

Deadline-aware Broadcasting in Wireless Networks with Local Network Coding

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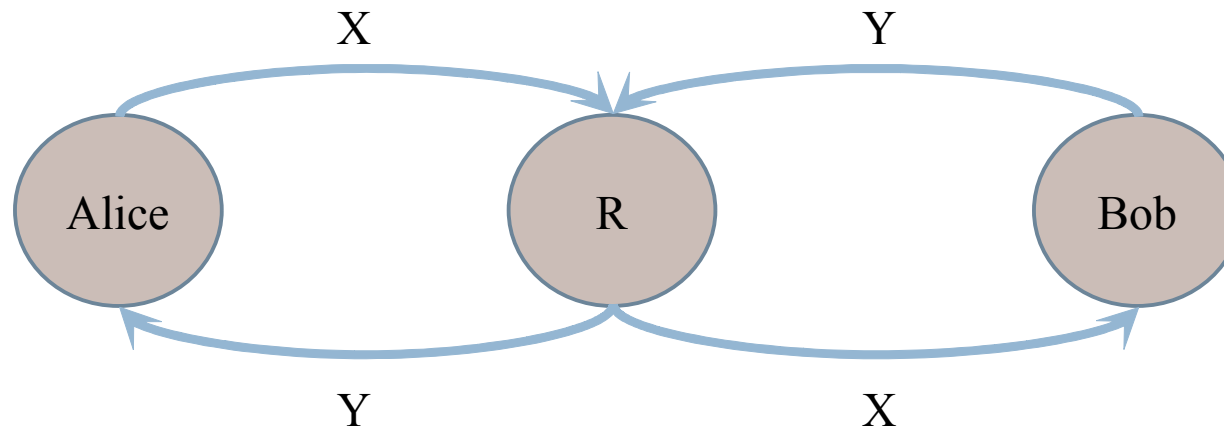
Agenda

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- Introduction
- Motivation
- Three phases algorithm
 - Broadcasting tree
 - Partitioning
 - Coding
- Simulation
- Conclusion

Alice and Bob (No coding)

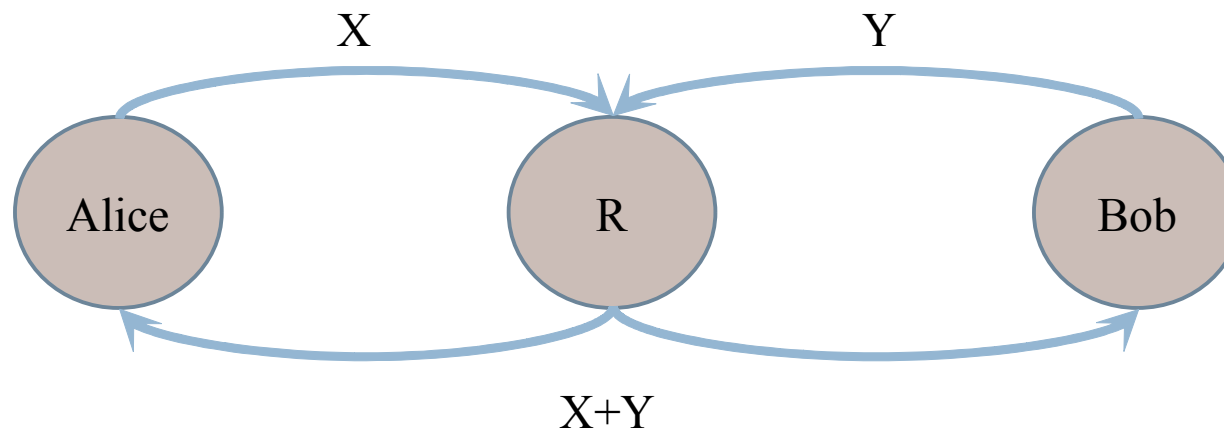
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4 transmissions

Alice and Bob (Coding)

