Two-way Relaying with Multiple-Antenna Relay Stations

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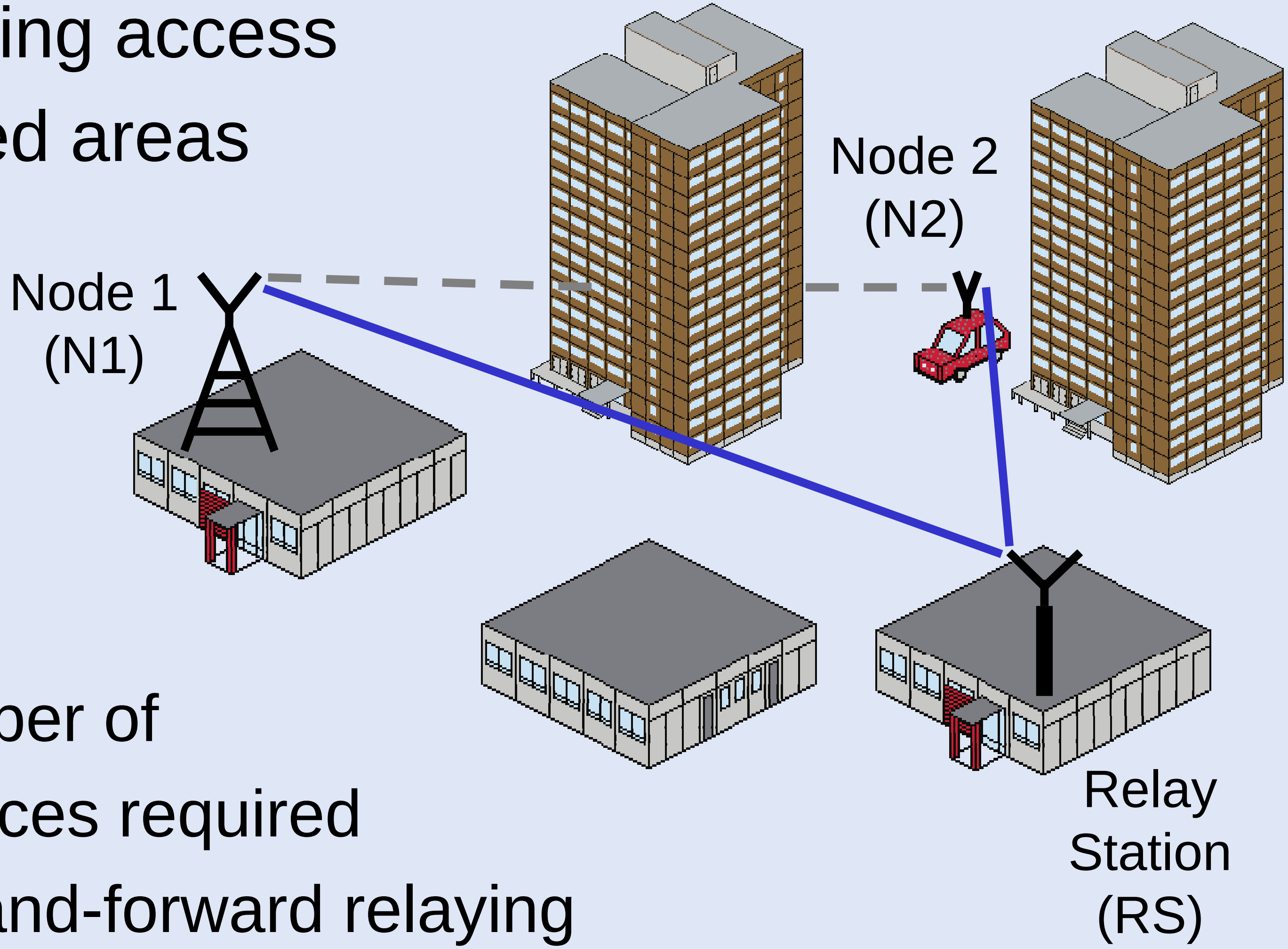
Relay Networks

