Some Results on the Index Coding Problem

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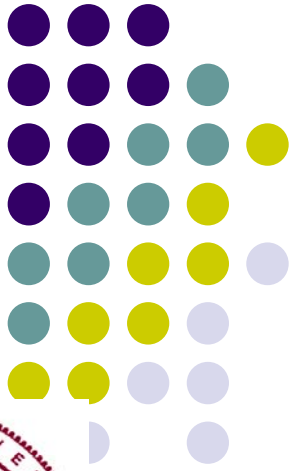
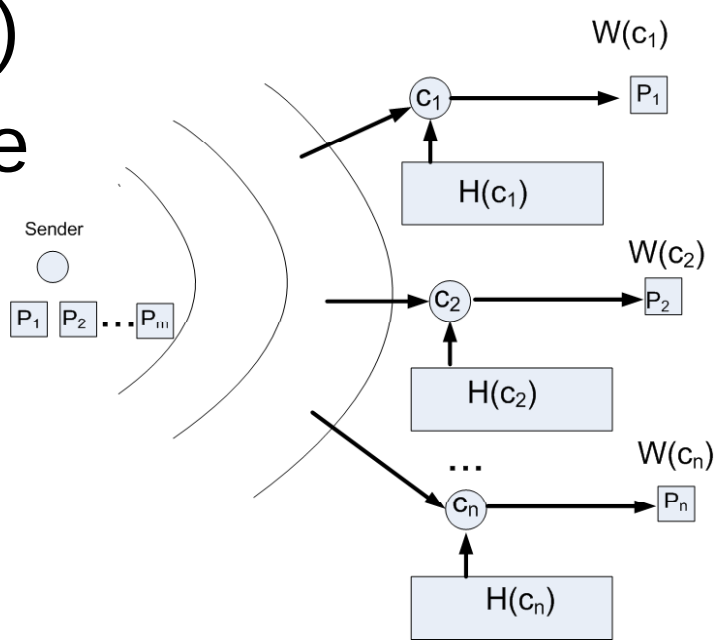


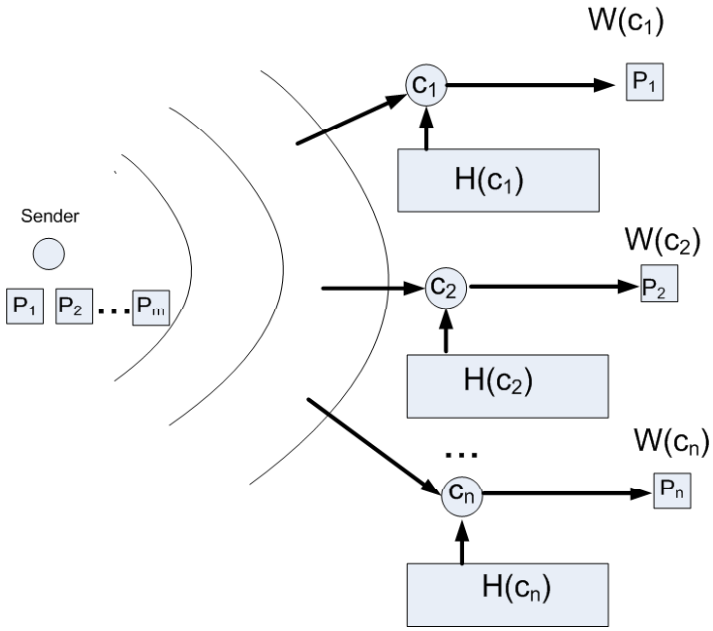
Index Coding

- A sender has a set of m messages $p_1,p_2,\ldots,p_m$
- Need to broadcast messages to n clients $c_1,c_2,\ldots,c_n$
- Each client c_i has a side information - a set $H(c_i)$ (known to the sender)
- Each client wants message in $W(c_i)$



