Decentralized Base Station Processing for Multiuser MIMO Downlink CoMP

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Outline

- MIMO Downlink CoMP
- Joint vs Decentralized Precoding
- Problem Statement
- System Model
- Projected Channel DPC
- Simulations
- Conclusion

MIMO Downlink CoMP

- Coordinated multi-point transmission/reception (CoMP) is also known as network MIMO and multicell MIMO.
- Base stations cooperate to increase the throughput.
- We discuss the CoMP downlink.

Joint vs Decentralized Precoding

- Joint
  - Multiple base stations act as a large virtual base station and transmit data to the users.
  - Optimal schemes are known.
- Decentralized
  - Each base station is the processor that carries out its localized task.
  - Only the data destined for the inside-cell users need to be available at the base station.

Joint vs Decentralized Precoding

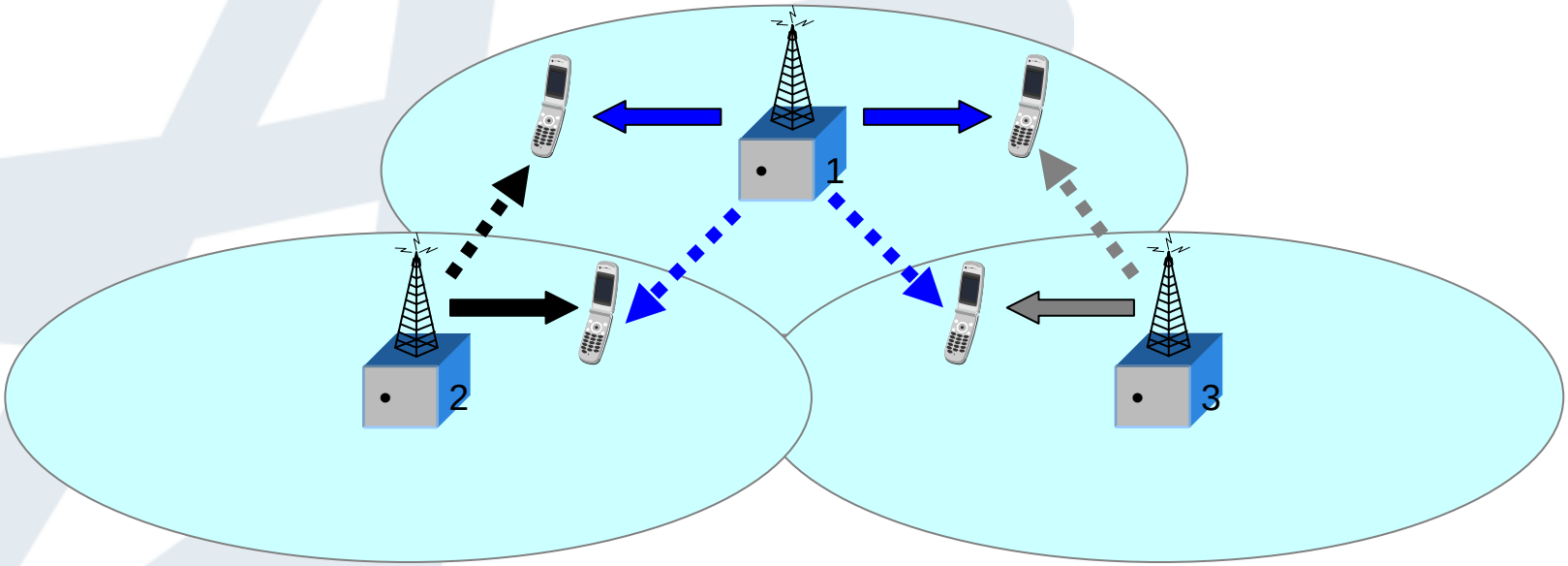
- Joint
  - The processor requires the combined downlink CSI from all base stations.
  - Co-channel interference helps transmission.
- Decentralized
  - Each base station only requires the downlink CSI from itself.
  - Co-channel interference negatively affects transmission.

Problem Statement

- To find a distributed precoder that reduces the burden on the backhaul for CSI and data exchange.
- To handle multiple inside-cell and outside-cell users with one or more antennas.
- To eliminate the effect of inter-cell interference and provide high data rate for the users.

System Model

- $\mathbf{H}$ denotes channel to inside-cell users.
- $\overline{\mathbf{H}}$ denotes channel to outside-cell users.