One-way Relaying:

e.g., providing access to shadowed areas

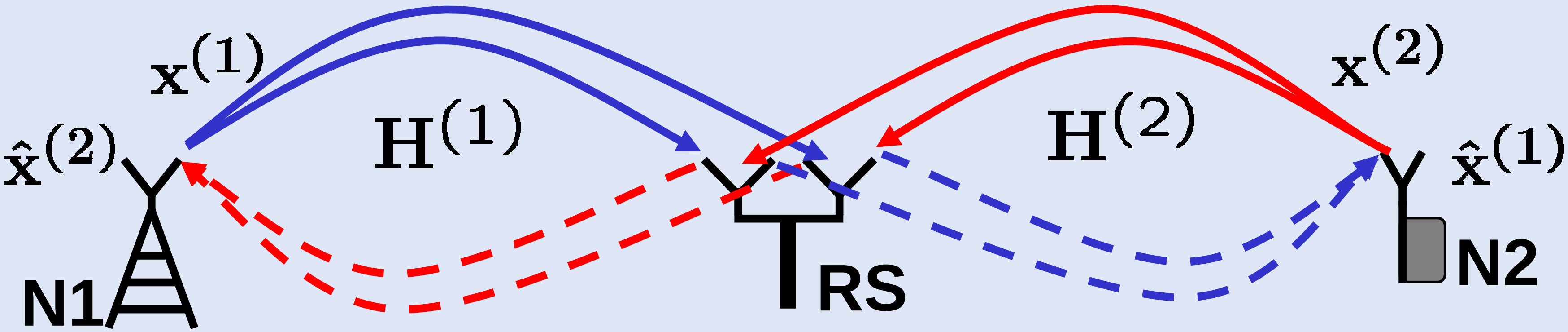


2 hops →

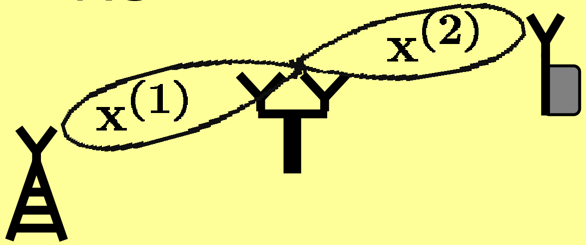
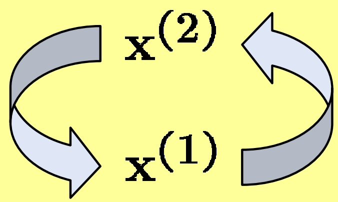
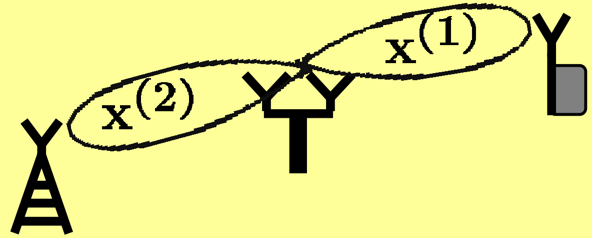
double number of radio resources required for amplify-and-forward relaying

MIMO Two-way Relaying

- number of antennas at N1 and N2: $M^{(1)} = M^{(2)} = M$
- number of antennas at RS: $M_{\text{RS}} \geq 2M$



CSI available at RS → design of a transceive filter

Receive processing	Mapping matrix G_{Π}	Transmit processing
G_R "separates" signals $x^{(1)}$ and $x^{(2)}$ at the RS	N1 shall be provided with $x^{(2)}$ and N2 shall be provided with $x^{(1)}$	G_T "transmits" $x^{(2)}$ in the direction of N1 and $x^{(1)}$ in the direction of N2
		

