On Broadcasting with Cooperative Diversity in Multi-Hop Wireless Networks

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Outline

- Introduction
- Related work
- Optimal cooperative broadcasting
- Distributed approach: Coop-cast
- Simulation
- Conclusion
Introduction

- Cooperative diversity:
  - Nodes that are in the close proximity of one another transmit the same packet at the same time to emulate an antenna array.

- Cooperative diversity can increase
  - The achieved transmission range
  - The achievable data rate
  - Reliability
Related work

- By using space time codes (ex. orthogonal code), nodes can transmit at the same time.

- With diversity gain, the signal can be recovered at a distance farther than when there is no diversity.
Optimal cooperative broadcasting

- Coop-cast tree with minimum cost can be reduced to a Steiner tree problem. => NP-Complete!!
  - One to one mapping
  - Appendix.
Coop-cast tree
Distributed approach : Coop-cast

- Counter-based approach
  - After receiving a given broadcast packet, a node sets a timer and counts the number of times it hears the same packet.

- Cooperative broadcast : multiple nodes broadcast

- SISO broadcast : single node broadcast
Algorithm(1/5)

- Source randomly selects some neighbors to coop-cast
  - Add the list to the packet
  - With k neighbors
  - If the node has other information (ex. GPS), it could choose better neighbors

- Source broadcasts the packet
Algorithm(2/5)

- When the chosen neighbors receive the packet
  - Send pilot tones orderly (ex. minimum ID first)
  - When receiving all pilot tones => broadcasting at the same time!!
When nodes receive this message

- If neighbors > k, then
do cooperative broadcast

- Else,
do SISO broadcast
Algorithm(4/5)
For reducing the message overhead, nodes set a timer and count the messages.
- If the number of messages exceed a threshold => Stopping broadcast!
- For cooperative: only count the cooperative broadcast messages
- For SISO: count all broadcast messages
Simulation

- Metrics
  - Coverage
  - Average end-to-end latency
  - Cost

- Set the count threshold \( \theta = 3 \)

- Timer = \( c \times \theta \times Tp \)
Coverage vs. Number of Nodes

No collision
Average End-to-End Latency vs. Number of Nodes

Reduces about 50%
Cost vs. Number of Nodes
Conclusion

- Cooperation can yield an extension in the transmission range, due to the diversity gain achieved in fading environment.
  - Increasing the broadcast coverage
  - Reducing the latency up to 50%
- Studying the optimal network-wide cooperative problem
Discussion (1/2)

- Since the cooperating transmitters are not co-located, the signals they transmit could be received at the destination with different delays and average received powers.
- Cooperative or Interference?!
Discussion (2/2)

80% less than 0.6\(\mu\text{s}\)