Network Coding-Based Broadcast in Mobile Ad hoc Networks

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Outline

- Introduction
- Related work
- CODEB
- Performance evaluation
- Conclusion

Introduction

- The overhead of using flooding to support broadcast is very high.
- Due to the broadcast nature of wireless media, not all nodes need to transmit in order for the message to reach every node.

Introduction

- Network coding has been shown to significantly improve transmission efficiency in wired networks ,and has been adapted to wireless networks.

- In this paper, we show how network coding can provide significant gains when applied to a deterministic broadcasting approach.

Related work

- Two main approaches for efficient broadcast:

-**Probabilistic** (gossiping-based)

Broadcast to neighbor with a given probability.

Disadvantage:

Difficult to tune the proper probability.

-**Deterministic**

Predetermine and select the neighboring nodes that forward the broadcast packet.

CODEB

- **Opportunistic listening:**

  -Node knows it's 2-hop neighbor and store the overheard packets for a limited period T.

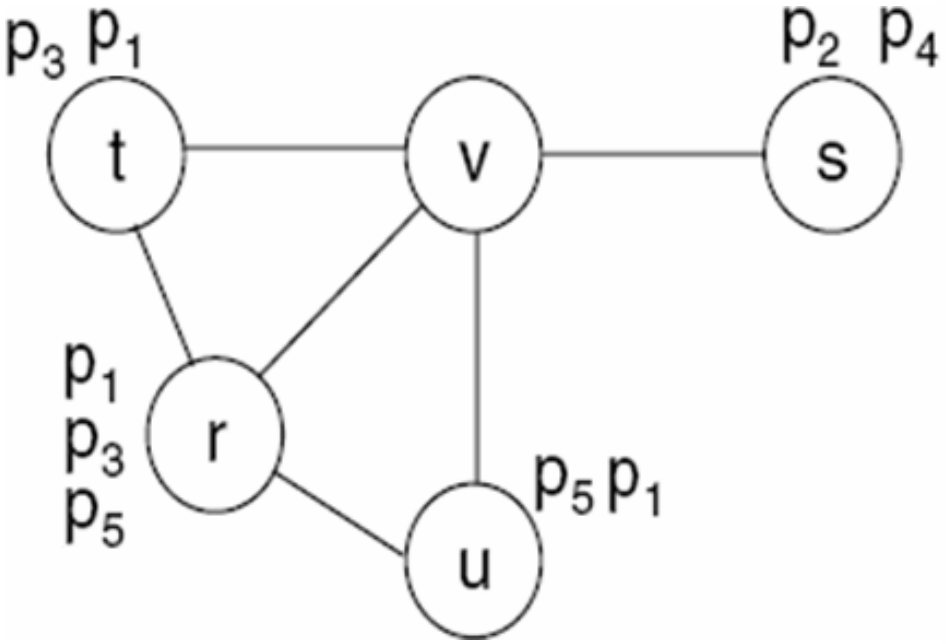
- **Forwarder selection and pruning:**

  -Use PDP to select forwarder ,a node only rebroadcasts a packet when it is chosen.

- **Opportunistic coding:**

  -Each node examines its to-be-forwarded packets and its current neighbor table to determine if it can send coded packet(s).

Neighbor reception table



v	p_1	p_2	p_3	p_4	p_5
r	1	0	1	0	1
s	0	1	0	1	0
t	1	0	1	0	0
u	1	0	0	0	1

Partial Dominant Pruning (PDP)

- Each node knows it's 2-hop neighbor.
  (By broadcast it's 1-hop neighbor to neighbors.)
- A node only rebroadcast when it chosen as forwarder.
- Node chose forwarders from it's 1-hop neighbor based on the number of 2-hop neighbor it can cover.

Partial Dominant Pruning (PDP)

$N(u)$:set of 1-hop neighbors of node *u*

$N(N(v))$:2-hop neighborhood of node v.

