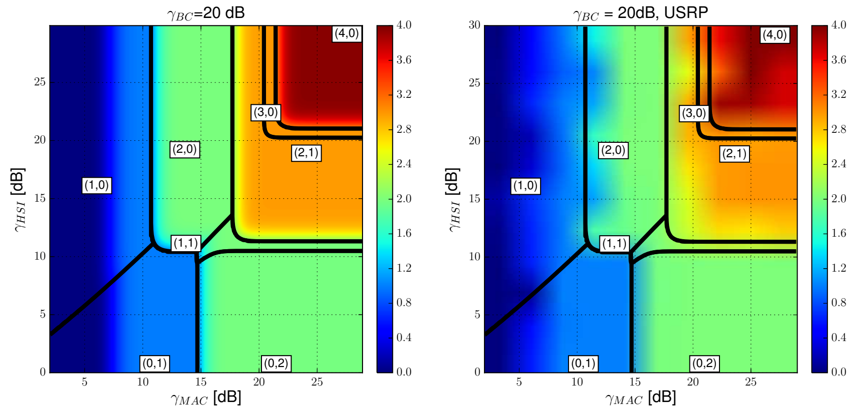


Figure 11: Comparison of T_{LB} and the throughput performance evaluated in a real world adaptive HW setup (T_{USRP}) for $\gamma_{\text{BC}} = 20\,\text{dB}$. The SNR mapping regions (including the optimal const. parameters $(N_b^{\text{I}}, N_s^{\text{I}})$) used in the HW evaluation are also emphasized in the figure.

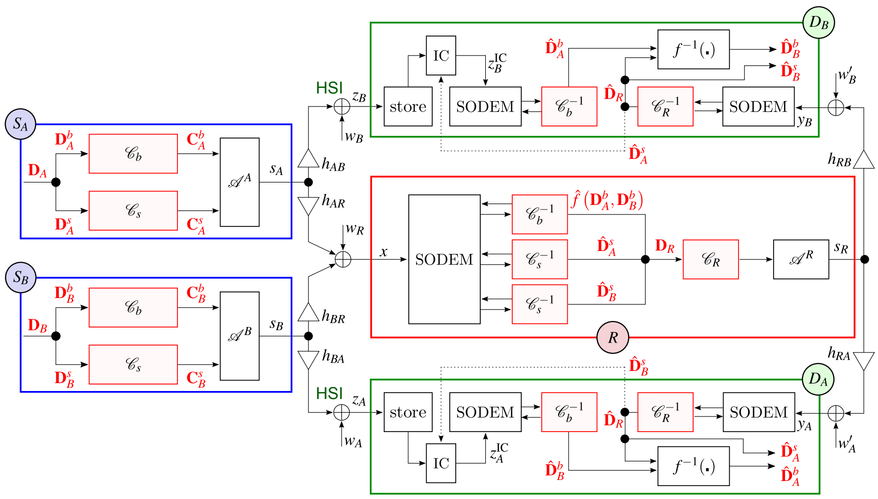
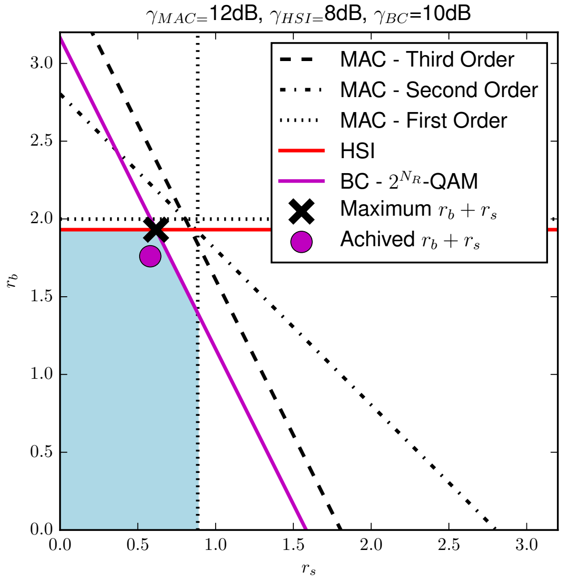


Figure 12: Relaying scheme in the encoded WBN system. SODEM stands for a soft-output demodulator, IC is the interference canceler. The channel encoders/decoders which are appended to the uncoded system are emphasized.



