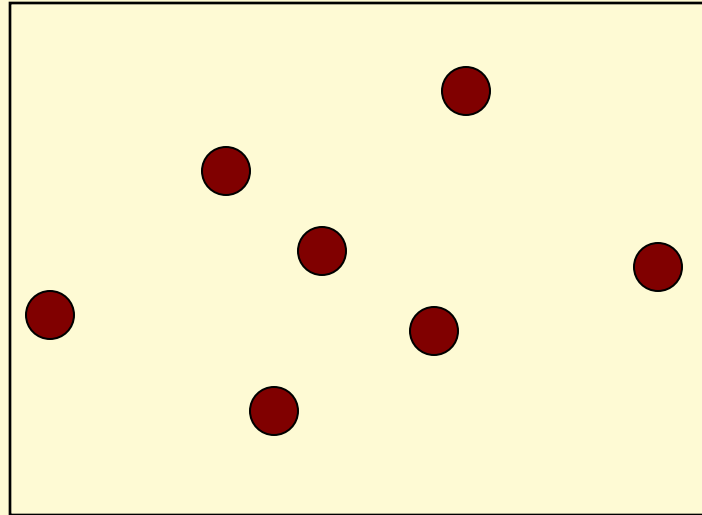

Cooperative Diversity with Power Allocation in Wireless Networks

Jianghong Luo, Rick Blum, Len Cimini,
Larry Greenstein, Alex Haimovich

Cooperative Diversity with Power Allocation

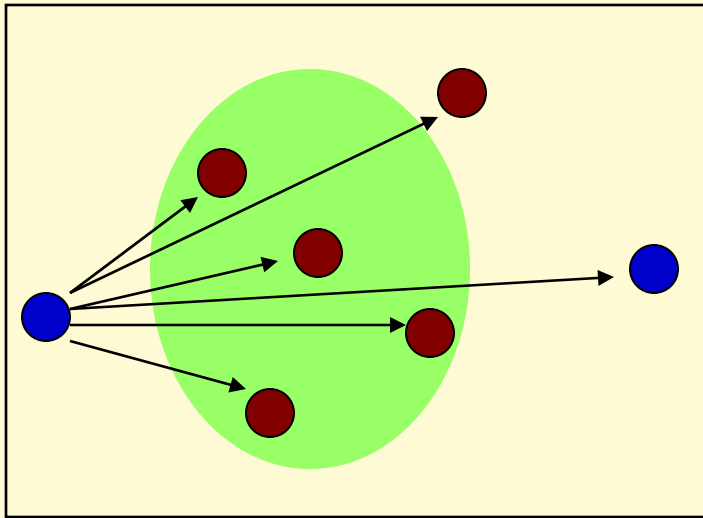


Uniformly
distributed
nodes

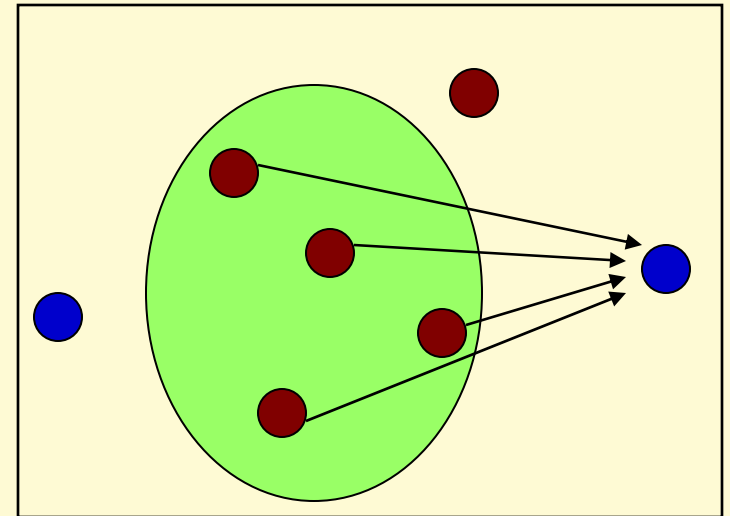
- ST-coded decode-and-forward scheme
- Derive a near optimum power allocation
 - Based on **mean** channel gain information
- Simple practical distributed ST-Coded schemes

Two-Stage Transmission

1: Source broadcasts



2: decoded nodes transmit



- Decoded set: nodes decode the message successfully.