4



3 transmissions

Deadline-Aware Broadcasting

5

□ X:

▣ Generation : slot 1

▣ Deadline: 6

Y:

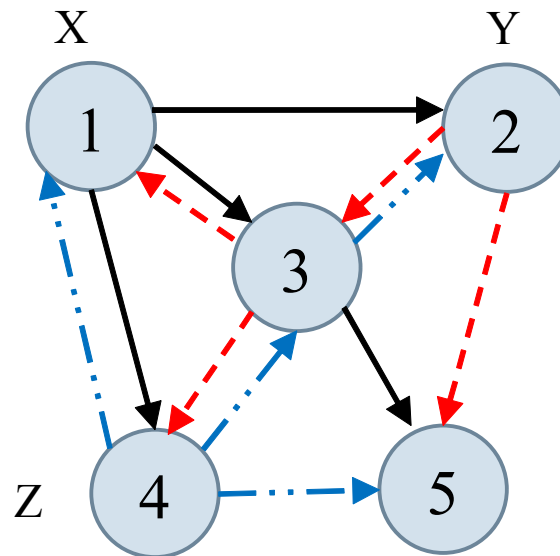
Generation: slot 3

Deadline: 6

Z:

Generation: slot 5

Deadline: 7



Deadline-Aware Broadcasting

6

□ X:

▣ Generation : slot 1

▣ Deadline: 6

Y:

Generation: slot 3

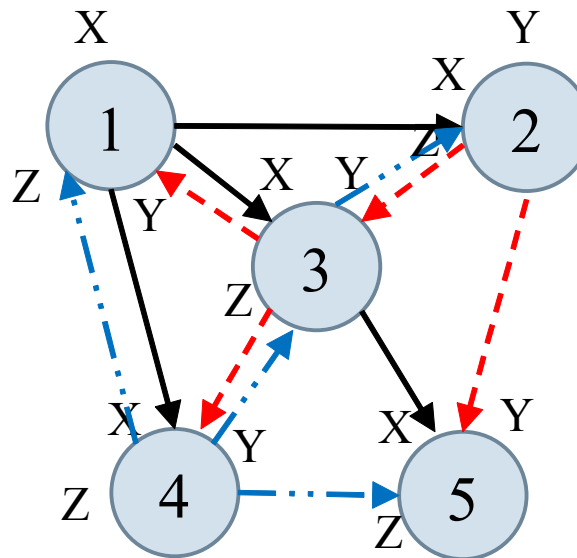
Deadline: 6

Z:

Generation: slot 5

Deadline: 7

- Without waiting



Time slot 4

- 3 transmissions by the relay node
- No deadline misses

Deadline-Aware Broadcasting

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□ X:

▣ Generation : slot 1

▣ Deadline: 6

Y:

Generation: slot 3

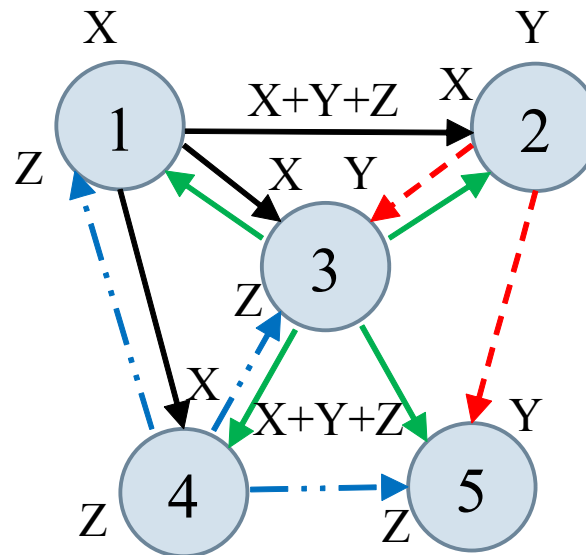
Deadline: 6

Z:

