**OPTIMAL RESOURCE ALLOCATION FOR NON-REGENERATIVE MULTIWAY RELAYING WITH RATE SPLITTING**

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**Summary**

- Global optimal resource allocation for a 3-user Gaussian MWRC with SND, AF relaying, and rate splitting.
- Non-convex optimization problem but only low non-convex variables as NC.
- Resource allocation framework that exploits problem structure:
  - Improved performance
  - Numerically stable and guaranteed convergence
  - Feasible solution even if terminated prematurely
- Numerical evaluation of rate splitting vs. "true" SND [1] vs. "traditional" SND vs. IAN

**Motivation**

- Heterogeneous dense small cell networks
- Wireless board-to-board communication in highly adaptive computing
- Industry 4.0: Satellite Communications

**System Model & Achievable Rate Regions**

![Diagram of System Model](image)

- Gaussian channels: Tx power $p_k \leq P_k$, noise $q_k = CN(0, N_k)$, SNR $S_k = 2q_k + q_k - b_k$
- Node $k$ transmits msg $b_k$ to $q_k$ and receives $b_k$. $A_k$ is interfering transmission of $M_k$
- Relay amplification: For relay Tx power $P_k$ chosen as $\sqrt{S_k}$ (SND, AF relaying, and rate splitting).

**Lemma (Rate Splitting [2])**

A rate triple $(R_1, R_2, R_3)$ is achievable for the Gaussian MWRC with AF relaying if, for all $k \in K$,

\[
R_k = \log (1 + |h_{k1}^2|b_{k1}^2 + q_k) \\
R_k = \log (1 + |h_{k2}^2|b_{k2}^2 + q_k) \\
R_k = \log (1 + |h_{k3}^2|b_{k3}^2 + q_k)
\]

and,

\[
A_k = \log (\frac{1}{|h_{k1}^2|b_{k1}^2 + q_k}) \\
A_k = \log (\frac{1}{|h_{k2}^2|b_{k2}^2 + q_k}) \\
A_k = \log (\frac{1}{|h_{k3}^2|b_{k3}^2 + q_k})
\]

where $S_k = b_k + q_k$ and $A_k = 1 + |h_{k1}^2|b_{k1}^2 + q_k - 1 - |h_{k1}^2|b_{k1}^2 - |h_{k2}^2|b_{k2}^2 - |h_{k3}^2|b_{k3}^2 - 1 - |h_{k1}^2|b_{k1}^2 - |h_{k2}^2|b_{k2}^2 - |h_{k3}^2|b_{k3}^2.$

**Problem (R)**

\[
\text{max}_{x, y, z} \sum_{k \in K} w_k R_k \\
\text{s.t.} \quad R_k = \log (1 + |h_{k1}^2|b_{k1}^2 + q_k) \\
R_k \geq 0, \quad S_k \geq 0
\]

**Problem Statement**

- $w \in \mathbb{R}^{n_0 \times 1}$, $R \geq 0$, $S \geq 0$
- $R(S)$ achievable region: Non-convex in $S$, linear in $R$
- $\text{RHS of } \mathbb{R}^{n_0 \times 1}$

**References**