On Broadcasting with Cooperative Diversity in Multi-Hop Wireless Networks

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Outline

- Introduction
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- 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

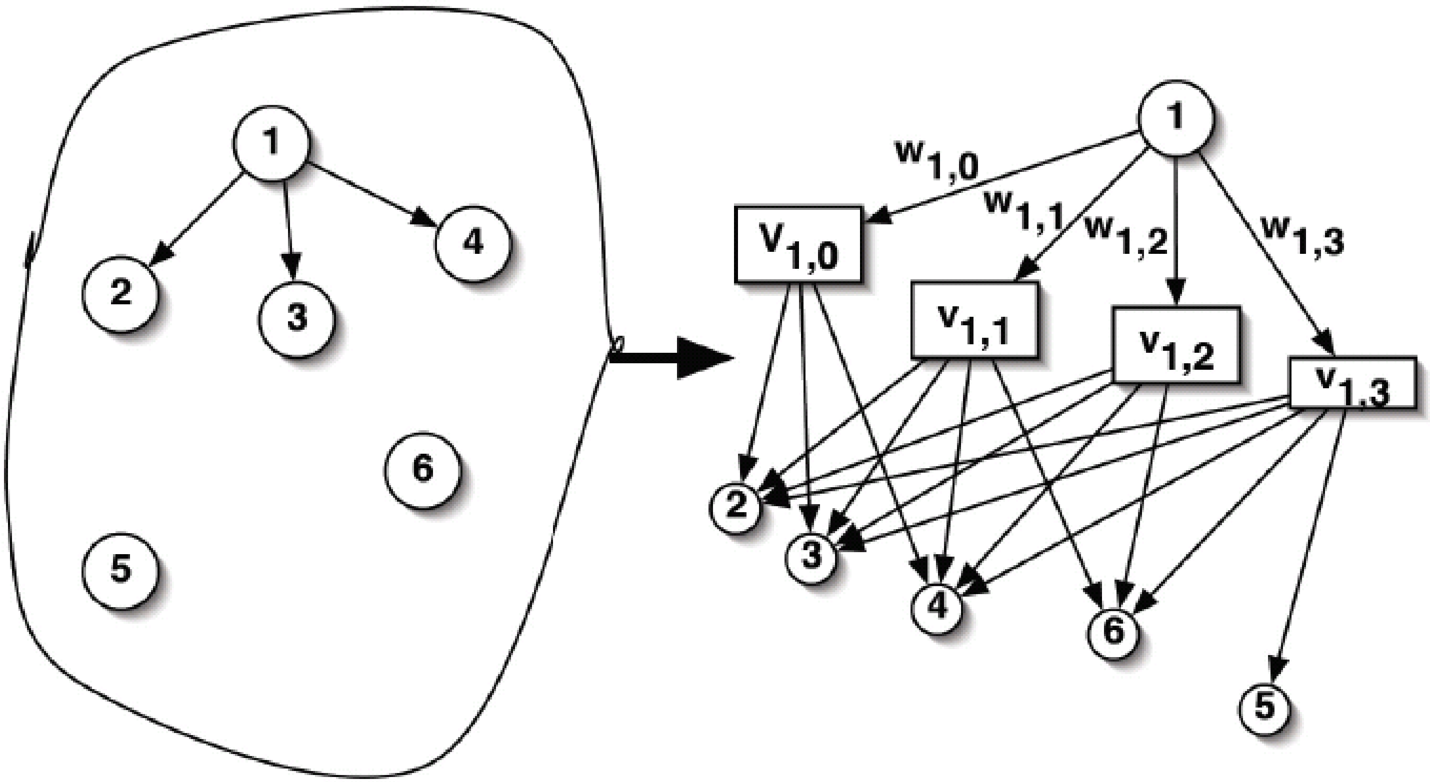
Related work

- 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!!