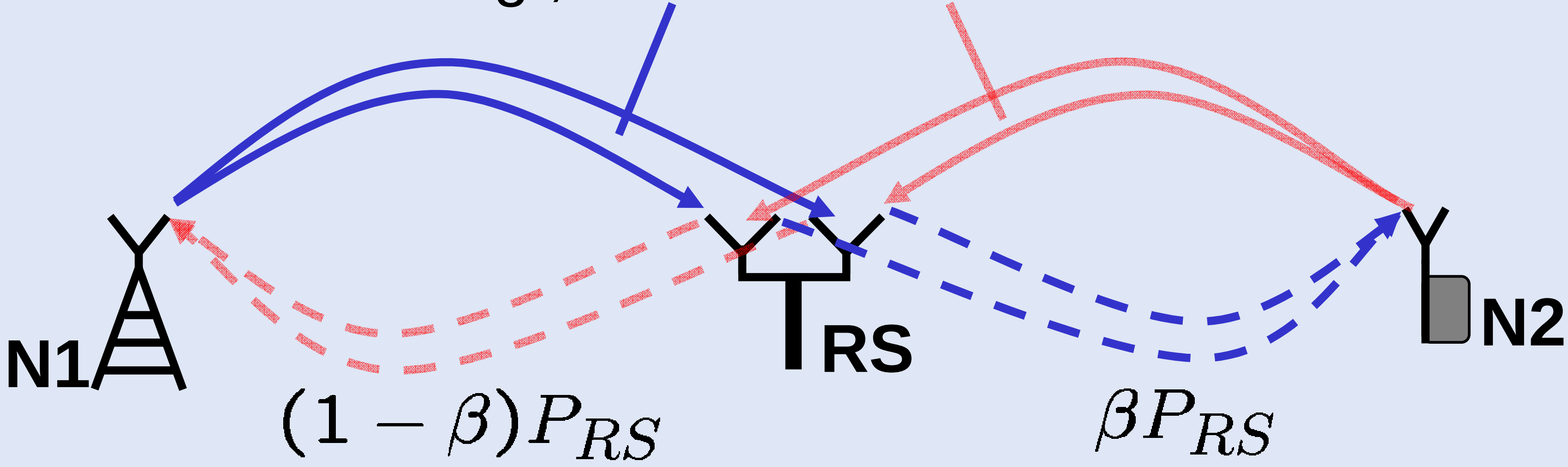
CSI in MIMO Two-way Relaying

- CSI is only required at the RS
- no CSI feedback channel required since the RS can estimate channels $\boldsymbol{H}^{(1)}$ and $\boldsymbol{H}^{(2)}$ in case of TDD
- reduced effort if RS uses same channel coefficients for transmit and receive filter matrix (e.g. ZF, MMSE)