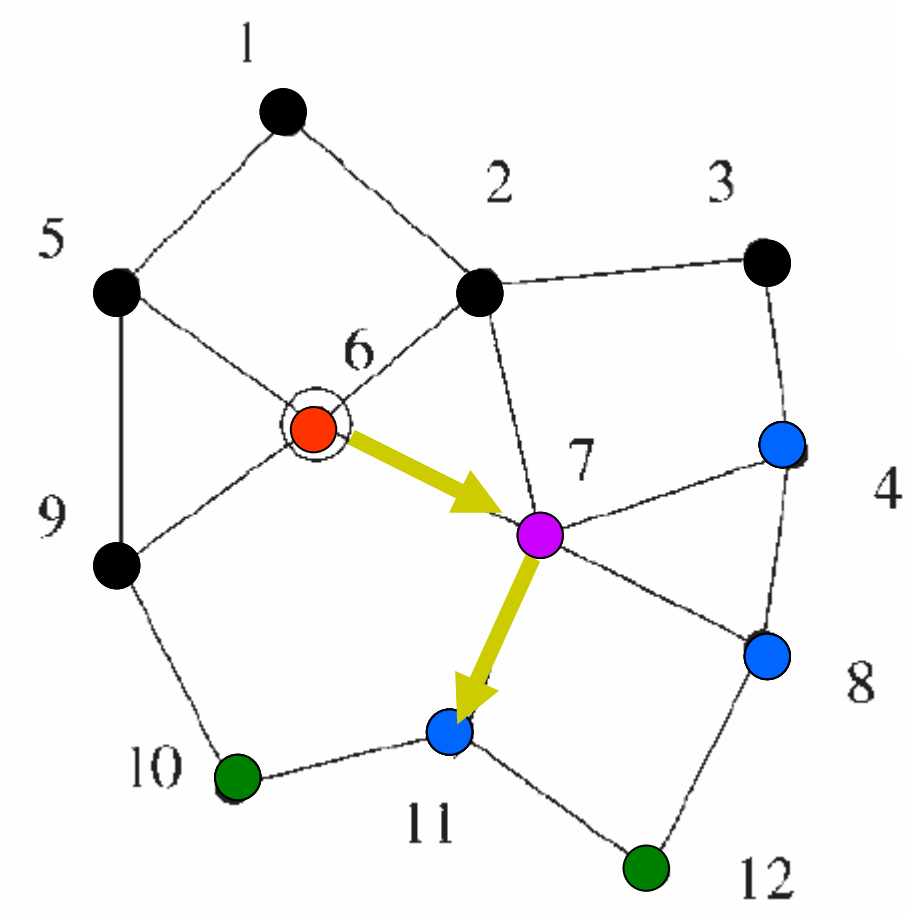
$$P(u,v) = N(N(u) \cap N(v))$$

$$B(u,v) = N(v) - N(u)$$

$$U(u,v) = N(N(v)) - N(u) - N(v) - P$$

- Greedy choose nodes in $B(u,v)$ to full cover $U(u,v)$.

Partial Dominant Pruning (PDP)



u	v	P	U	B	F
ϕ	6	ϕ	1,3,4,8,10,11	2,5,7,9	7,2,9
6	7	1,3,6,7	10,12	4,8,11	11
6	2	2,4,6,8,11	ϕ	1,3	[ ]
6	9	1,6,9	11	10	10
7	11	ϕ	9	10,12	10
9	10	ϕ	7,12	11	11