Generation: slot 5

Deadline: 7

- Waiting time=4



Time slot 3

- 1 transmissions by the relay node
- Deadline misses

Deadline-Aware Broadcasting

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□ X:

▣ Generation : slot 1

▣ Deadline: 6

Y:

Generation: slot 3

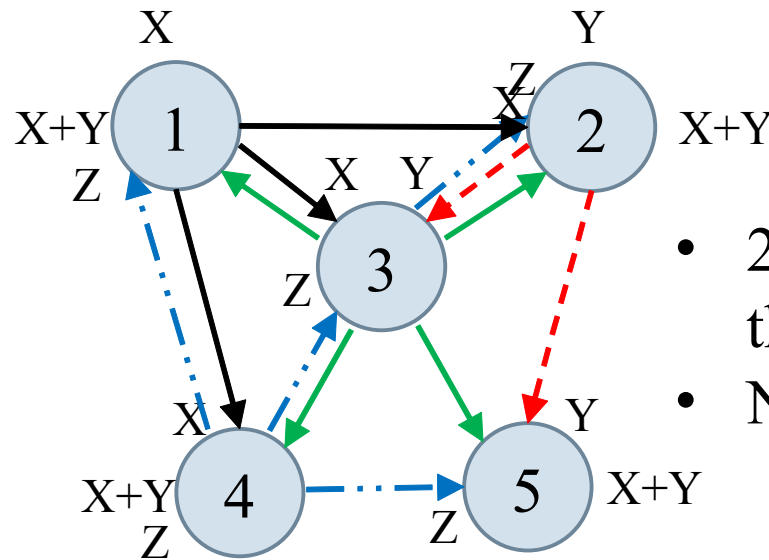
Deadline: 6

Z:

Generation: slot 5

Deadline: 7

- Waiting time=2



- 2 transmissions by the relay node
- No deadline misses

Time slot 4

Setting

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- Multi-hop network
- Multiple broadcast sessions
- Perfect links
- Multi-channel multi-radio capability

- Objective: minimizing the number of transmissions
- Constraint: Each packet has a deadline to be received by all of the nodes

NP-completeness

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- The problem of energy-efficient broadcasting, subject to the deadline constraints, is NP-complete
- Polynomial time reduction from a well known NP-complete problem.
- Vector packing problem

