Two-Way Relaying with Multiple Antennas using Covariance Feedback

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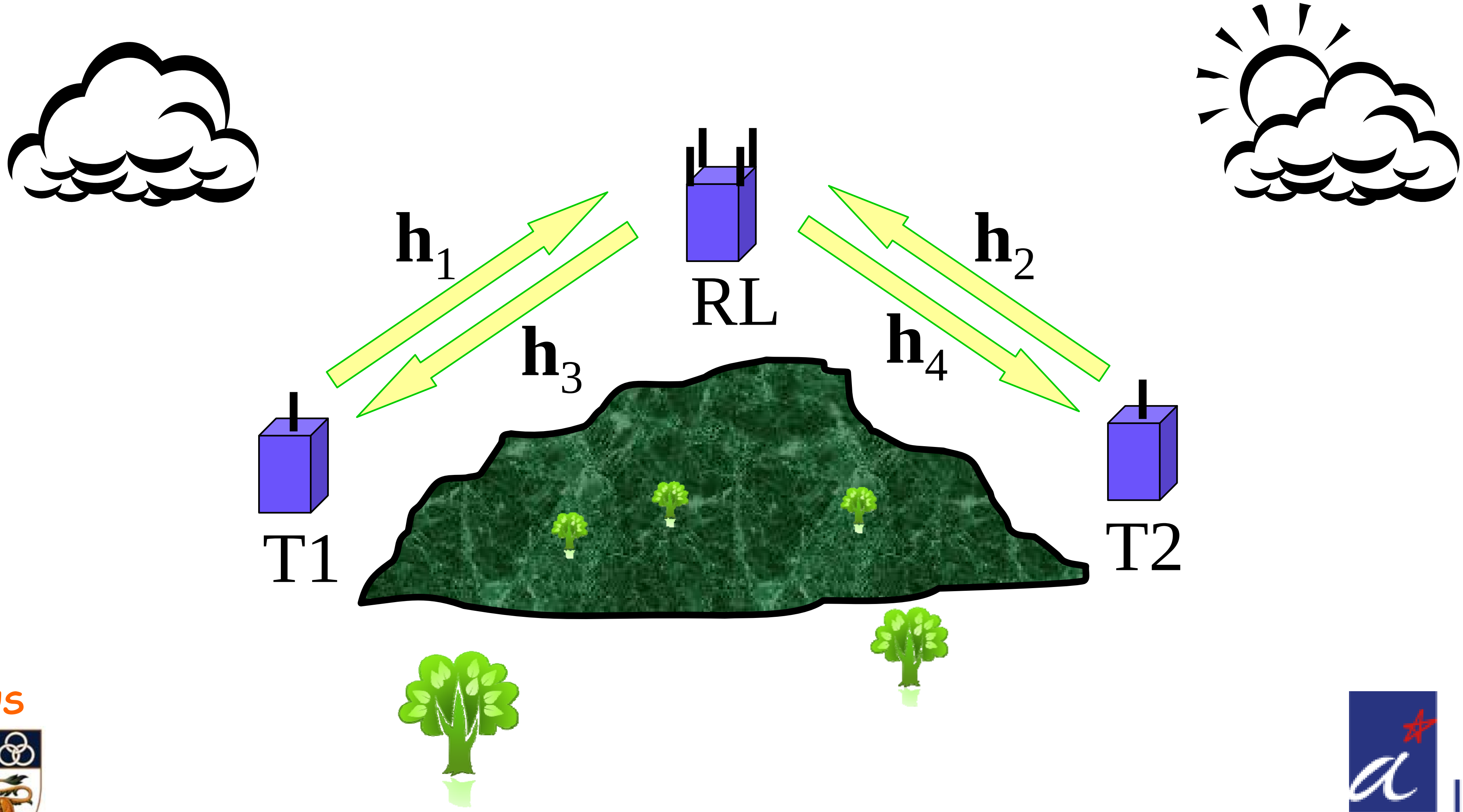
VTC 2008 Fall, Calgary

Introduction

- Physical-layer Network Coding (PNC)



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Sum Rate Maximization given Instantaneous CSI

$$\underset{\mathbf{A}}{\text{maximize}} \quad r(\mathbf{A}) = 0.5(r_1(\mathbf{A}) + r_2(\mathbf{A}))$$

$$\text{subject to} \quad \gamma_3 \leq \bar{\gamma}_3$$

- [5] Y.-C. Liang and R. Zhang, “Optimal Analogue Relaying with Multi-Antennas for Physical Layer Network Coding,” *Proc. Int. Conf. Commun.*, pp. 3893-3897, May. 2008.

