ACHIEVING GLOBAL OPTIMALITY FOR WIRELESSLY POWERED MULTI-ANTENNA TWRC WITH LATTICE CODES

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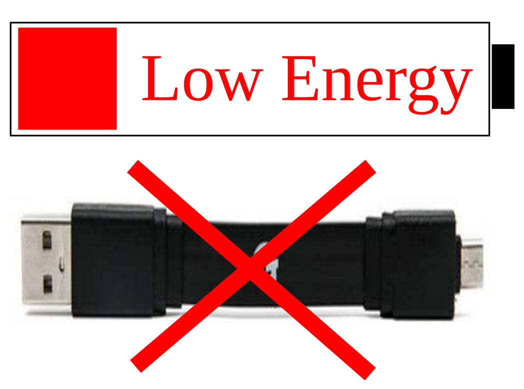
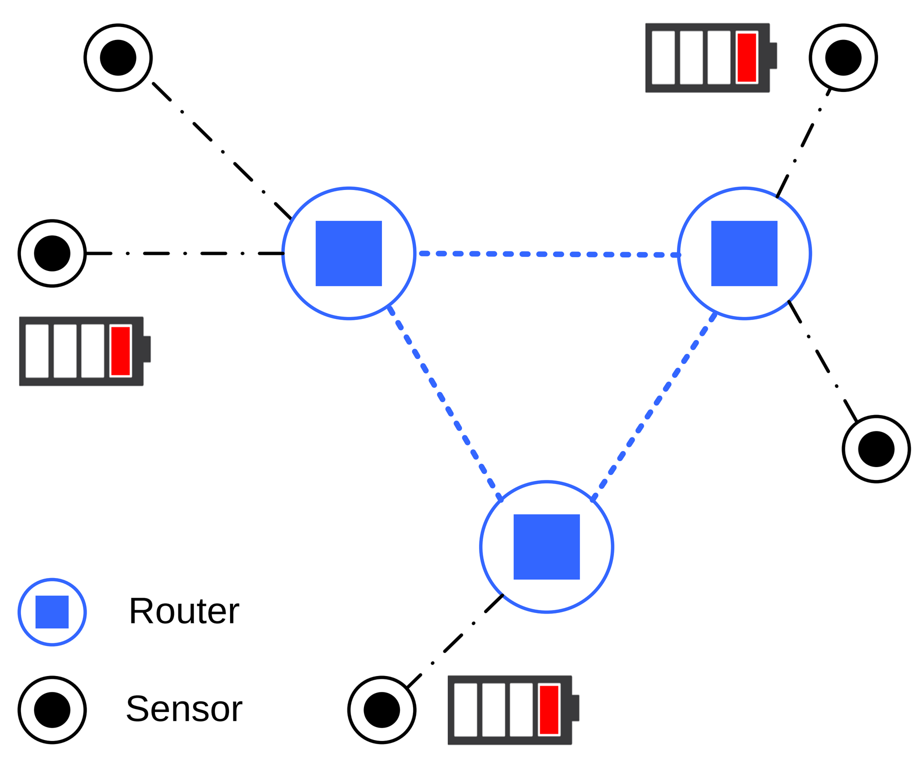
Motivation