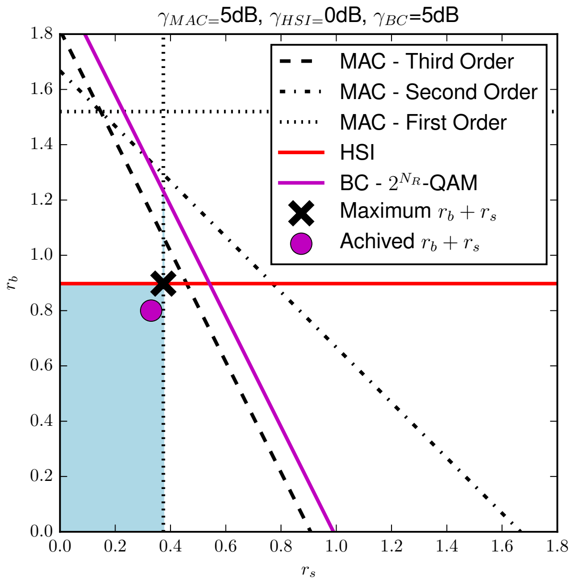


Figure 13: Numerically evaluated cut-set bounds (mutual information for finite input constellations) for $(N_b = 2, N_s = 1)$ source constellations and 16-QAM at the relay. The particular SNR conditions are available in the titles of both sub-figures.

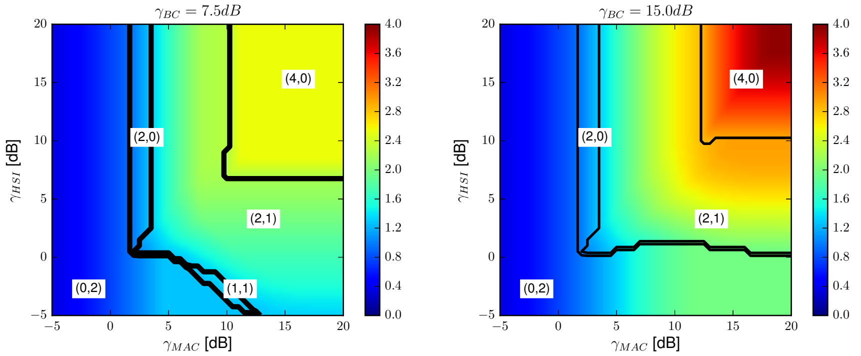


Figure 14: Maximal encoded system throughput $T_C^{\max}$ for $\gamma_{\mathrm{BC}} = 7.5\,\mathrm{dB}$ and $\gamma_{\mathrm{BC}} = 15\,\mathrm{dB}$.

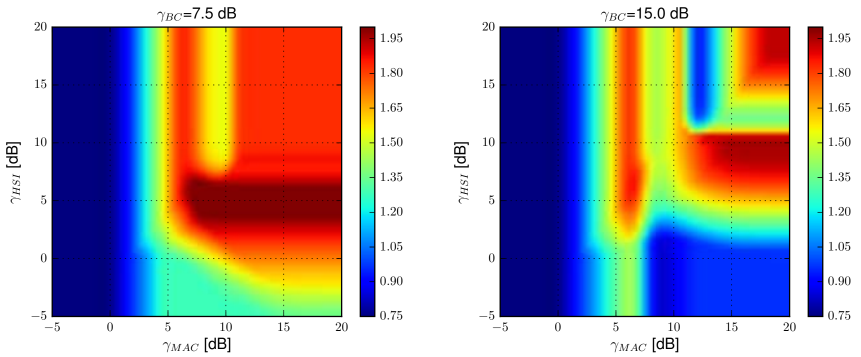


Figure 15: Throughput enhancement $\Delta T_C = T_C^{\max} - T_{\mathrm{LB}}$ [bits/channel use] of the coded over uncoded WBN system for $\gamma_{\mathrm{BC}} = 7.5\,\mathrm{dB}$ and $\gamma_{\mathrm{BC}} = 15\,\mathrm{dB}$. Note that $0.75 \leq \Delta T_C \leq 2$ in the analyzed range of channel SNRs.