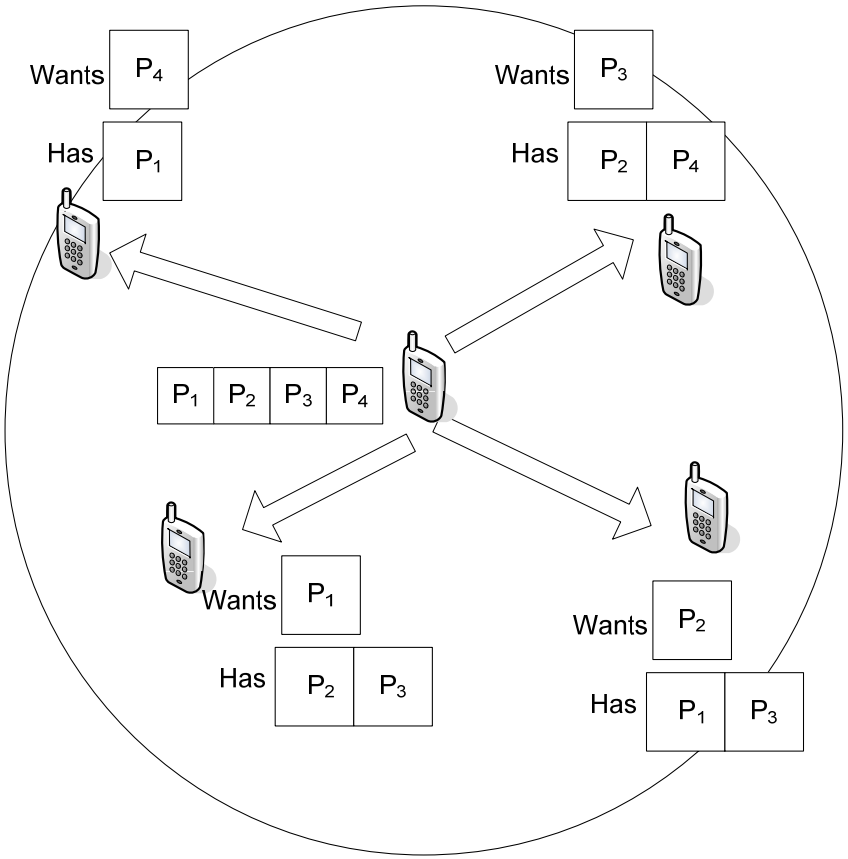
Index Coding

- Goal: design a coding scheme that minimizes the total number of transmissions
  - Each client must be able to recover all packets in set $W(c_i)$
  - Using the packets transmitted over the channel and side information



Opportunistic coding

- When a node transmits a packet it uses its knowledge of what its neighbors have heard



$p_1+p_2+p_3$

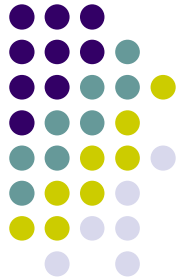
p_1+p_4

Connection to Network Coding

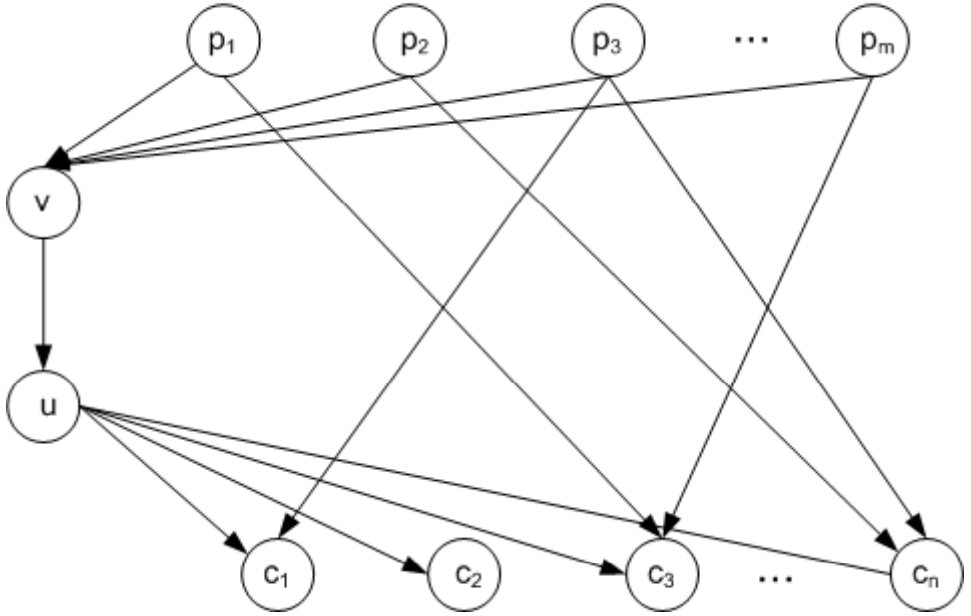
- Theorem: For every network coding problem $\mathbb{N}$ there exists a corresponding index coding problem $\mathbb{I}_{\mathbb{N}}$ such that
  - A linear network code for $\mathbb{N}$ implies an optimal linear index code for $\mathbb{I}_{\mathbb{N}}$ over the same field
  - And vice versa