$$D_S = \{i \mid p_s h_{s,i} > \eta\}$$

Allocation Problem

Allocation problem: short-term power constraint

$$\begin{aligned} \min_{p_s, p_j, j \in D} \Pr & \left\{ p_s h_{s,d} + \sum_{j \in D} p_j h_{j,d} < \eta \right\} \\ p_s + \sum_{j \in D} p_j & \leq P \\ p_s h_{s,j} & \geq \eta, \quad j \in D \\ p_s h_{s,j} & \geq \eta, \quad j \notin D \end{aligned}$$

Challenges:

- Outage probability: closed-form expression **complicated**
- 2^N possible decoded set D

Approach

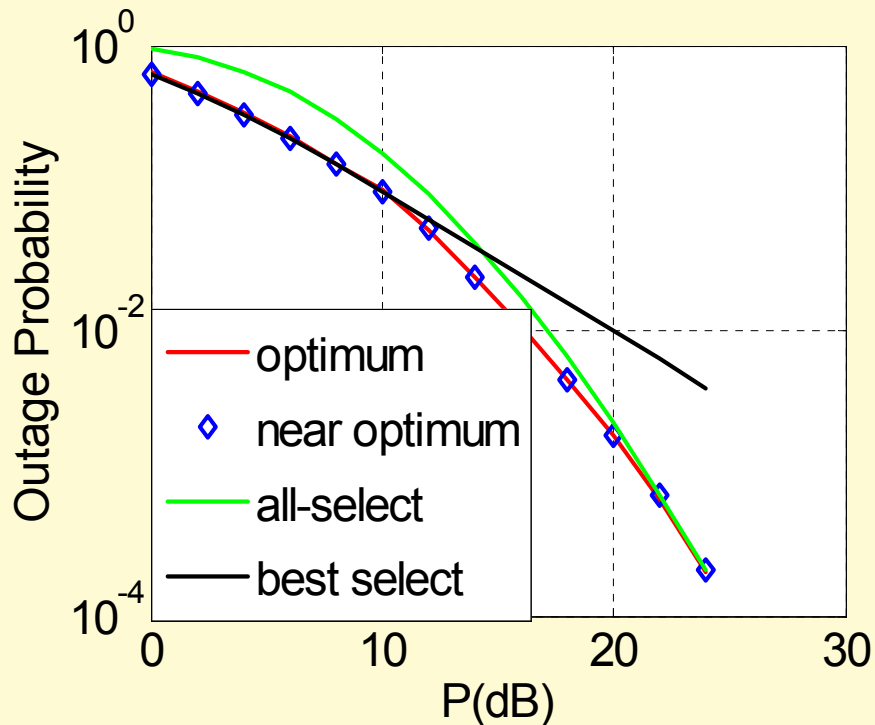
- Tight upper bound for outage probability

$$\Pr\left\{\sum p_i h_i < \eta\right\} \leq \min_K \min_{B_K} \min_{p_i} \frac{\eta^K}{K! \prod_{i \in B_K} p_i m_i}$$

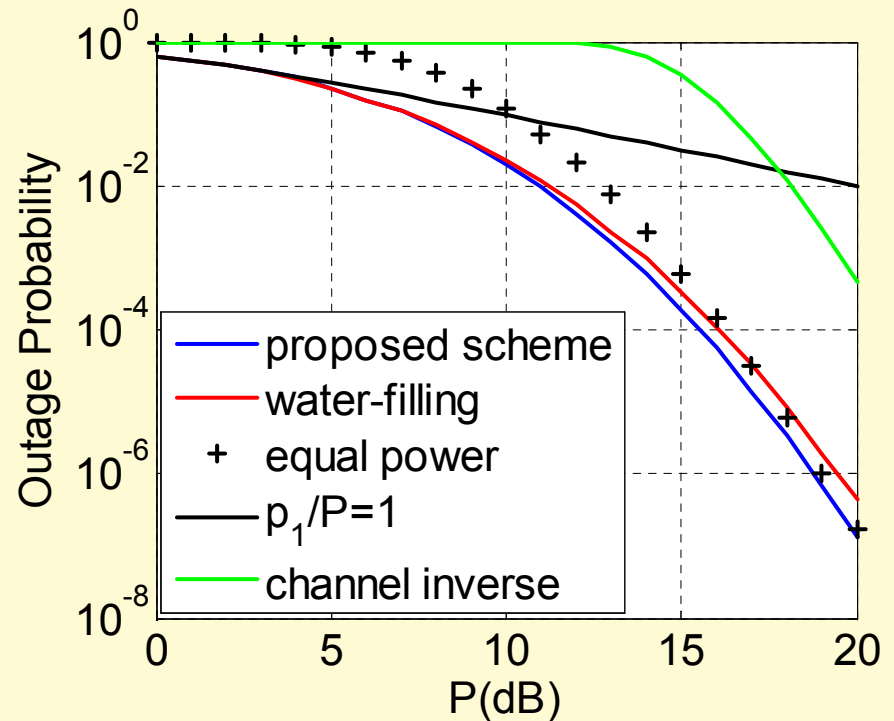
- Approach: simple near-optimum solution.
 - Divide the total power $P = P_s + P_r$.
 - Near-optimal power allocation among relay.
 - Equal power allocation among Selected relays..
 - Near-optimal $\rho = P_s/P = 0.5$.