$N(u)$

$N(N(v))$

$P(u,v) = N(N(u) \cap N(v))$

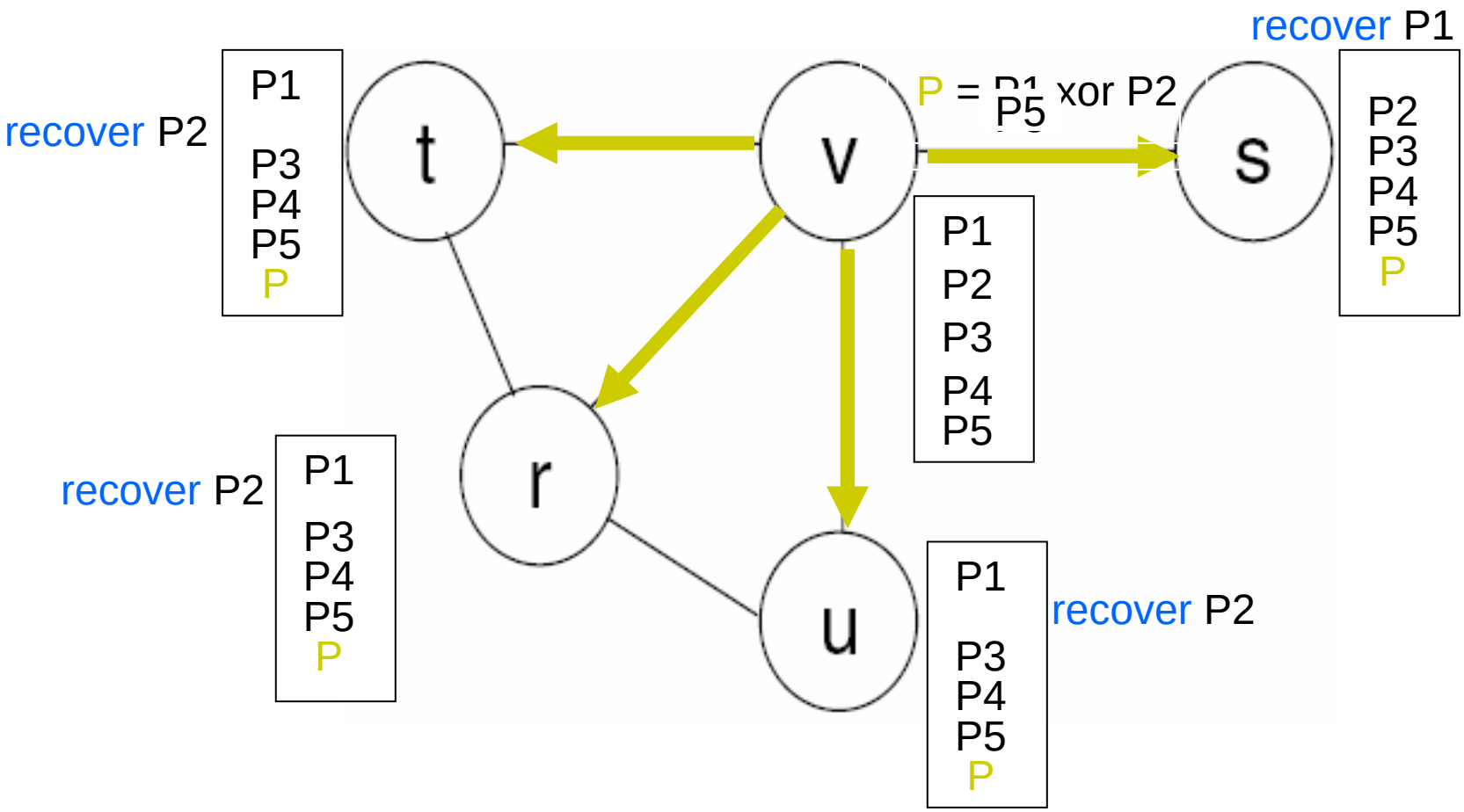
$B = N(v) - N(u)$

$U = N(N(v)) - N(u) - N(v) - P$

Packet encoding algorithm

- XOR-based :
- Reed-Solomon code based :