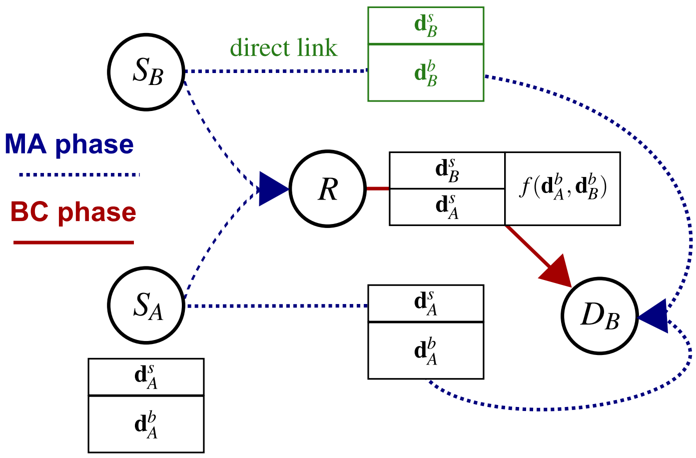
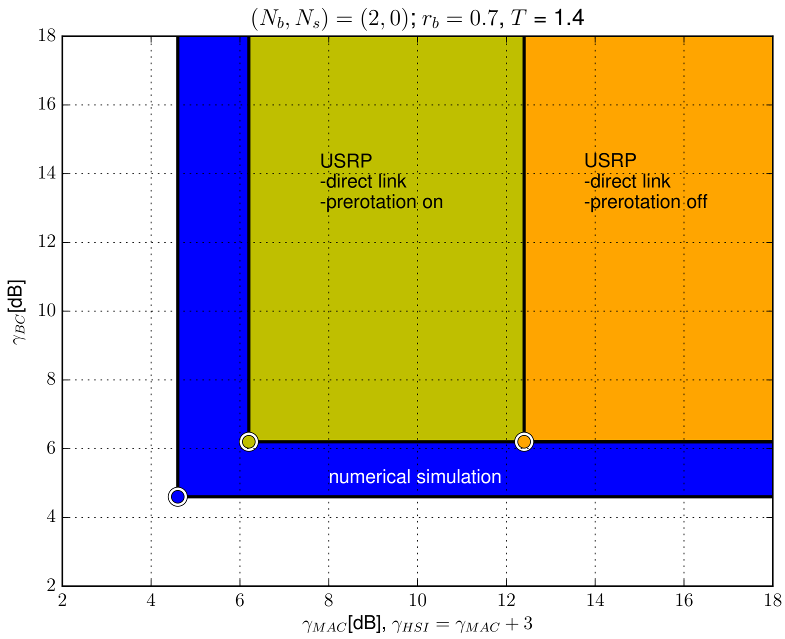


Figure 16: Direct channel at destination D_B in the robustness analysis (likewise, a direct channel is assumed to be present also at D_A).



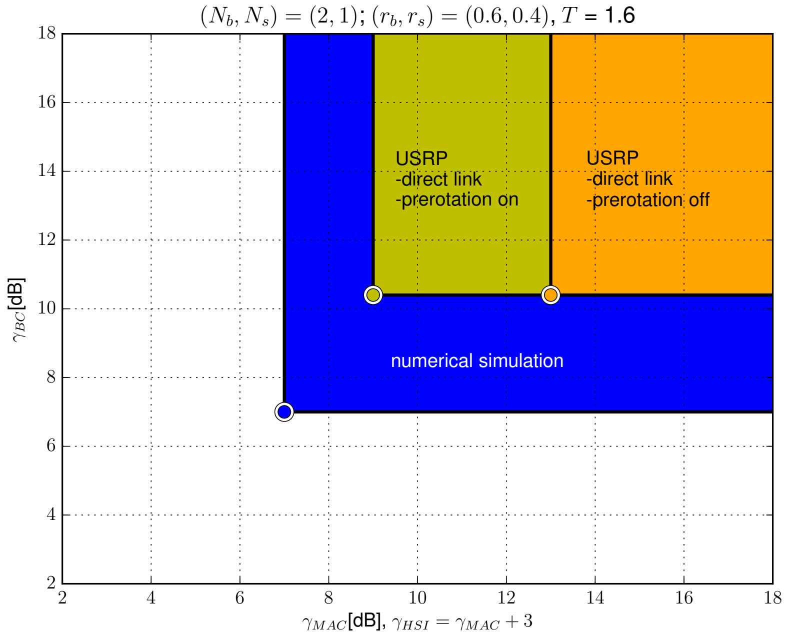


Figure 17: Robustness analysis for two fixed (N_b, N_s, r_b, r_s) scenarios.