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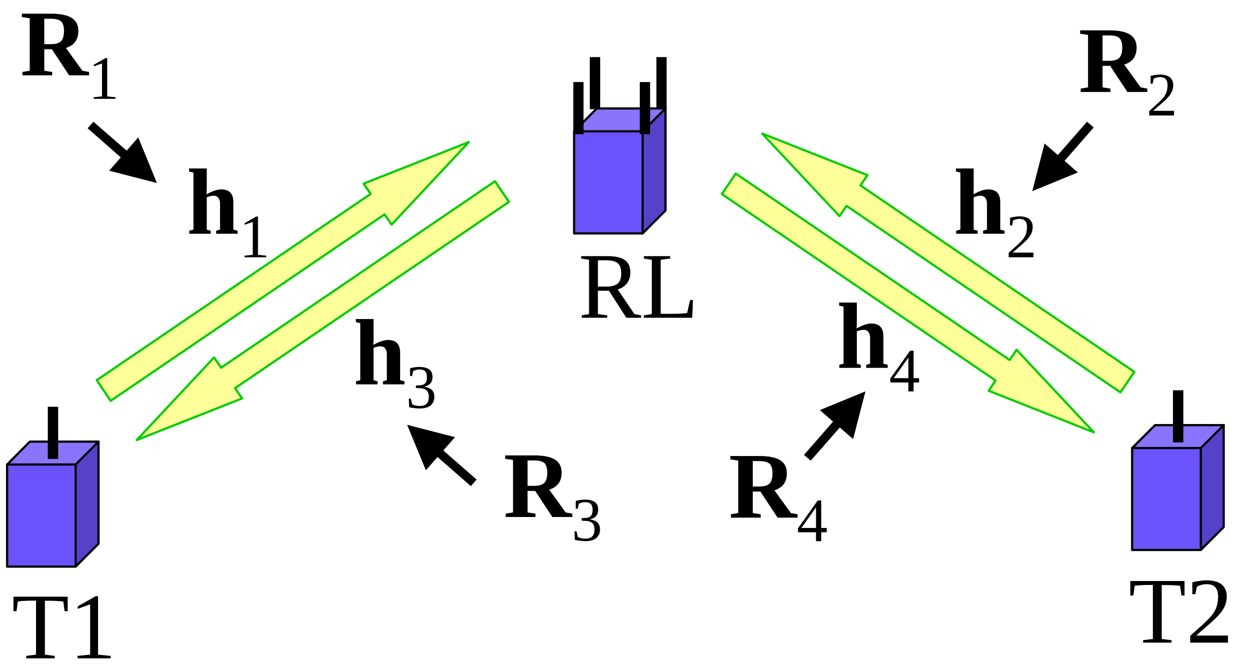
Sum Rate Maximization given Covariance CSI (1)



Sum Rate Maximization given Covariance CSI (2)

$$\begin{aligned} &\underset{\mathbf{A}}{\text{maximize}} \quad E[r(\mathbf{A})] = E\left[0.5(r_1(\mathbf{A}) + r_2(\mathbf{A}))\right] \\ &\text{subject to} \quad E[\gamma_3] \leq \overline{p}_3 \end{aligned}$$

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Sum Rate Maximization given Covariance CSI (3)

- Sample Average Approximation (SAA)
  - Overestimate (“SAA1”)
  - Underestimate (“SAA2”)
  - Optimality gap

- [15] A. J. Kleywegt, A. Shapiro, and T. Homem-de-Mello, “The sample average approximation method for stochastic discrete optimization,” *SIAM Journal on Optimization*, vol. 12, no. 2, pp. 479--502, 2002.