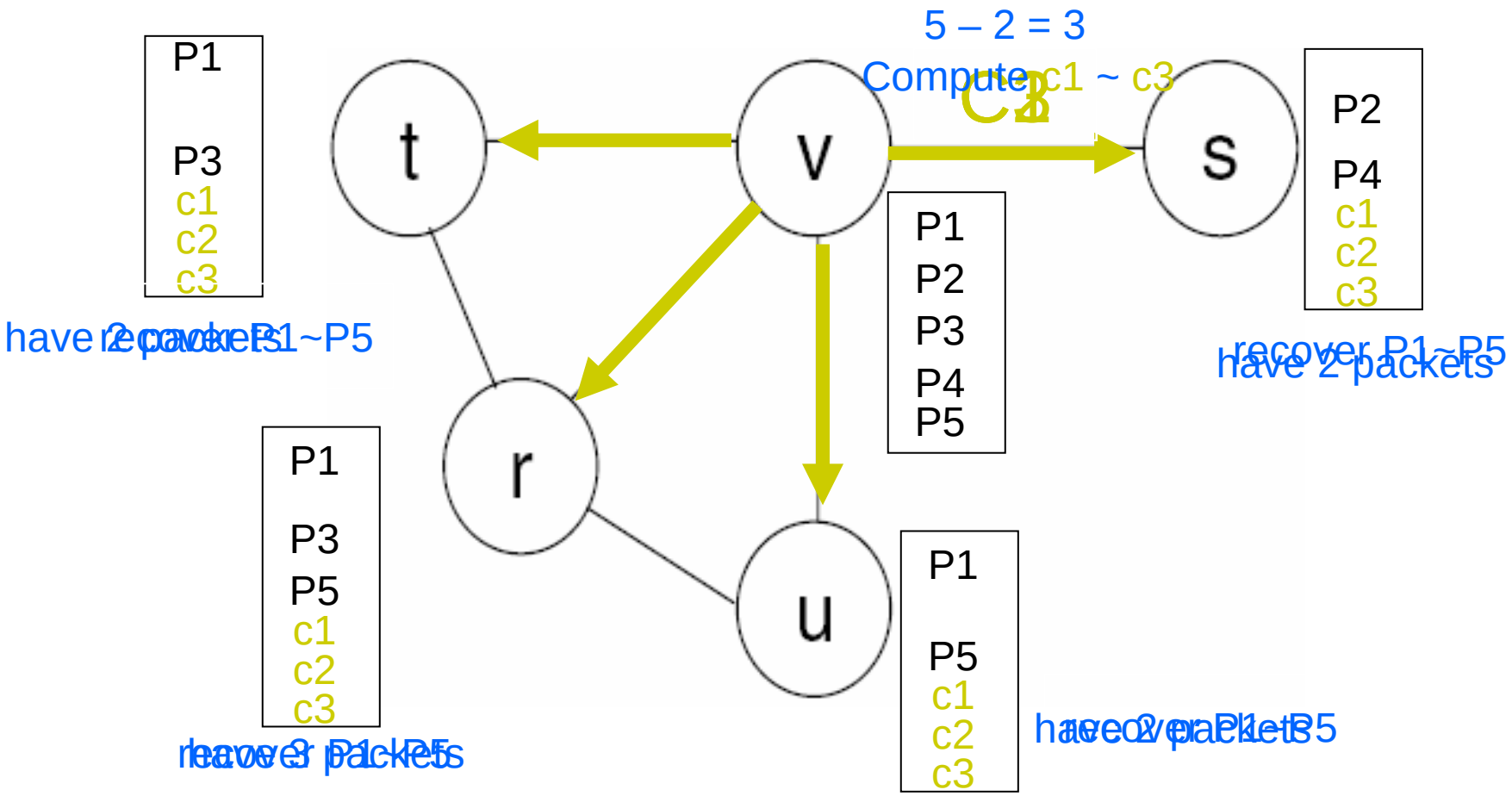
Use XOR-based algorithm:



Reed-Solomon codes

- Block-based error correcting codes with a wide range of applications in digital communications and storage.
- N data blocks with M checksum blocks.
- Can reconstructed from any of M blocks fail in the (N+M) blocks.