Sensor Networks
Wearable Computations
Medical Electronics





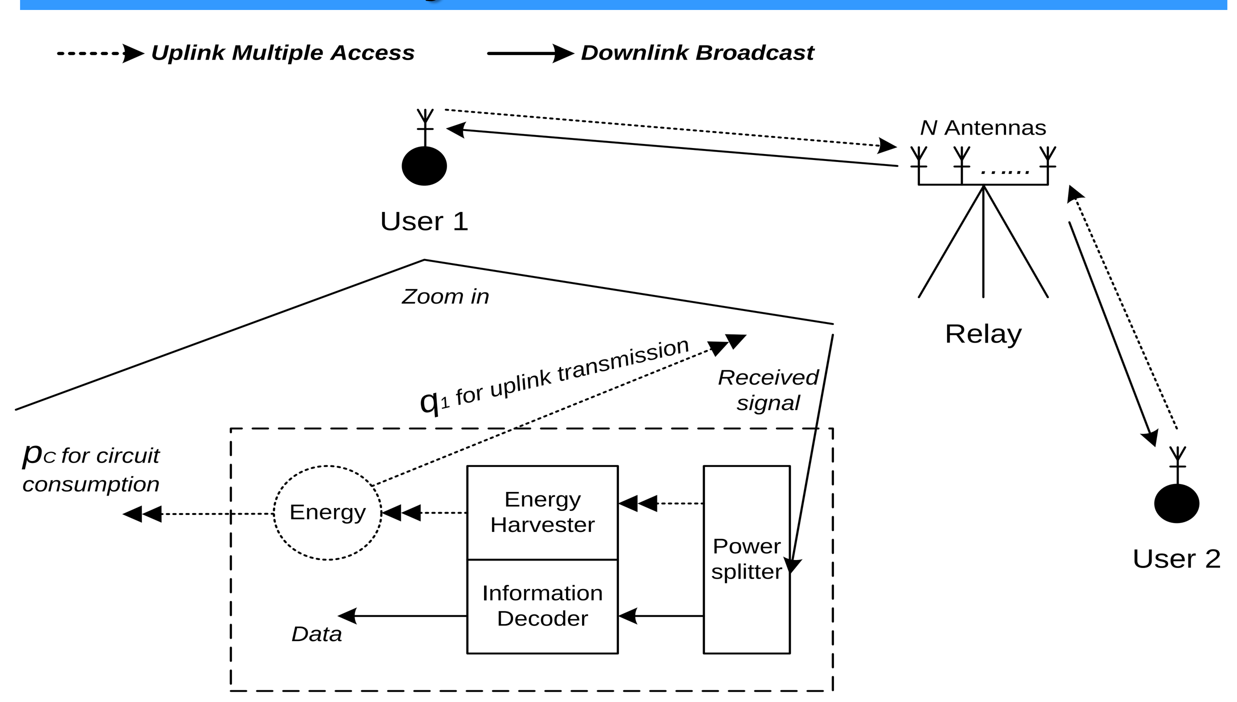
Main Result

An algorithm with complexity $O(2N^2)$ achieves the global optimum for wirelessly powered two-way relay channel, with N being the number of antennas at relay.

Key Steps

Analyze Optimal Condition → Find Subspace → Establish Rank Guarantee → Semi-Definite Program

System Model



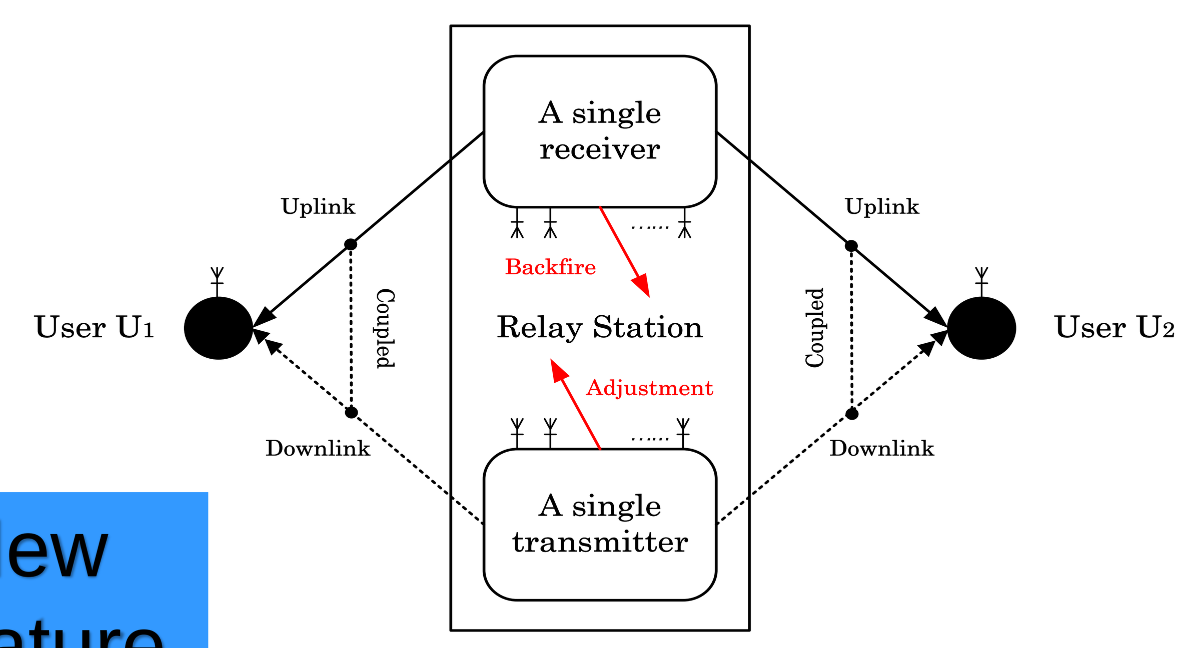
Information Exchange

Lattice code based compute and forward network coding

Wireless Power Transfer

The received signal at users is split for energy harvester

New Feature



Pairwise Uplink-Dowlink Coupling

Optimization Problem

$$\min_{\mathbf{v},\mathbf{w},p,\{q_i,\beta_i\}} \; p+q_1+q_2$$

$$\text{s.t.} \quad \frac{q_i|\mathbf{w}^H\mathbf{h}_i|^2}{\sum_{j=1}^{2} q_j|\mathbf{w}^H\mathbf{h}_j|^2} + \frac{q_i|\mathbf{w}^H\mathbf{h}_i|^2}{\sigma_r^2} \geq 2^{2\bar{R}_i}, \quad \forall i$$