$$S^* = \left\{ j \in D \mid m_{j,d} \geq \frac{\eta}{(1-\rho)P}, \text{ or } m_{j,d} \text{ largest} \right\}$$

Power Allocation Among Relays

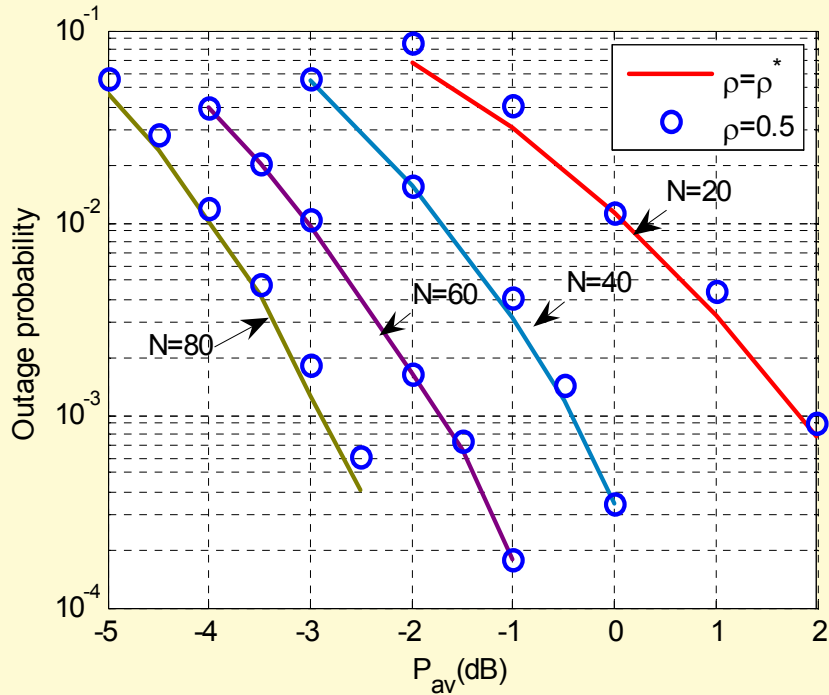


N=3 nodes, with
 $m=[0, -10, -20]$ dB

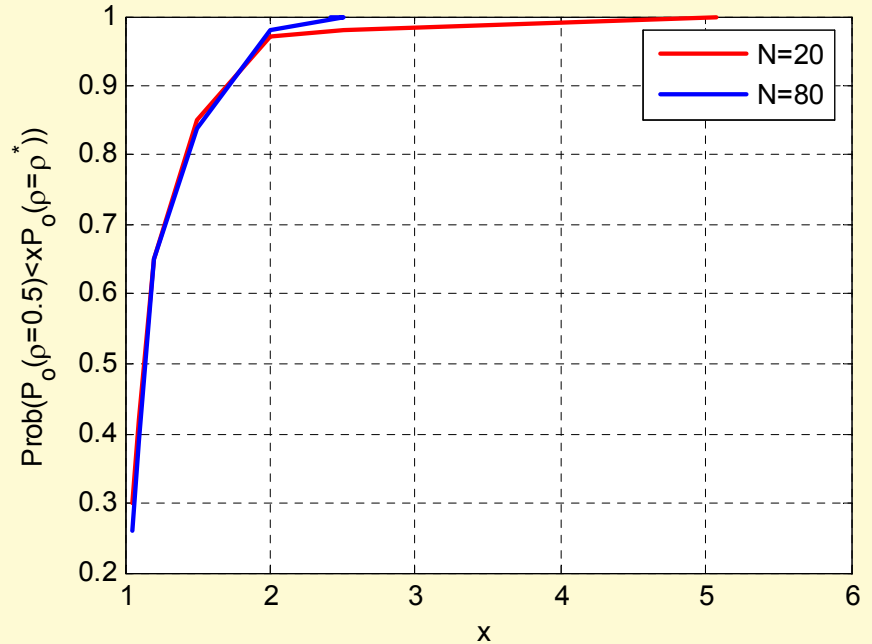


N=10 nodes, with
 $m=[0, -3, -6, -8, -10, -12, -14, -16, -18, -20]$ dB

Near-Optimal Power Ratio

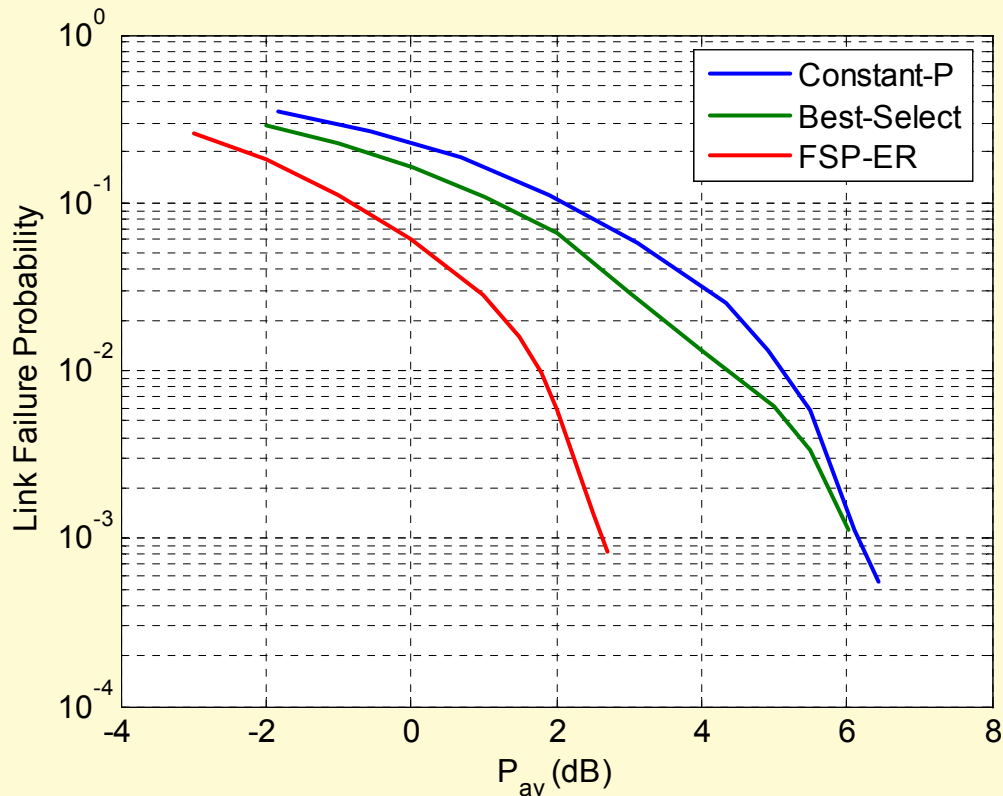


Sample outage probability in random networks



Distribution of $P_o(\rho=0.5) < x P_o(\rho^*)$

Link-Failure Probability



$N=10$ uniformly distributed nodes, target link $P_{out}=0.01$

Simple Distributed ST-Coded Relay

- Challenges for ST-Coded relay for large N
 - ❖ Synchronization & channel estimation
- m-group ST-coded relay
 - ❖ ST-codes among groups
 - ❖ Simple relay within group
 - ❖ Groups determined distributed and randomly
- Distributed power allocation
 - ❖ Each decoded node uses a fraction of source power
- Performance-complexity tradeoff

Link-Failure Probability