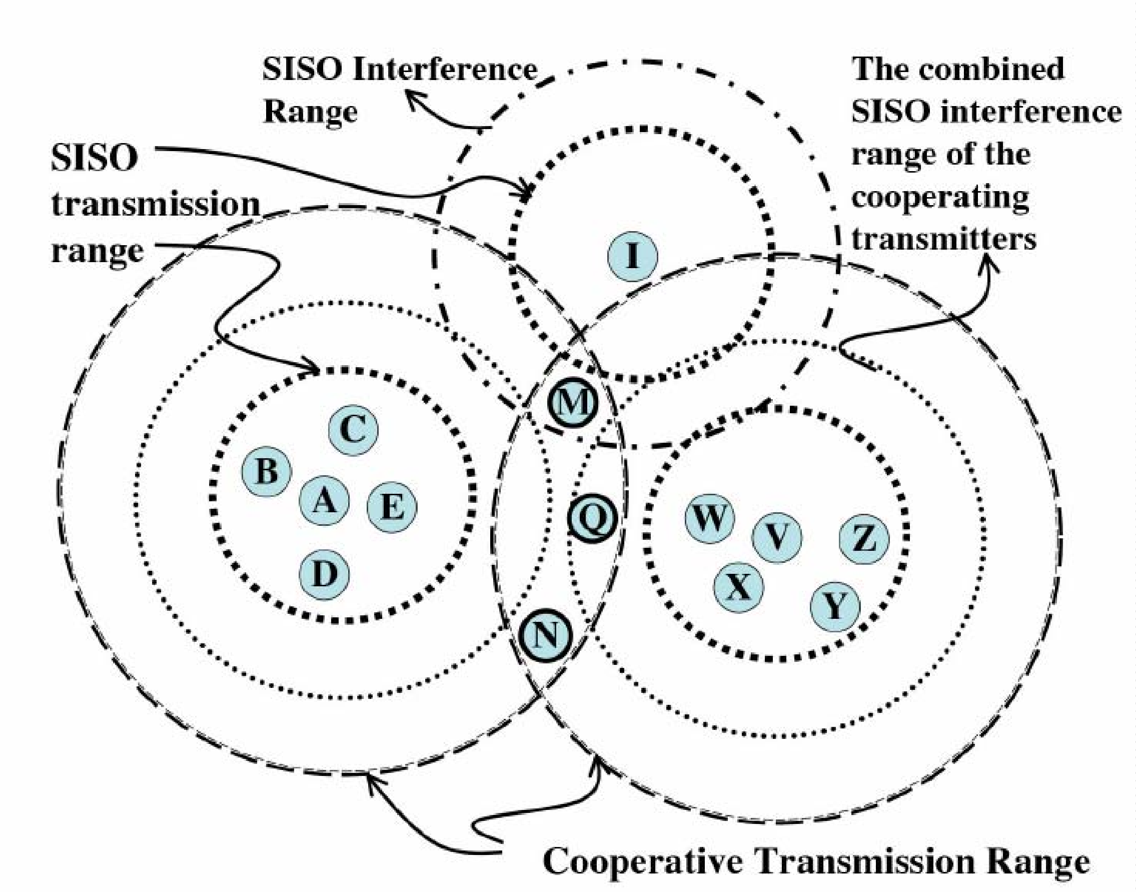
Algorithm(3/5)

- When nodes receive this message
  - If neighbors > k , then

    do cooperative broadcast
  - Else ,

    do SISO broadcast

Algorithm(4/5)