High-Level Solution

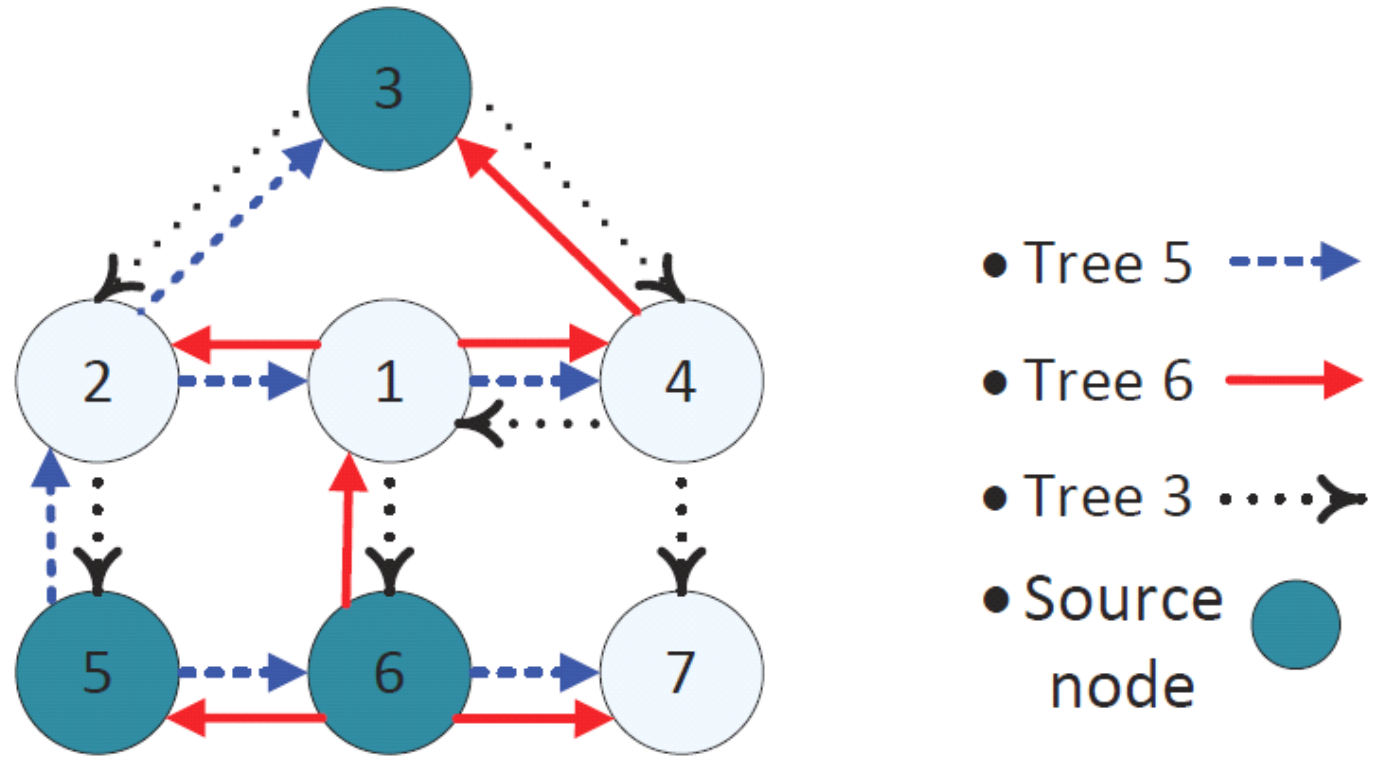
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- Constructing broadcasting trees
 - ▣ Ensures the decodability of the coded packets
 - ▣ It is done once in the initializing phase
- Partitioning the set of packets
 - ▣ Guarantees meeting all the deadlines
 - ▣ It is done once in the initializing phase
- Performing coding
 - ▣ The relay nodes do the actual coding
 - ▣ This phase is repeated periodically

Broadcasting Tree

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□ Spanning tree



Constructing Broadcasting Trees

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- Iterative construction
 - ▣ Starts from the sources in increasing order of their packet's deadlines
 - ▣ Uses BFS to traverse the network
- Rules
 - ▣ Rule1: Node v selects the parent u that has the maximum number of effective neighbors
 - ▣ Rule2: Node v selects the parent u where selecting that node does not increase $\Delta(u)$