Optimizing Network Sum Rate

Different $SNR^{(1)}$ and $SNR^{(2)}$ on the first hops,

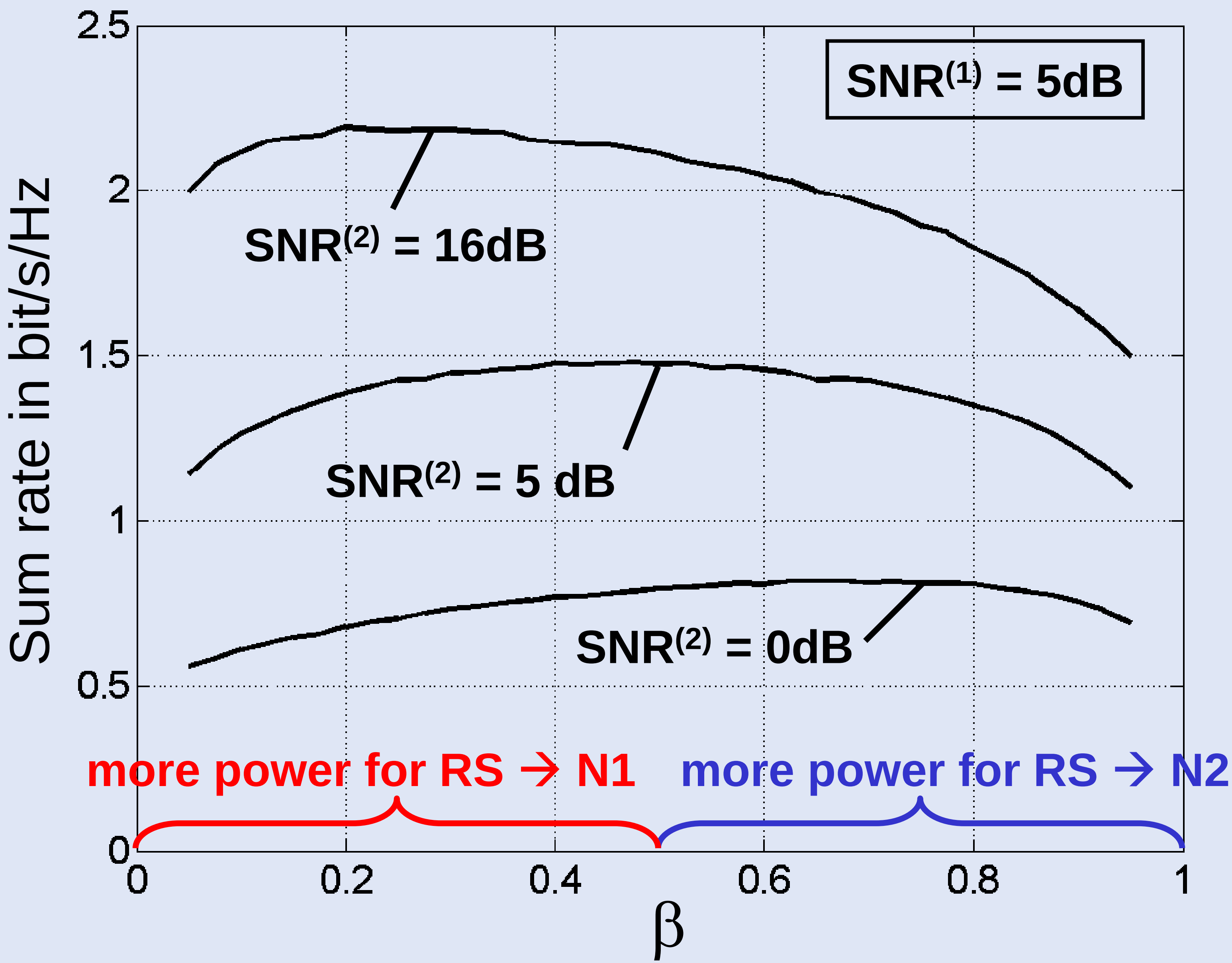
e.g., $SNR^{(1)} >> SNR^{(2)}$



$$0 \leq \beta \leq 1$$

→ at the RS, put more transmit power into the data stream which is dedicated to N2 than in the data stream which is dedicated to N1