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Low-complexity Solutions based on Covariance CSI (1)

- Method 1:
  - Instantaneous Equivalent Rate Maximization (IER-Max)
- Principle eigenvectors

$$\underset{\mathbf{G}}{\text{maximize}} \quad \tilde{r}(\mathbf{G}) = 0.5(\tilde{r}_1(\mathbf{G}) + \tilde{r}_2(\mathbf{G}))$$

$$\text{subject to} \quad \tilde{\gamma}_3 \leq \bar{p}_3$$

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Low-complexity Solutions based on Covariance CSI (2)

- Method 2:
  - MRR-MRT
- Principle eigenvectors:

$$\mathbf{F}_A = [\mathbf{u}_1, \mathbf{u}_2] \in C^{M\times 2}$$

$$\mathbf{F}_B = [\mathbf{u}_4^T; \mathbf{u}_3^T] \in C^{2\times M}$$

$$\mathbf{A} = \alpha \mathbf{F}_B^H \mathbf{F}_A^H$$

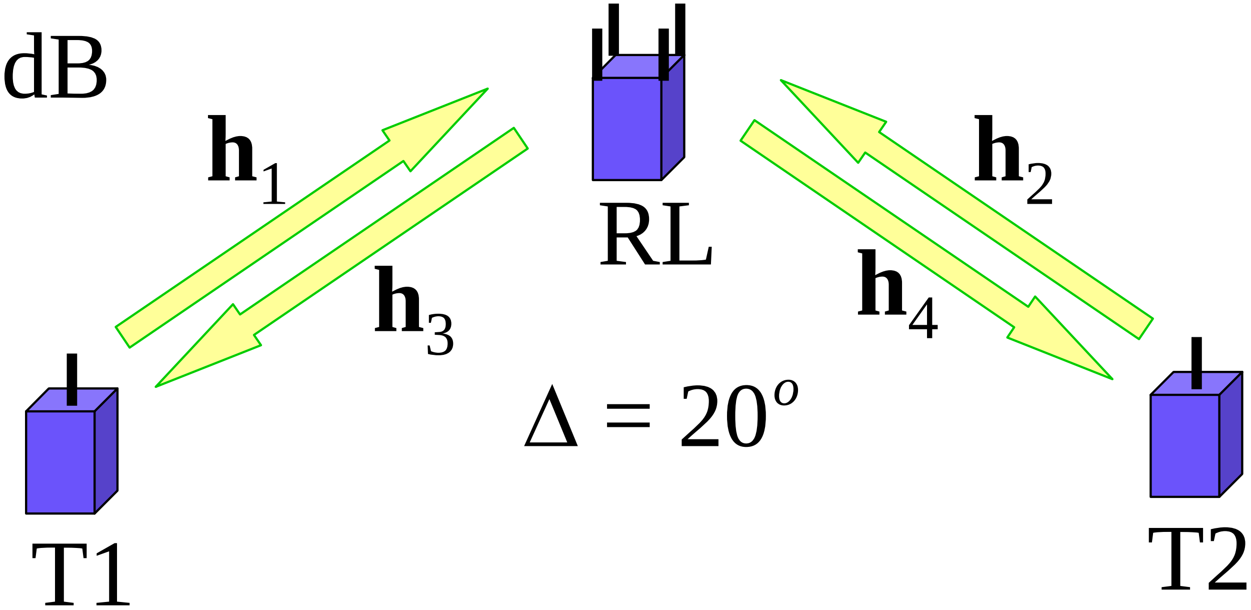
Simulations

$$f_A = f_1 = f_2 = 1.8\,\text{GHz}$$

$M = 4$ antennas

SNR=10 dB

$N = 5000$



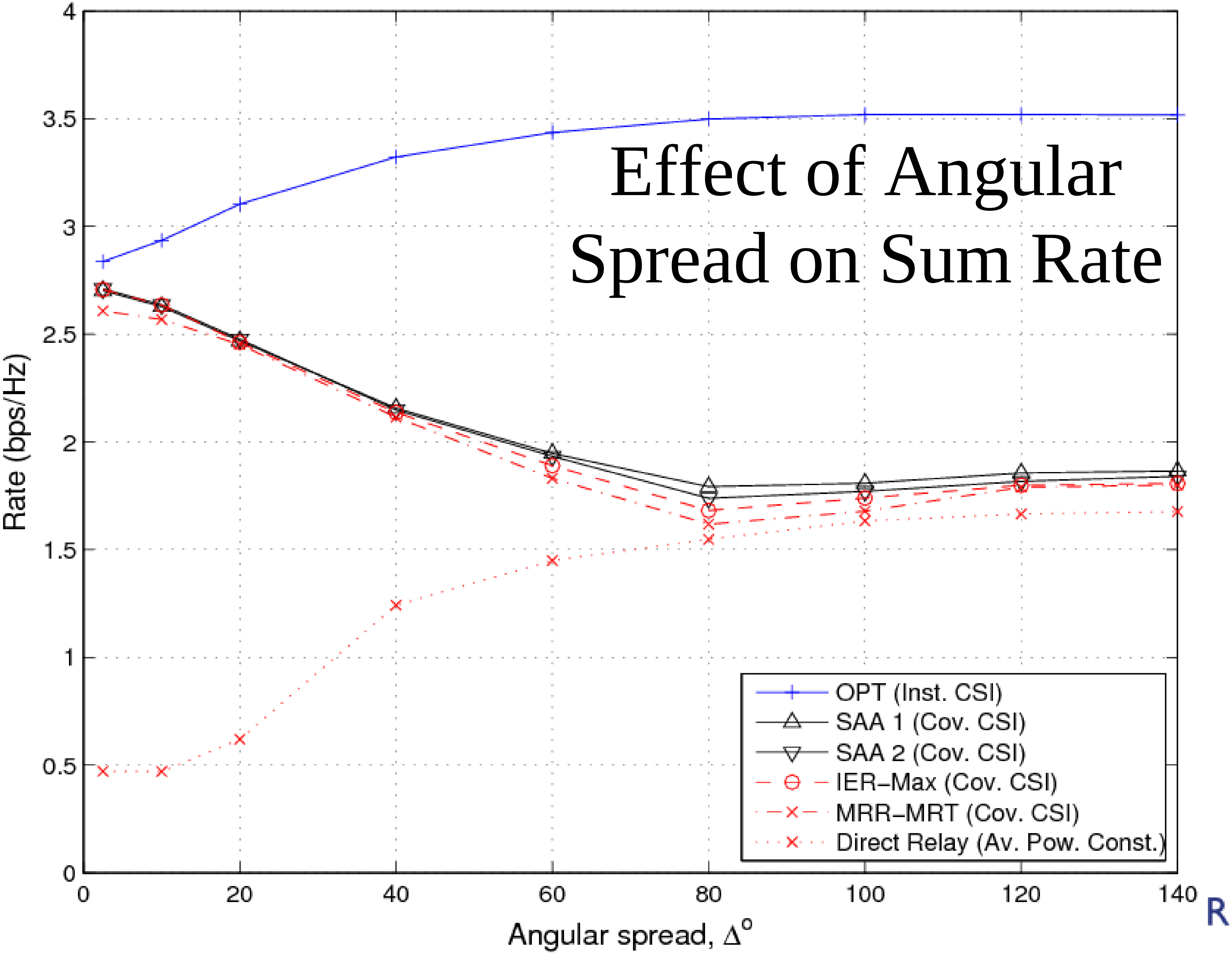
$\Delta = 20^o$