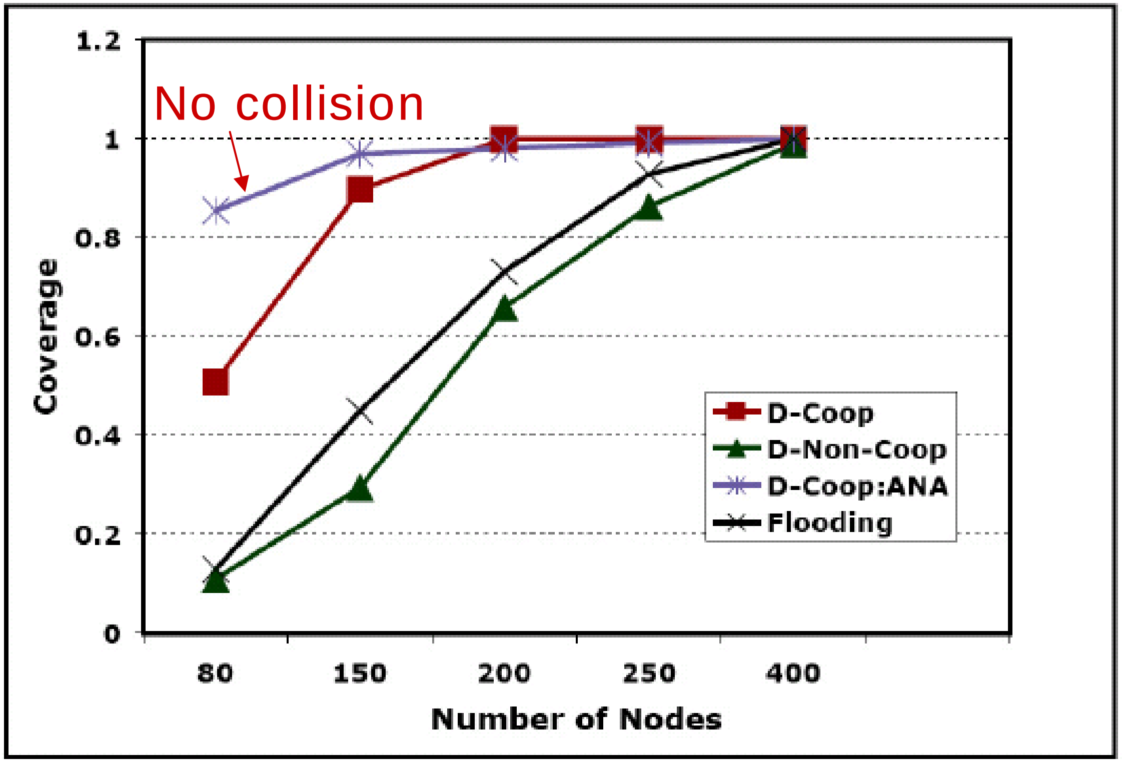
Algorithm(5/5)