$$1+\frac{\beta_i p|\mathbf{g}_i^H\mathbf{v}|^2}{\beta_i\sigma_u^2+\sigma_z^2} \geq 2^{2\bar{R}_{3-i}}, \quad \forall i$$

$$\eta(1-\beta_i)(p|\mathbf{g}_i^H\mathbf{v}|^2+\sigma_u^2)-2p_c \geq q_i, \quad \forall i$$

$$q_i \geq 0,\ \beta_i \in [0,1], \quad \forall i$$

$$p \geq 0,\ \|\mathbf{v}\|=\|\mathbf{w}\|=1.$$

Design variables:

- $\mathbf{v}$: relay transmit beamformer
- $\mathbf{w}$: relay receive beamformer
- p : relay power
- q_i : user power
- β_i : user power splitting ratio

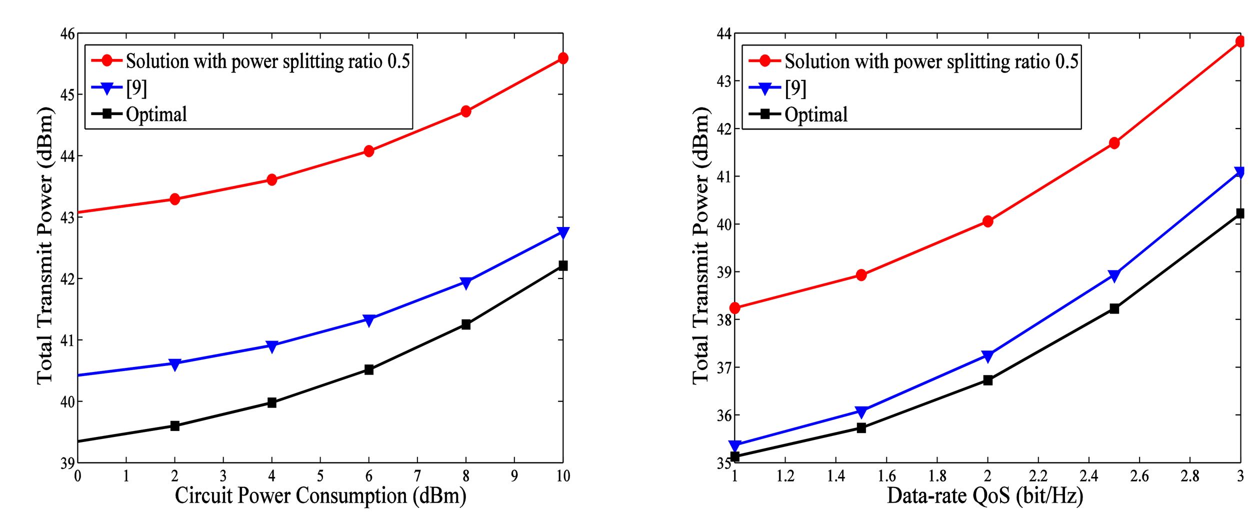
Parameters:

- $\mathbf{h}_i$: uplink channel
- $\mathbf{g}_i$: downlink channel
- $\bar{R}_i$: data-rate QoS
- $\sigma_u^2, \sigma_z^2, \sigma_r^2$: noise power
- η : power conversion efficiency

Challenges

- ❖ Nonlinearly coupled.
- ❖ Nonconvex over each variable.
- ❖ Existing block coordinate descent algorithm only converges to suboptimal solution.

Simulations[1]



- ❖ Achieve the lowest transmit power.
- ❖ Save 3dB and 1dB power compared to the fixed splitter design and [9][2], respectively.

➢ *Note 1: total transmit power for the case of N=8, path loss equal to 30dB, and noise power equal to -30dBm (a) Versus circuit power at data-rate QoS equal to 3bits/Hz; (b) Versus data-rate QoS at circuit power equal to 5dBm.*

➢ *Note 2: [9] is the block coordinate decent algorithm.*

Future Work

- ❖ Wirelessly powered two way relay channel with amplify and forward scheme.
- ❖ The capacity region of wirelessly powered two way relay channel.
- ❖ Employment of multiple antennas at users.