Cooperation in Wireless Networks
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Introduction, Motivation and Objective

Introduction
- Channel qualities: fading, shadowing, distance attenuation; interference
- Wireless Multicast Advantage

Motivation
- Exploit spatial diversity through combined use of antennas belonging to different users

Objective
- To simply utilize relaying capability intelligently at the network protocol level; Cross-layer design
- Performance Analysis: Stable Throughput, Delay

Opportunistic Cooperation Strategy
- User \( k \) transmits a packet,
  1). If the destination successfully decodes the packet, the packet exits the network;
  2). If the destination doesn’t decode the packet, but some of \( k \)’s subsequent users decode the packet, the one with the best channel to the destination will keep the packet and take responsibility to transmit it, all other users drop that packet (this can be done by checking ACKs);
  3). Otherwise, if none of \( k \)’s subsequent users nor the destination decodes the packet, the packet remains at \( k \)’s queue for retransmission.

Opportunistic relaying & multi-hop relaying

A General Multiple-Access System

- Multiple-Access: \( N \) users, unicast to the single common destination \( (D) \)
- Exogenous Bernoulli arrivals to each user, \( \lambda_i \)
- Erasure channel model:
  - Packet reception probability
  \[ P_{i,j} = \Pr \left[ \frac{p_{i,j} P_j}{N_j} > \gamma \right] \]
  - “Ordered” channel qualities
  \( P_{N,D} > P_{N-1,D} > \cdots > P_{1,D} \)
- Feedback ACK is perfect

MAC Policy
- Conflict-free work-conserving policy
- TDMA scheduling, time allocation \( \Omega = (\omega_1, \omega_2, \ldots, \omega_N) \)

Performance Analysis
- Characterized the closed-form expressions for the Stable Throughput Region, Average Delay

Numerical Results: Stale Throughput
- Both policies yield same stable throughput region under cooperation
- \( N \) users simultaneously increase stable throughput rate
- \( p_{1,2} \) increases \( \Rightarrow \) region enlarges

Average Delay
- Priority-based, prioritizes user 1’s packets
- Delay improved for both users

Conclusion
- All users in the network can simultaneously have performance gains in terms of stable throughput and delay.