Partitioning the Set of Packets

14

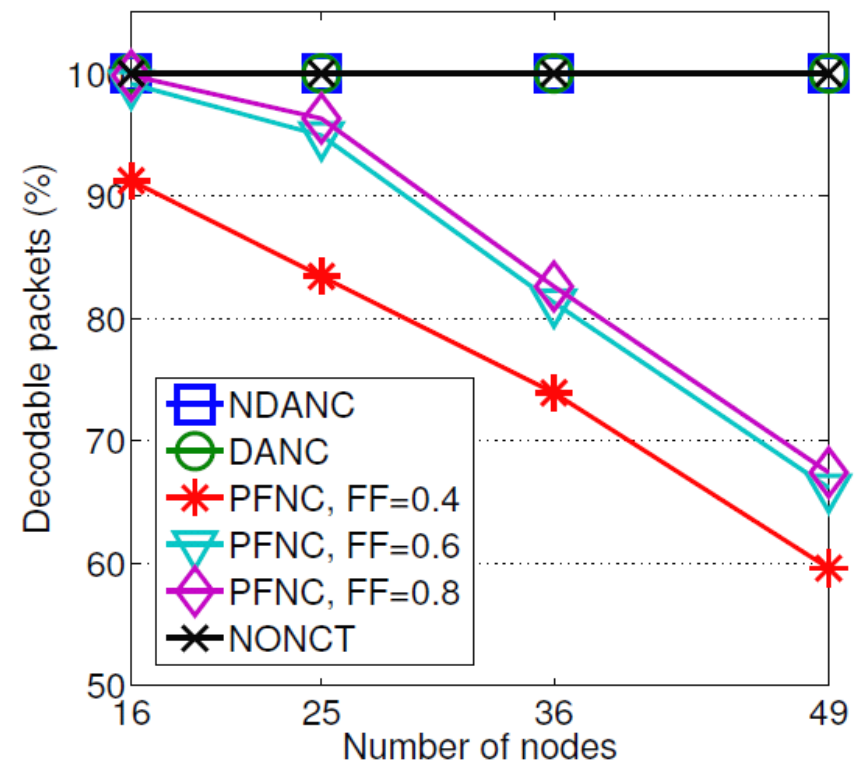
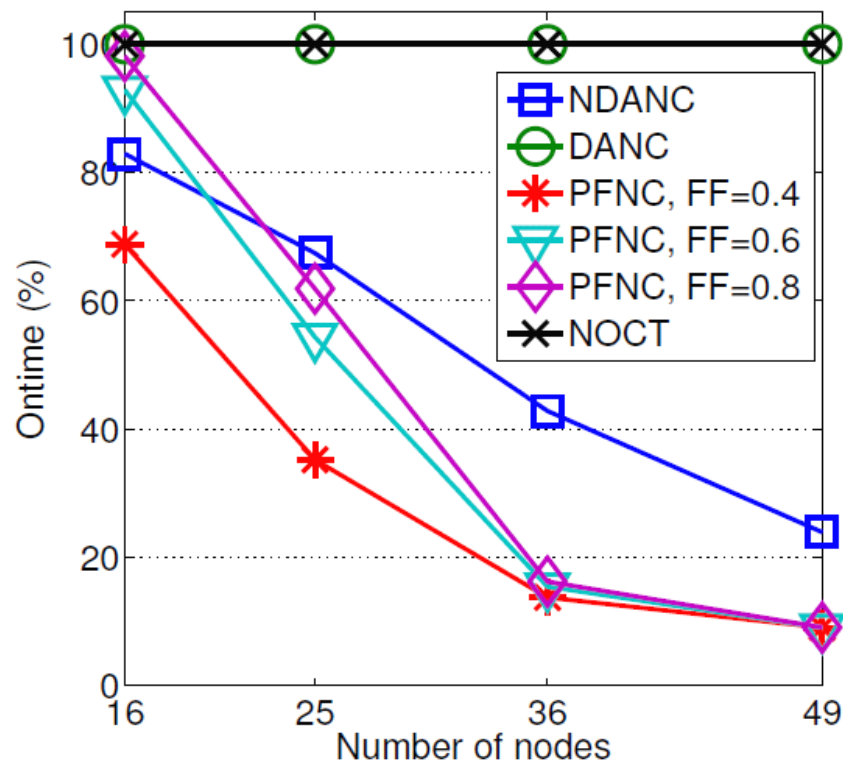
- Sorts the list of the packets in increasing order of their deadlines.
- Places the first packet in a partition.
- What if we place the next packet in the current partition?
 - ▣ Calculates the receiving time
 - ▣ Receiving time $<$ deadlines: puts to the partition
 - ▣ Receiving time $>$ deadlines: makes a new partition

Simulations

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- NDANC: Non Deadline-Aware NC
- DANC: Deadline-Aware NC