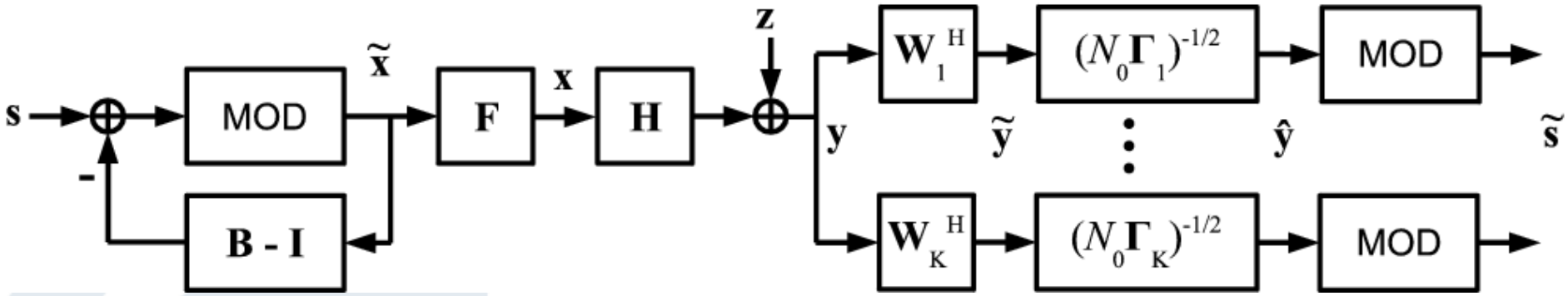
Projected Channel DPC

- The base station projects its signal away from outside-cell users.
  - Evaluate the SVD of the outside-cell channel $\overline{\mathbf{H}} = \overline{\mathbf{U}\boldsymbol{\Sigma}\mathbf{V}}^{H}$
  - Taking the dominant eigenvectors $\overline{\mathbf{V}}_1$
  - Derive the projected channel $\mathbf{H}_{\perp} = \mathbf{H}\left(\mathbf{I} - \overline{\mathbf{V}}_1\overline{\mathbf{V}}_1^{H}\right)$
- Dirty paper coding (DPC) is applied for the inside-cell users.

Projected Channel DPC

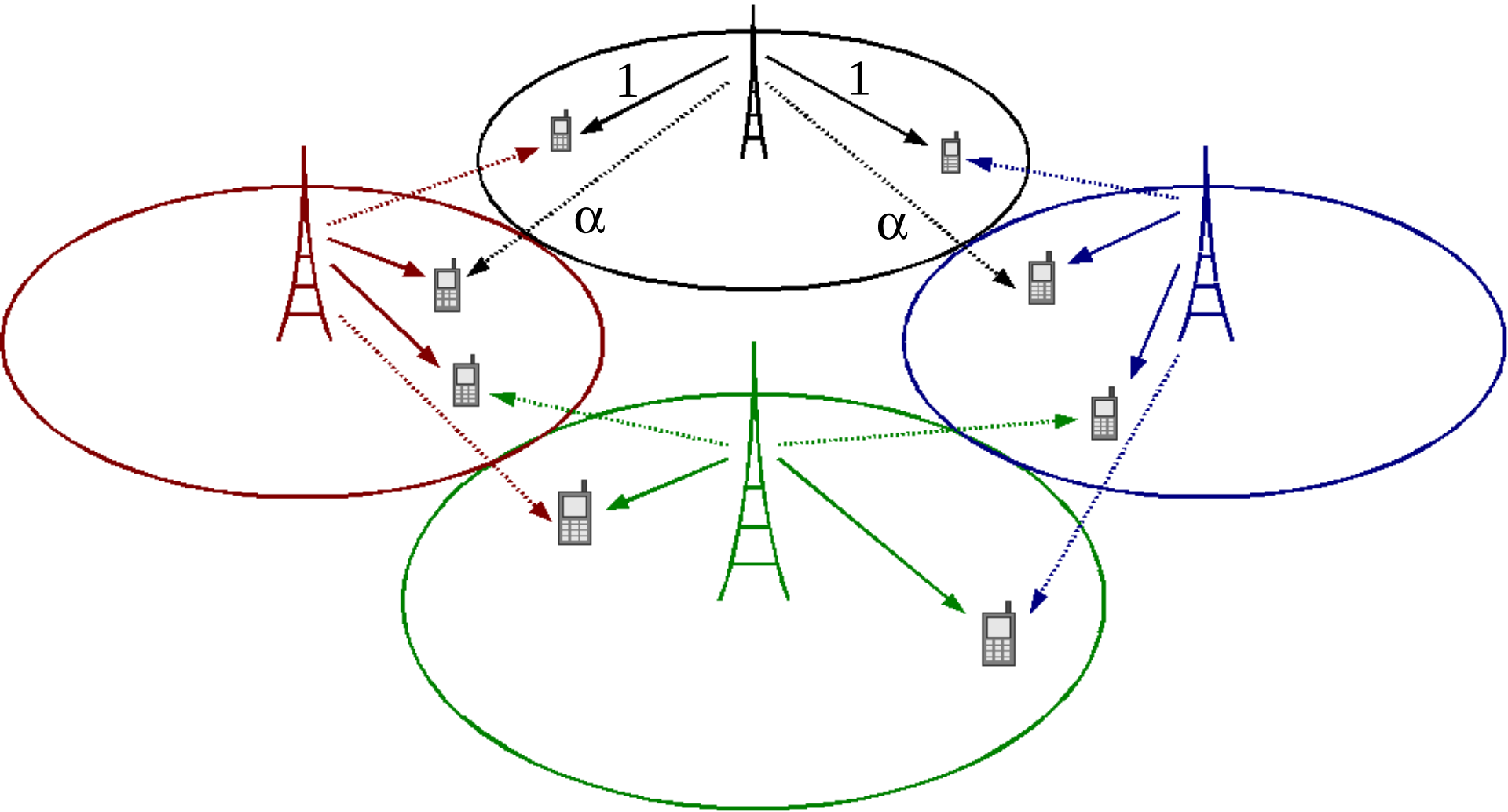
- Block diagonal DPC processing
  - e.g. block diagonal geometric mean decomposition (BD-GMD) is applied.