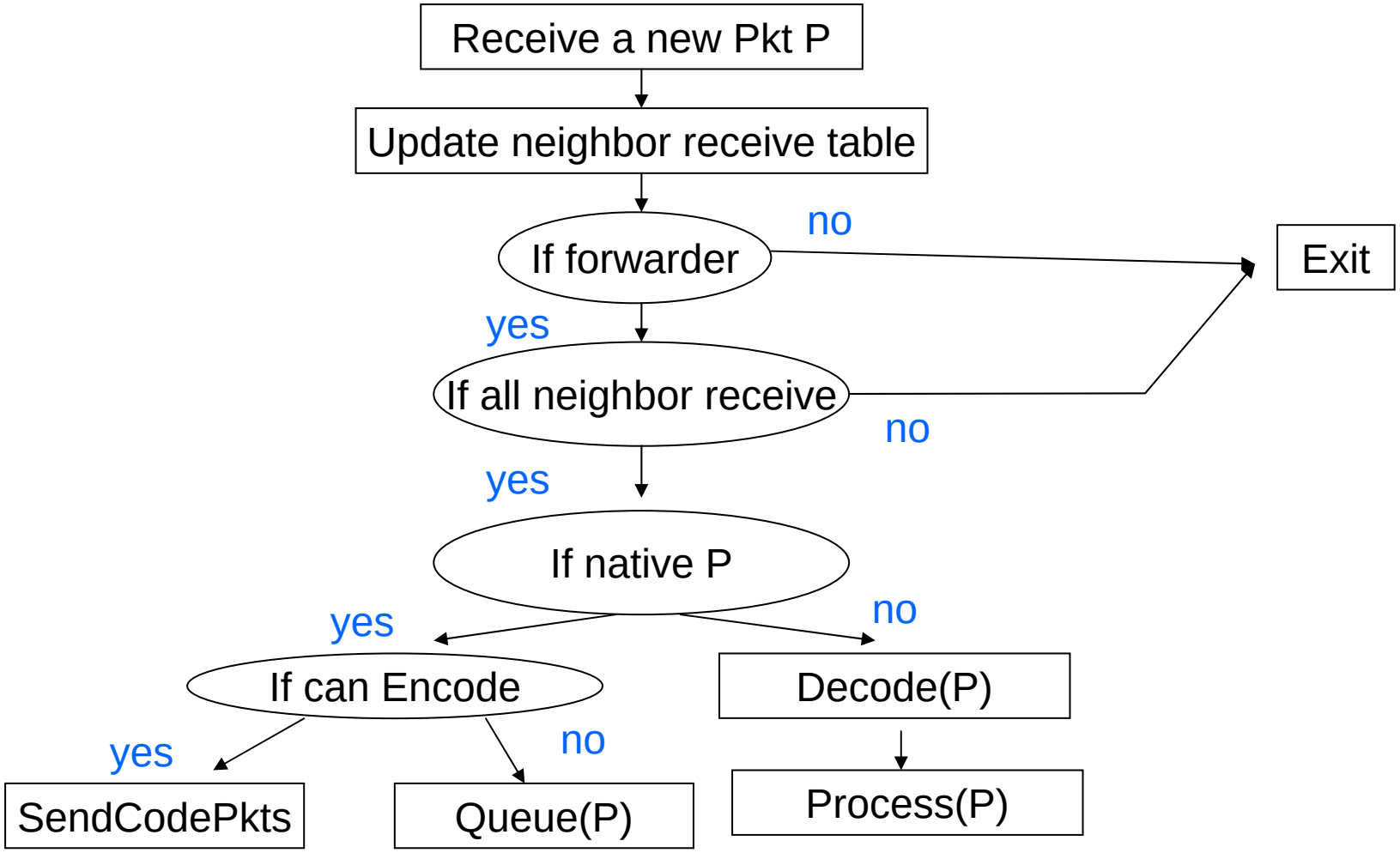
Use Reed-Solomon codes



Packet decoding

- Each node maintains a Packet Pool, in which it keeps a copy of each native packet it has received or sent out.
- The table is garbage collected every few seconds.
- When a coded packet is received, the node decodes and then processes the packet.