S. ElRouayheb, A. Sprintson, C. Georghiades, "On the Relation Between the Index Coding and the Network Coding Problems, " submitted to ISIT 2008

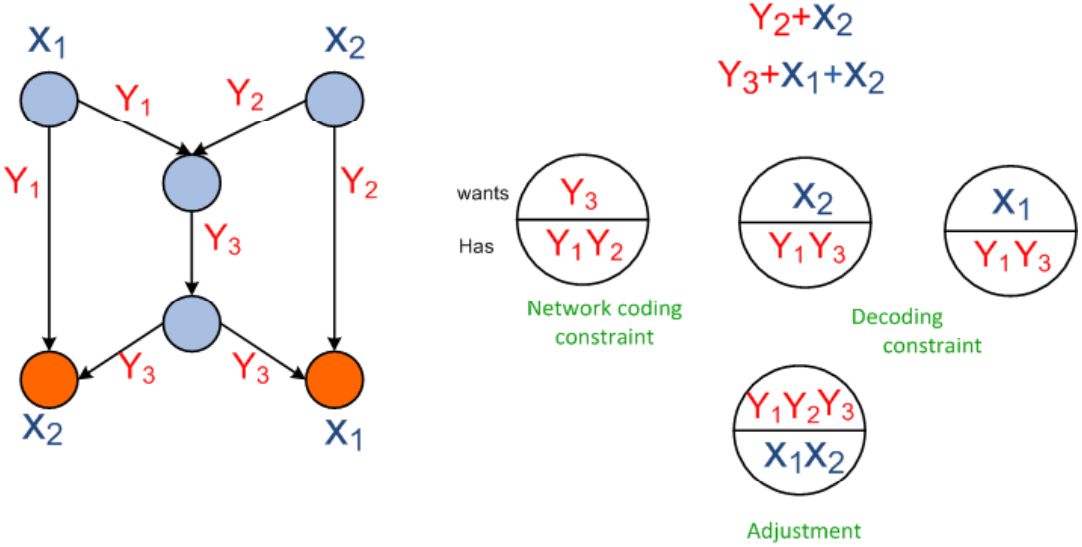
Connection to Network Coding



- One direction - easy



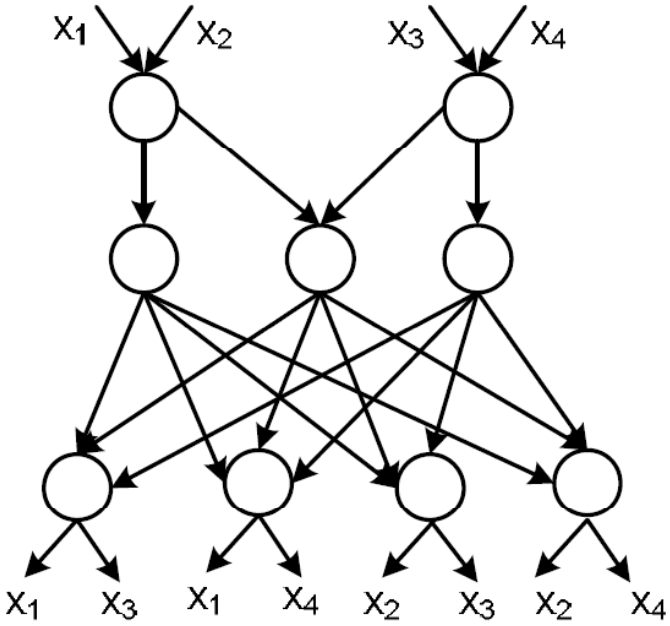
Proof Idea



- Add new variables associated with edges outgoing from a source or a forwarding node
- Add three type of clients: Encoding, decoding and adjustment
- Solution for network coding will imply a solution for index coding and vice versa

Block Index Coding

- We use the previous theorem to prove that block index coding outperforms scalar one
- Idea: use reduction on the M-network



Non-Linear Index Coding

- We also show that non-linear index codes might lead to fewer number of transmissions than linear ones
- Reduction from Zeger et al. network