Sum Rate depending on β

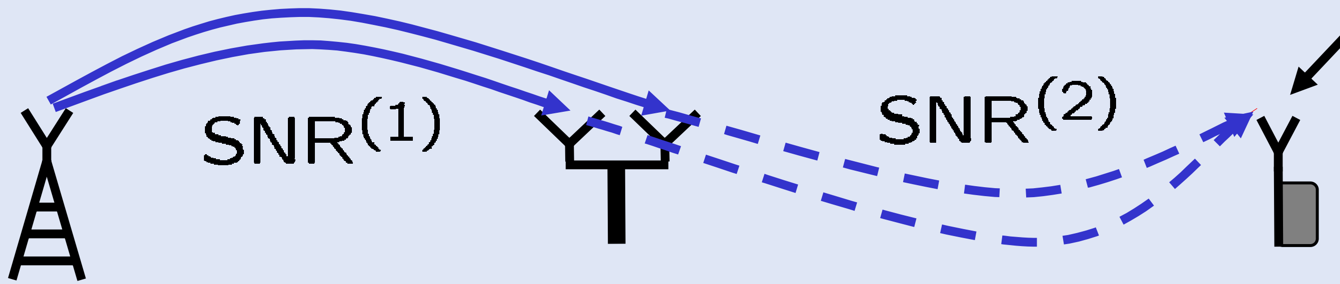


Optimization Problem

$$\beta_{opt} = \arg\max_{\beta} \left\{ C^{(1\to 2)} + C^{(2\to 1)} \right\}$$

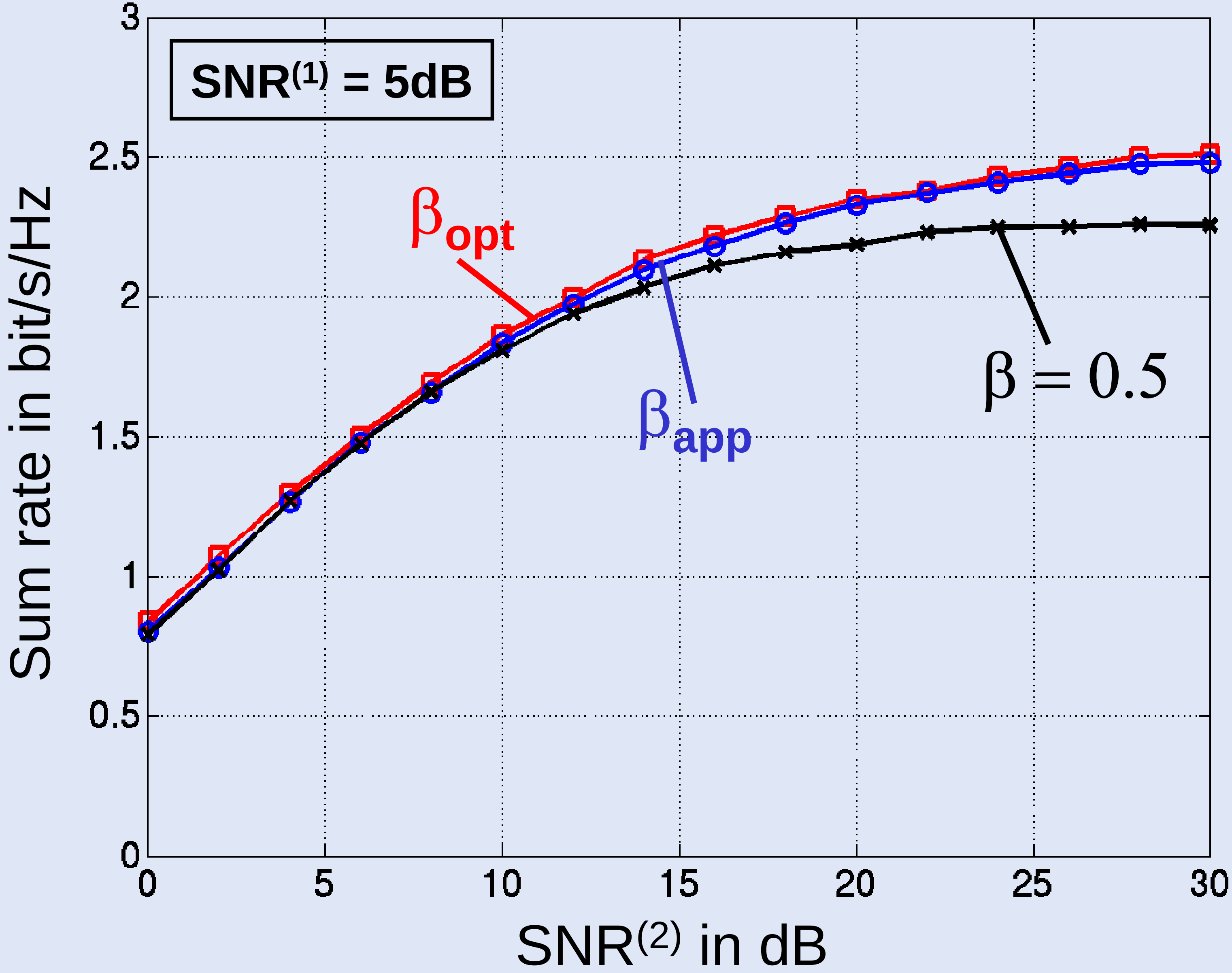
subject to: $0 \leq \beta \leq 1$ → **Numeric optimization**

Approximation: $\tilde{C}^{(1\to 2)} = \frac{1}{2}\log_2\left(1 + \mathrm{SNR}_{\mathrm{ov}}^{(1\to 2)}\right)$



$$\beta_{app} = \frac{\mathrm{SNR}^{(1)} + 1 - \sqrt{(\mathrm{SNR}^{(1)}+1)(\mathrm{SNR}^{(2)}+1)}}{\mathrm{SNR}^{(1)} - \mathrm{SNR}^{(2)}}$$

Sum Rate for Approximation



Conclusion & Outlook

- MIMO two-way relaying avoids loss of factor 2 for the network sum rate compared to one-way relaying
- Network sum rate may be increased by non-uniform power distribution at the RS for different SNRs

- Reduction of CSI signaling effort in the network
- Radio resource allocation in multiple-access AF / DF relay networks
- Asymmetric traffic