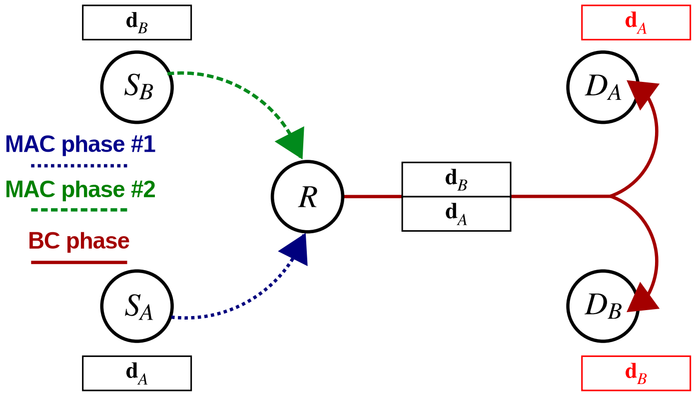


Figure 18: Three-step reference scenario with conventional network coding.

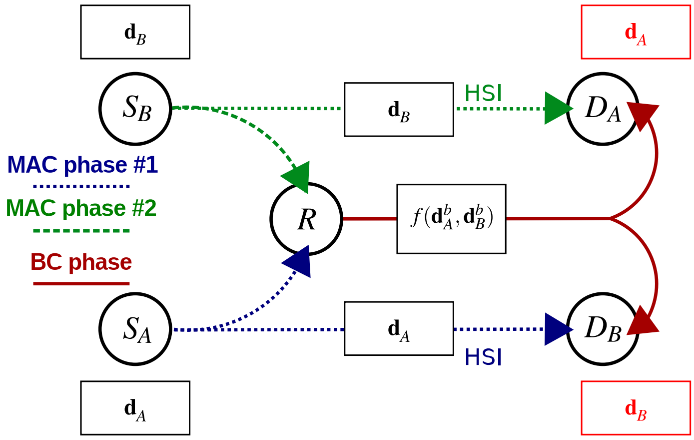


Figure 19: Three-step reference scenario with conventional routing.

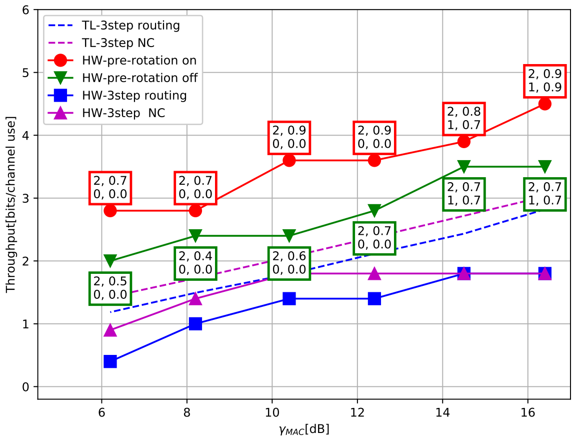


Figure 20: Performance comparison for the setup $\gamma_{\mathrm{BC}} \approx \gamma_{\mathrm{MAC}}$ and $\gamma_{\mathrm{HSI}} \approx \gamma_{\mathrm{MAC}}$+3dB. The numbers in boxes correspond with particular values (first row:(N_b, r_b), second row:(N_s, r_s)) achieving a given maximal throughput.

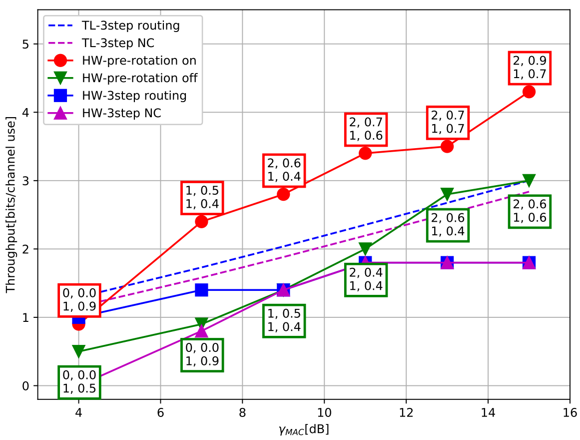


Figure 21: Performance comparison for the setup $\gamma_{\mathrm{BC}} \approx \gamma_{\mathrm{MAC}}$+5dB and $\gamma_{\mathrm{HSI}} \approx \gamma_{\mathrm{MAC}}$-1dB. The numbers in boxes correspond with particular values (first row:(N_b, r_b), second row:(N_s, r_s)) achieving a given maximal throughput.