- 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

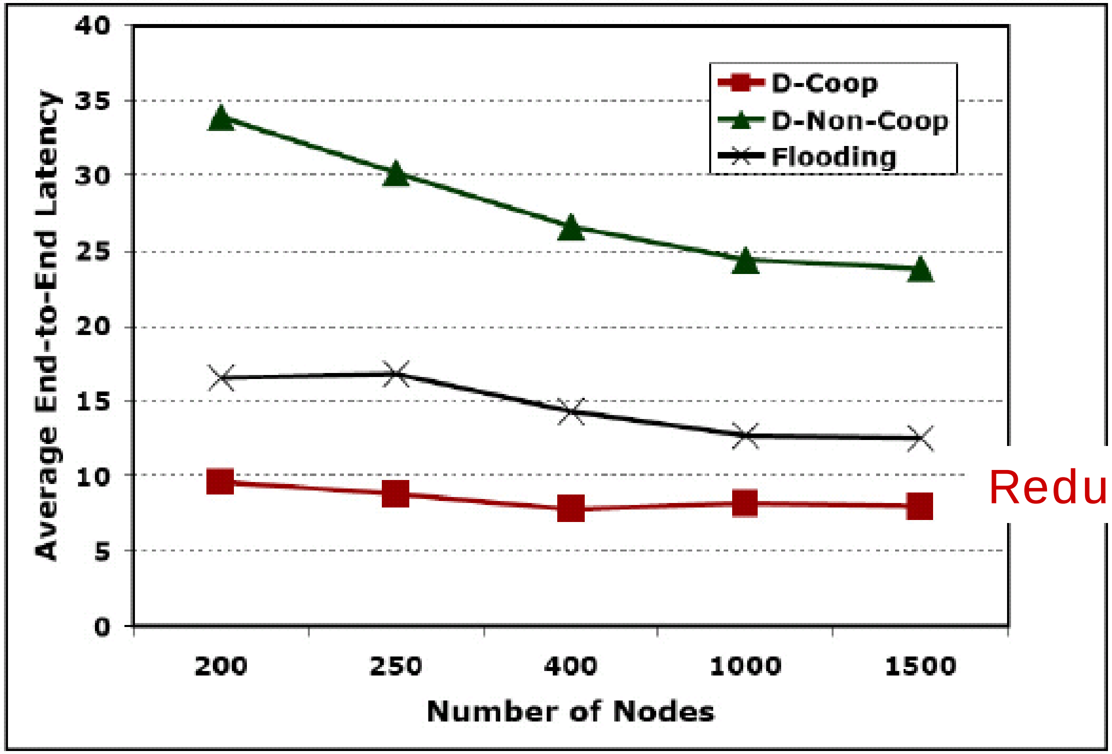
Simulation

- Metrics
  - Coverage
  - Average end-to-end latency
  - Cost
- Set the count threshold $\theta=3$
- Timer=c* θ *Tp

Coverage vs. Number of Nodes

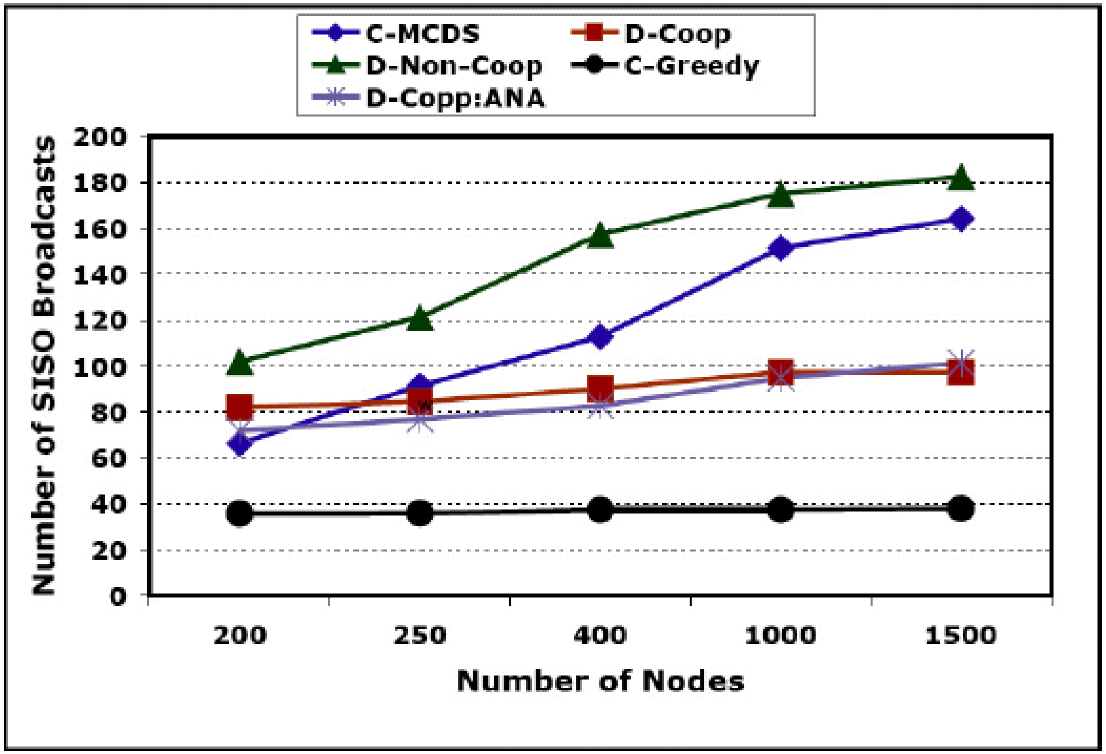


Average End-to-End Latency vs. Number of Nodes



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)