CODEB flow chart



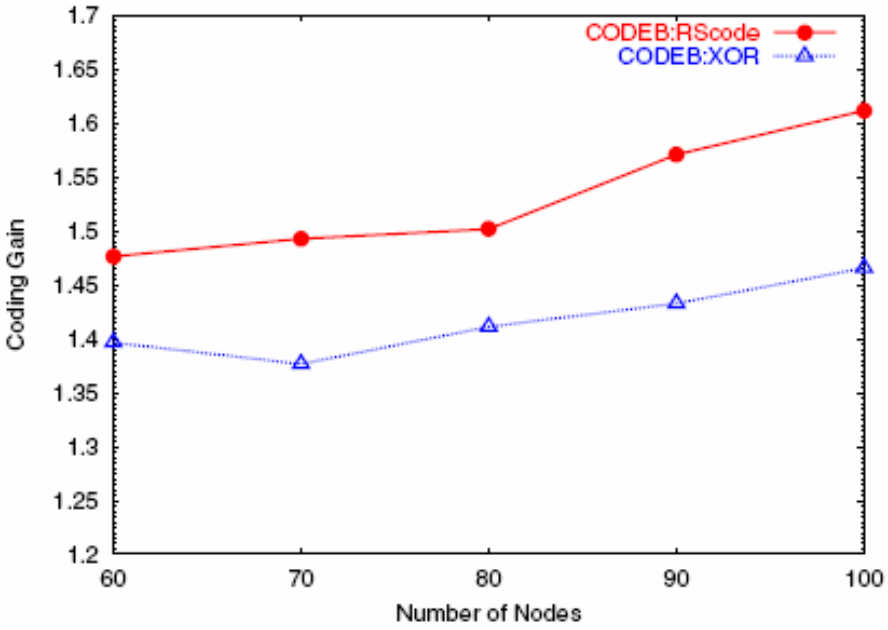
Performance evaluation

- Coding gain:

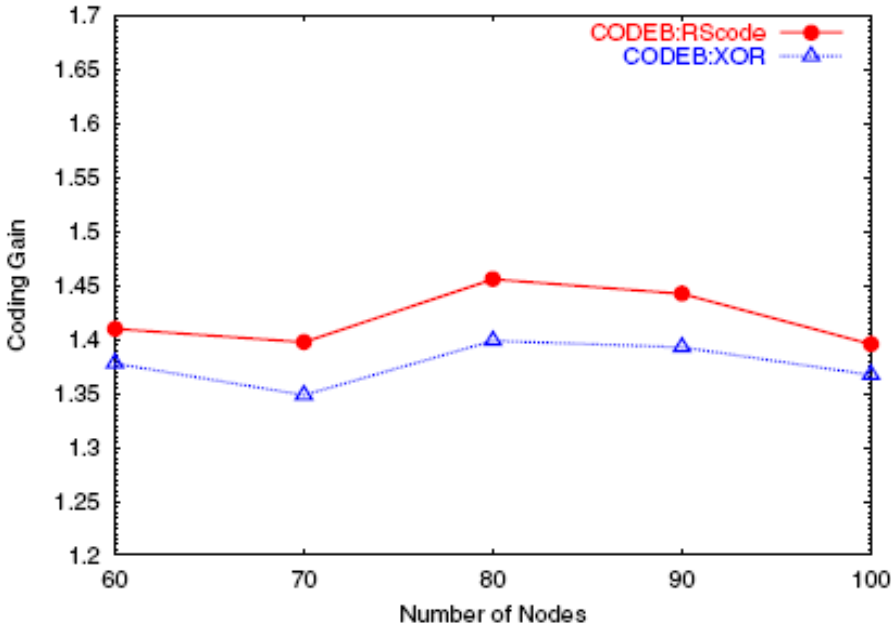
  -The ratio of the number of transmission required by PDP, to the number of transmissions used by CODEB.