- PFNC: Probabilistic Forwarding NC
- NONCT: Non Coding Tree

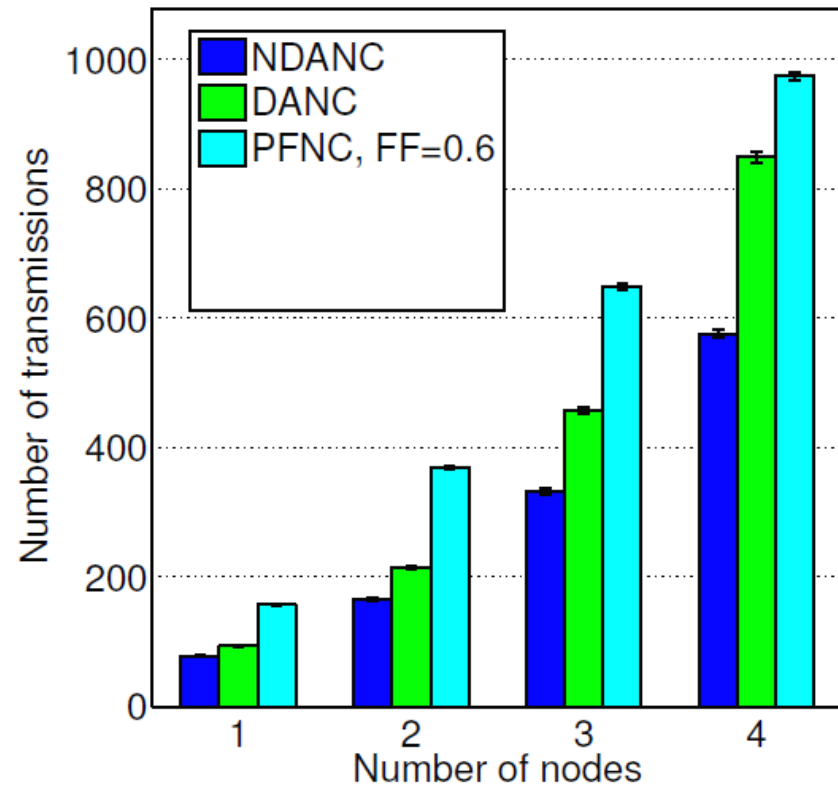
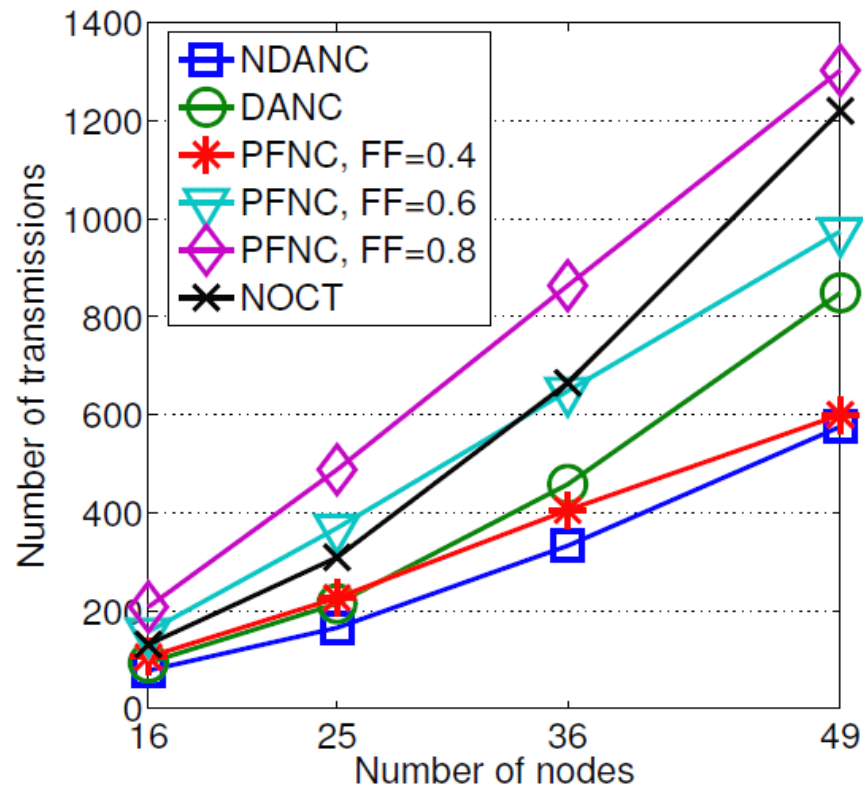