$$\mathbf{P}^{H}\mathbf{H}_{\perp}\mathbf{Q} = \mathbf{L} \qquad \mathbf{H}_{\perp}\mathbf{Q} = \mathbf{H}\mathbf{Q}$$



Simulations

- Figure 2: Circular Wyner Model with M=4 cells and K users per cell.



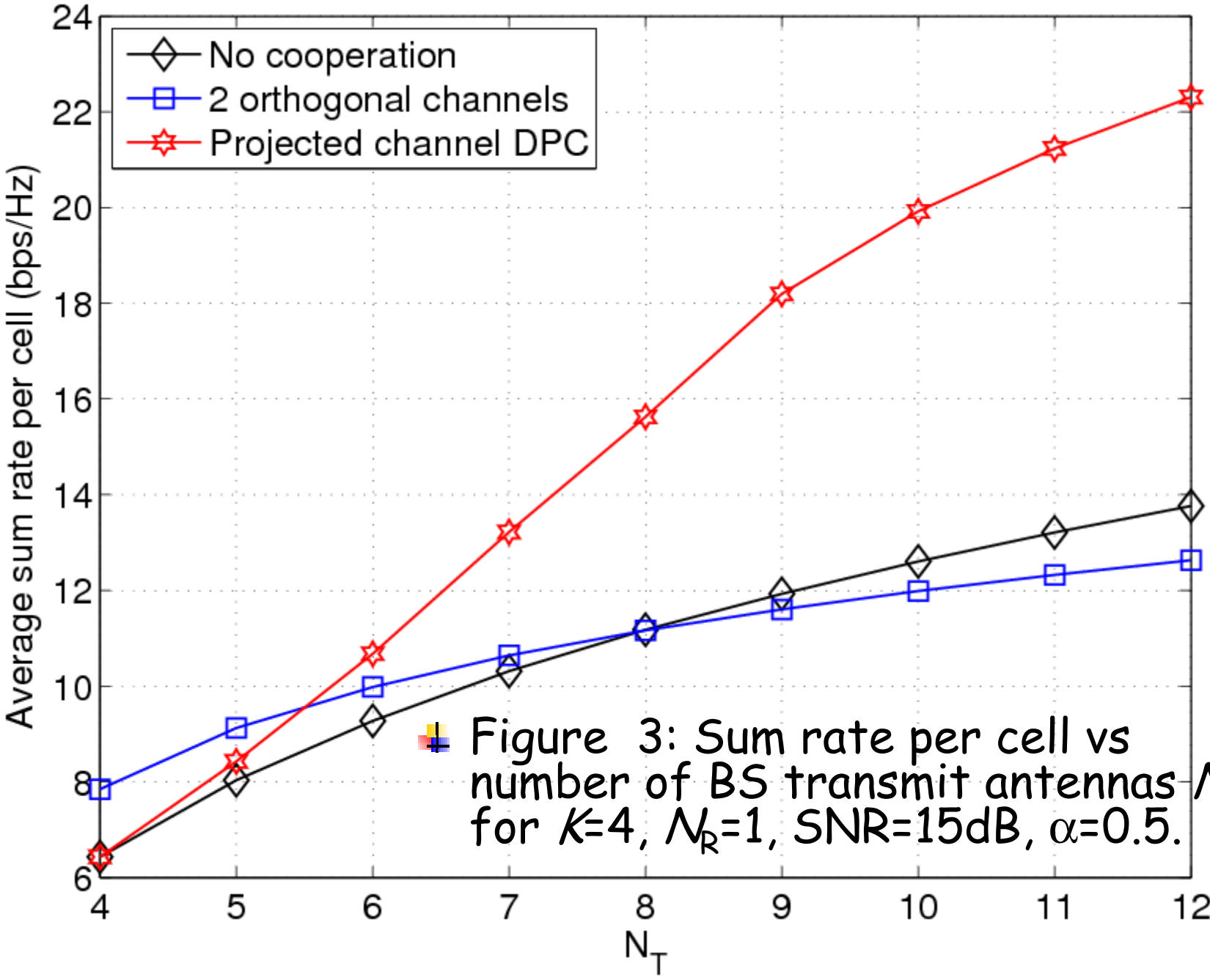
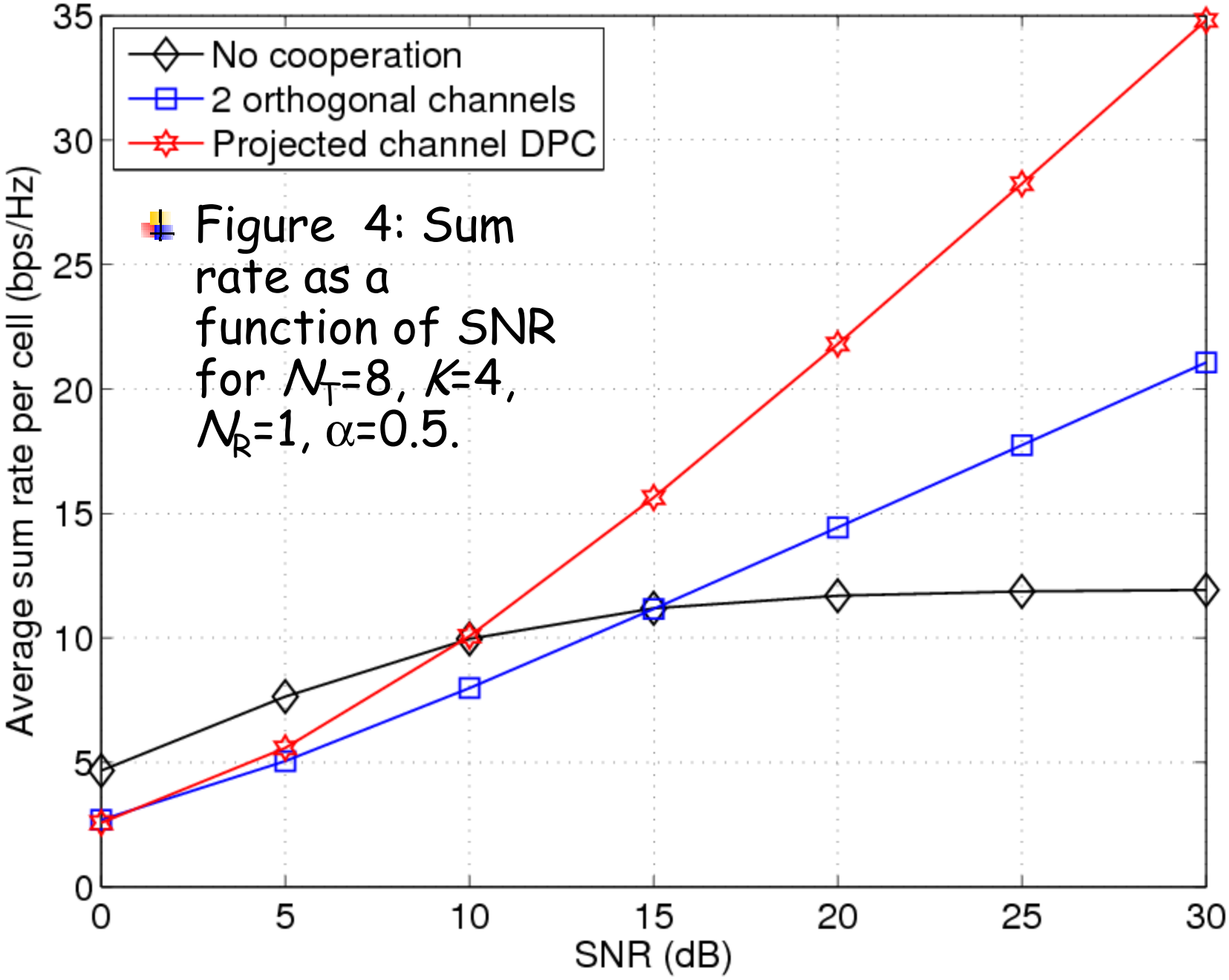


Figure 3: Sum rate per cell vs number of BS transmit antennas N_T for K=4, N_R=1, SNR=15dB, α=0.5.



- Figure 4: Sum rate as a function of SNR for N_T=8, K=4, N_R=1, α=0.5.

Conclusion

- Network MIMO is an attractive technology to tackle interference and increase spectral efficiency
- Projected Channel DPC is a decentralized precoder for the MIMO downlink CoMP that reduces the burden on the backhaul for CSI and data exchange.
- Our precoder eliminates all outside-cell interference and provides high data rate for the users.