- Packet delivery ratio

Performance evaluation

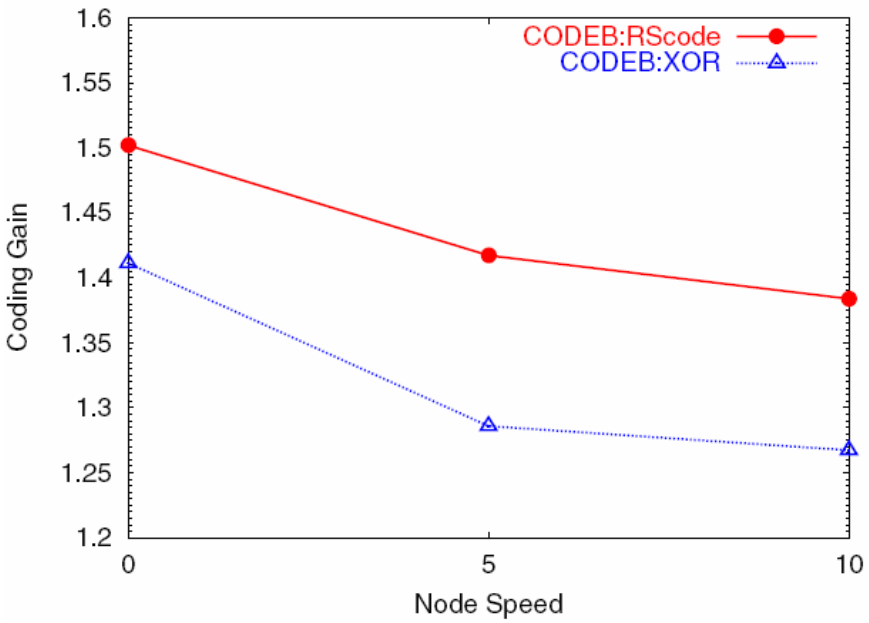


Dense topology

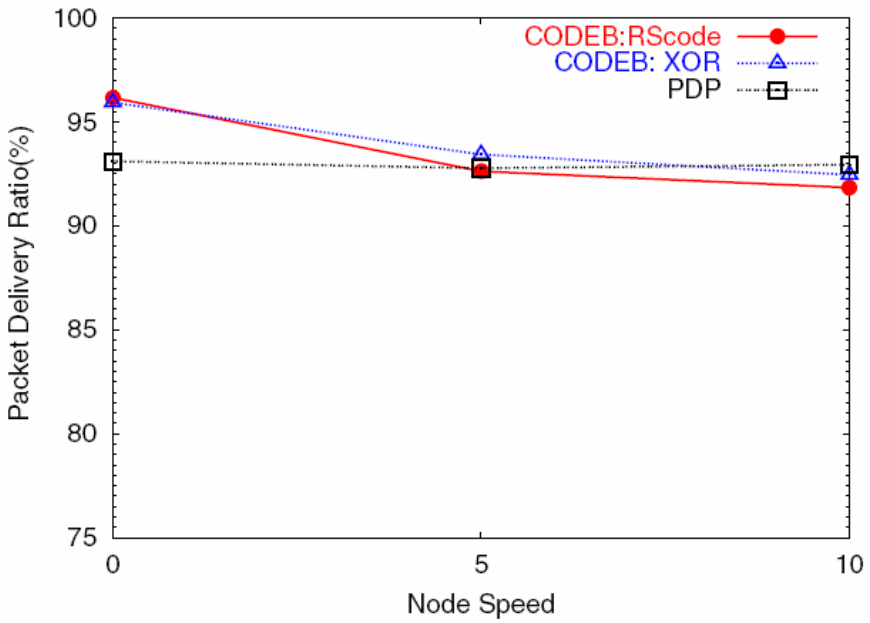


Sparse topology:

Performance evaluation

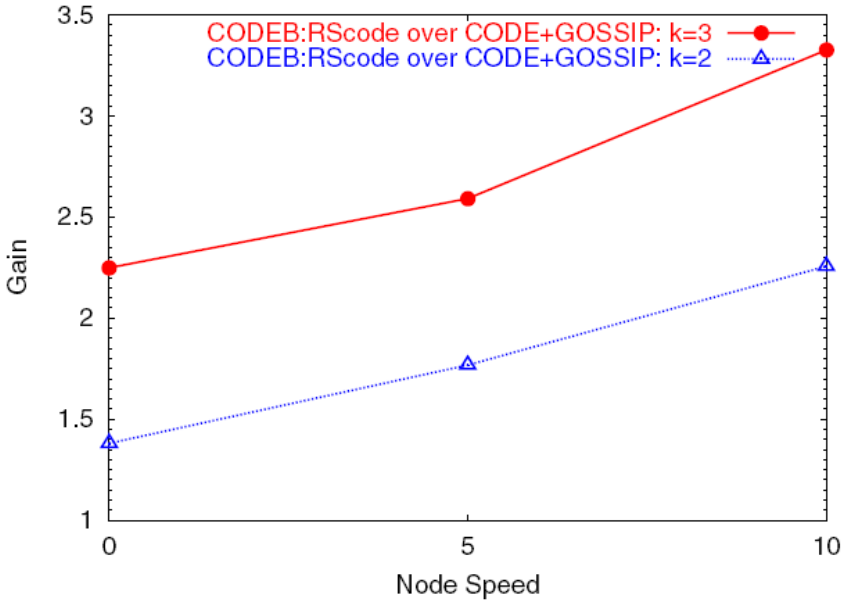


(a) Coding gain for low load

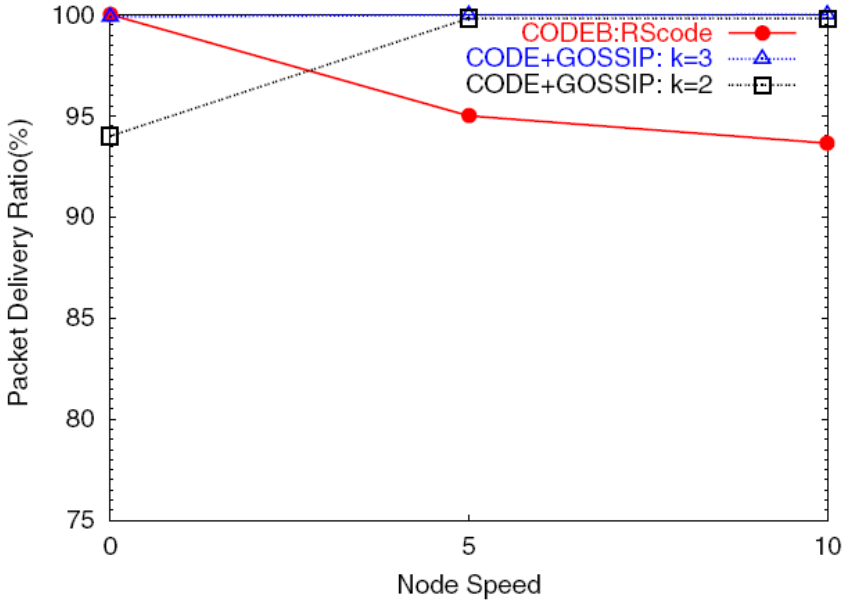


(b) Packet delivery ratio for low load

Performance evaluation



(a) CODE:RScode over CODE+GOSSIP



(b) Packet delivery ratio

Conclusion

- This paper shows how to incorporate network coding into a non-coding based localized algorithm called PDP for improving broadcast efficiency.
- The CODEB coding algorithm can potentially be applied to other non-coding based schemes.

Discussion

- How about joint forwarding and coding?
- Whether there exists efficient schemes where nodes implicitly volunteer to be forwarders based on the local RF condition.