Simulations

16

- NDANC: Non Deadline-Aware NC
- DANC: Deadline-Aware NC

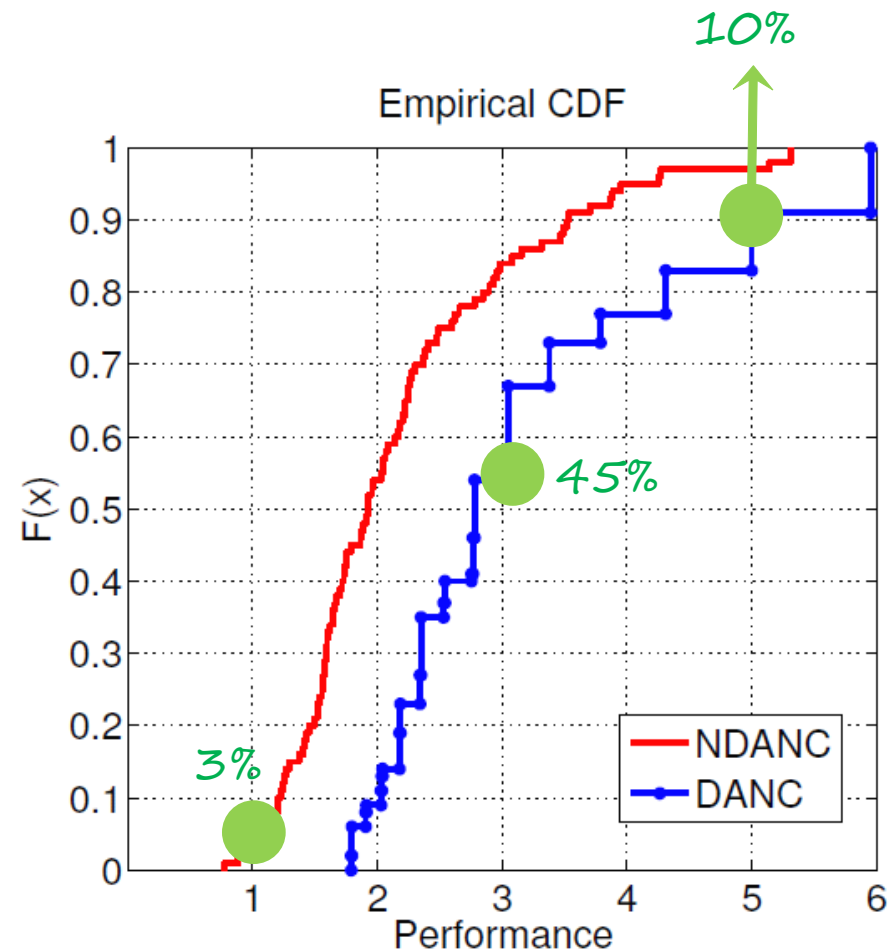
- PFNC: Probabilistic Forwarding NC
- NONCT: Non Coding Tree



Simulations

17

- Performance over PFNC FF=0.4
- NDANC: Non Deadline-Aware NC
- DANC: Deadline-Aware NC
- PFNC: Probabilistic Forwarding NC



Summary

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- The problem of energy-efficient broadcasting, subject to the deadline constraints, is NP-complete
- Three phases heuristic
 - ▣ Constructing broadcasting trees
 - ▣ Partitioning the packets
 - ▣ Performing coding among the same partition
- Future work
 - ▣ Scheduling in the case of single channel
 - ▣ Non reliable links

Questions