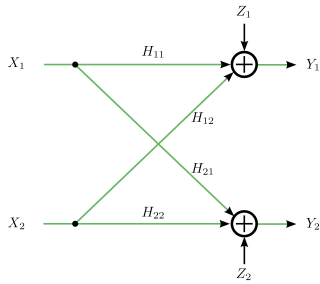




How Interference Affects the Data Rate in Wireless Networks

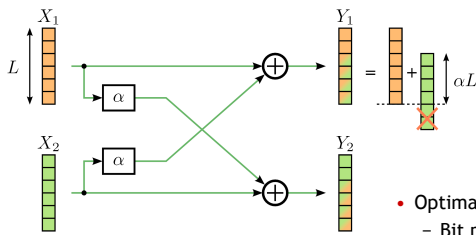
Bernd Bandemer, Stanford University, Department of Electrical Engineering
 Advisors: Professors Arogyaswami Paulraj and Abbas El Gamal
 In collaboration with: Gonzalo Vazquez-Vilar

Gaussian Interference Channel



- Two transmitters (Tx) would like to send information to two receivers (Rx)
- Limiting factors:
 - Transmit power constraint
 - Interference
 - Thermal Noise
- Capacity region is unknown
 - Which data rate combinations are feasible?

Deterministic Interference Model

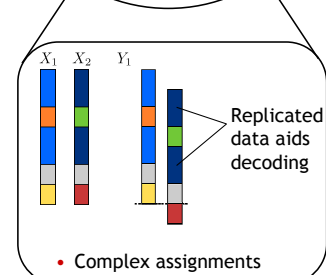
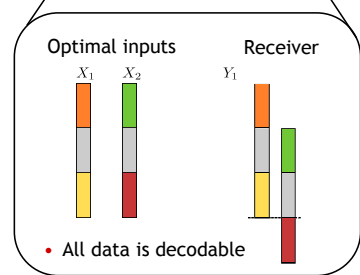
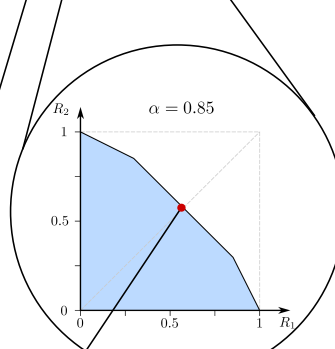
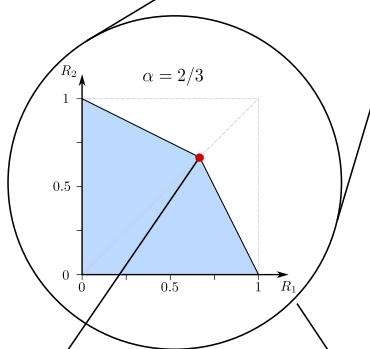
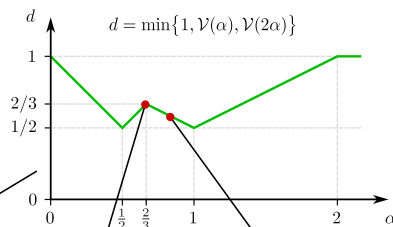


- No randomness
- Captures behavior
 - Power: Vector size
 - Interference: XOR
 - Noise: Truncation
- Optimal transmit strategies
 - Bit pipe assignments

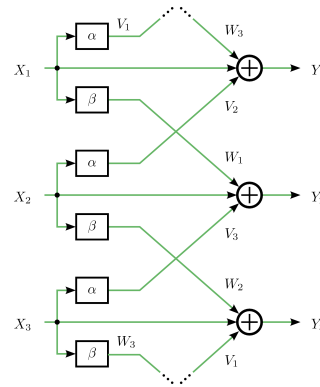
Two User Pairs

- Data rate varies with α
- Define normalized data rate

$$d = \frac{\#(\text{decodable bits})}{L}$$
 (relative to "no interference" case)
- Let $\mathcal{V}(x) := \frac{1+|x-1|}{2}$
- Interference regimes are visible



Three User Pairs



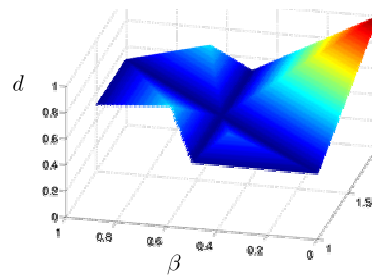
- Fully connected channel with three Tx/Rx pairs
- Cyclic symmetry
 - Two shift parameters

$$\alpha \in [1, 2]$$

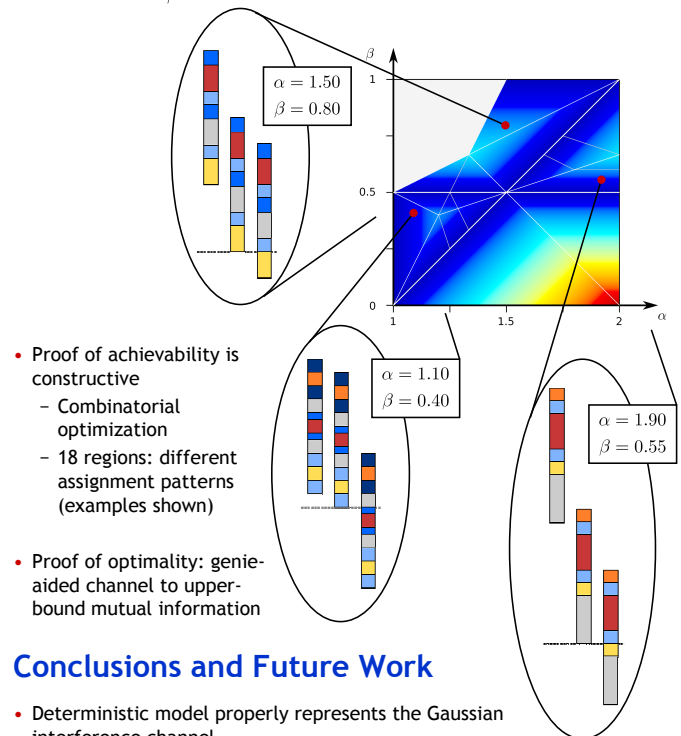
$$\beta \in [0, 1]$$
- Results also apply to the K-user-pair channel with local connectedness
- Maximize the symmetric normalized data rate

Main Result

$$d = \min\{1, \mathcal{V}(\alpha), \mathcal{V}(\beta), \mathcal{V}(2\beta), \mathcal{V}(\alpha - \beta)\}$$



- Piecewise linear
- Similar structure as in two-user-pair case
- d is never less than 0.5
 - Interference alignment



- Proof of achievability is constructive
 - Combinatorial optimization
 - 18 regions: different assignment patterns (examples shown)
- Proof of optimality: genie-aided channel to upper-bound mutual information

Conclusions and Future Work

- Deterministic model properly represents the Gaussian interference channel
- Future extensions:
 - Find optimal assignment patterns systematically
 - Non-symmetric channel
 - Non-symmetric rates