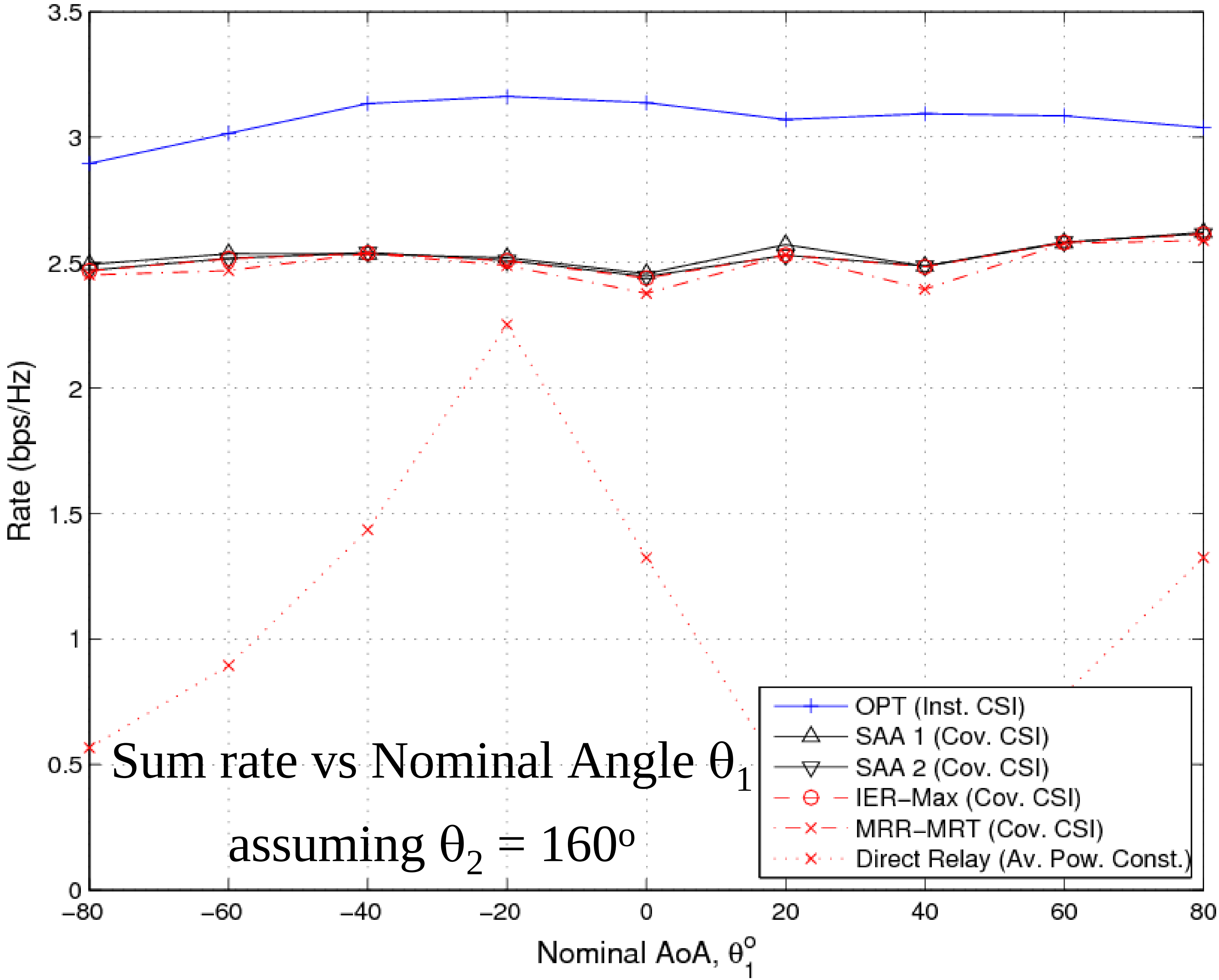
$\bar{\theta}_1 = 10^o$

$\bar{\theta}_2 = 160^o$

$$f_B = f_3 = f_4 = 2.6\,\text{GHz}$$

Effect of Angular Spread on Sum Rate





Sum rate vs Nominal Angle θ_1

assuming $\theta_2 = 160^o$

Conclusion

- Two-way relaying
- Physical layer network coding
- Multiple antennas
- Sum rate maximization
- Covariance feedback
- Efficient near-optimal methods
- Angular spread, nominal angles

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