Thesis

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Projet MASCOTTE - INRIA/I3S(CNRS-UNSA)

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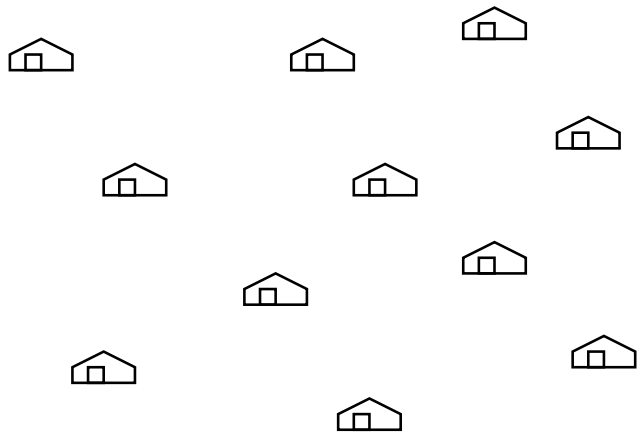
Motivation



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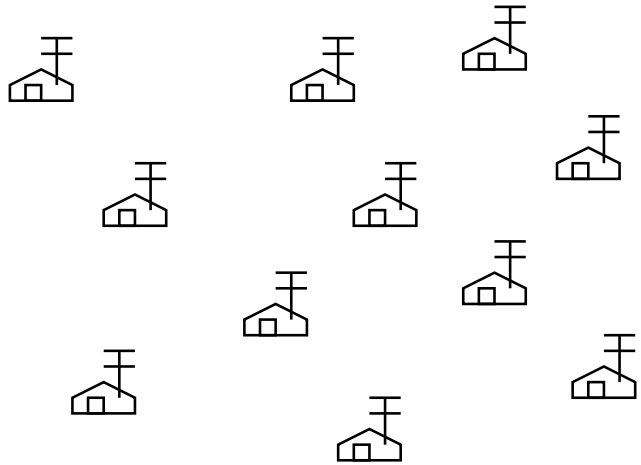

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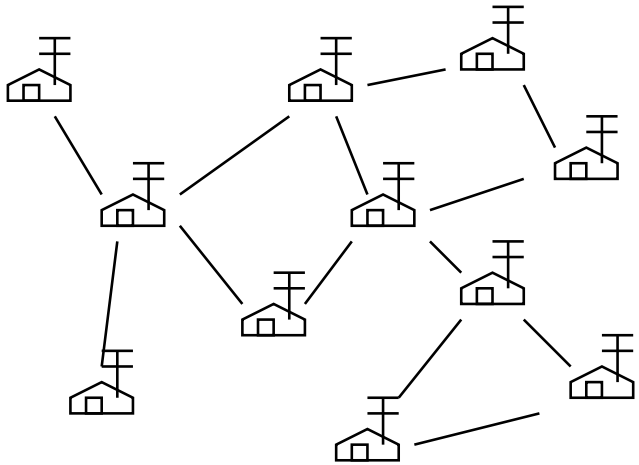

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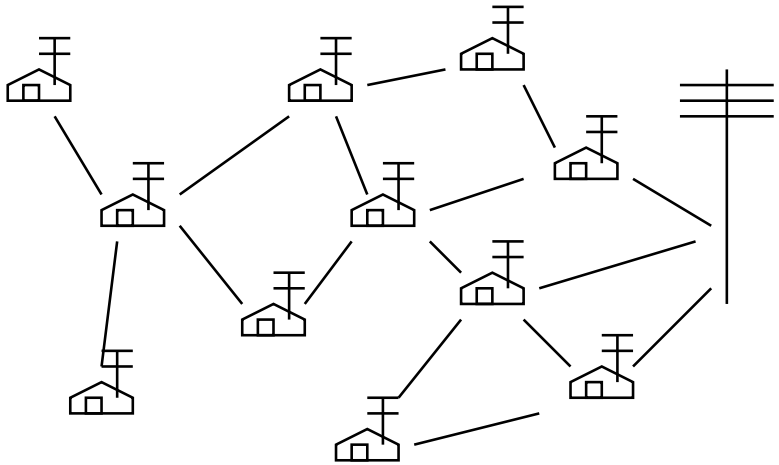
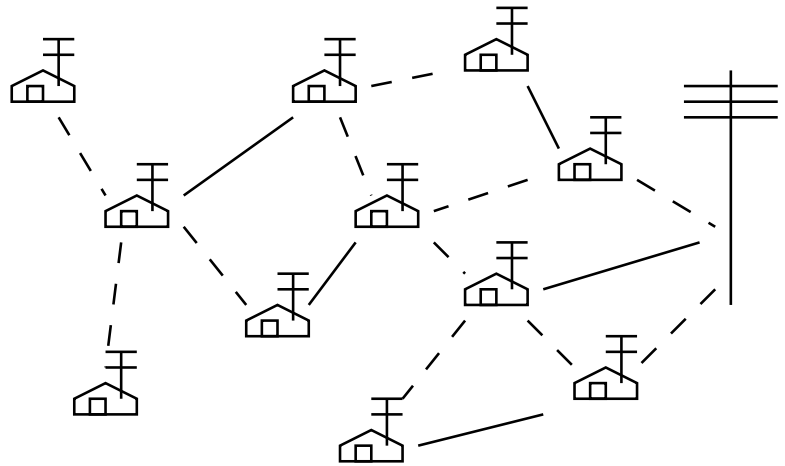


Gathering Problem

- The nodes have messages.
- There is a special node called gateway.
- Messages must be collected by the gateway.

Interference

- All the nodes cannot transmit at the same time!
- Round: A set of simultaneous transmissions.



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Linear Program

- messages $\longrightarrow$ flow demand
- constraints
  - Flow conservation
  - interference

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Interference Model

- oriented interference. $a \leftarrow b \qquad u \leftarrow v$
- d_T Transmission distance
- $d_I > d_T$ Interference distance

Example

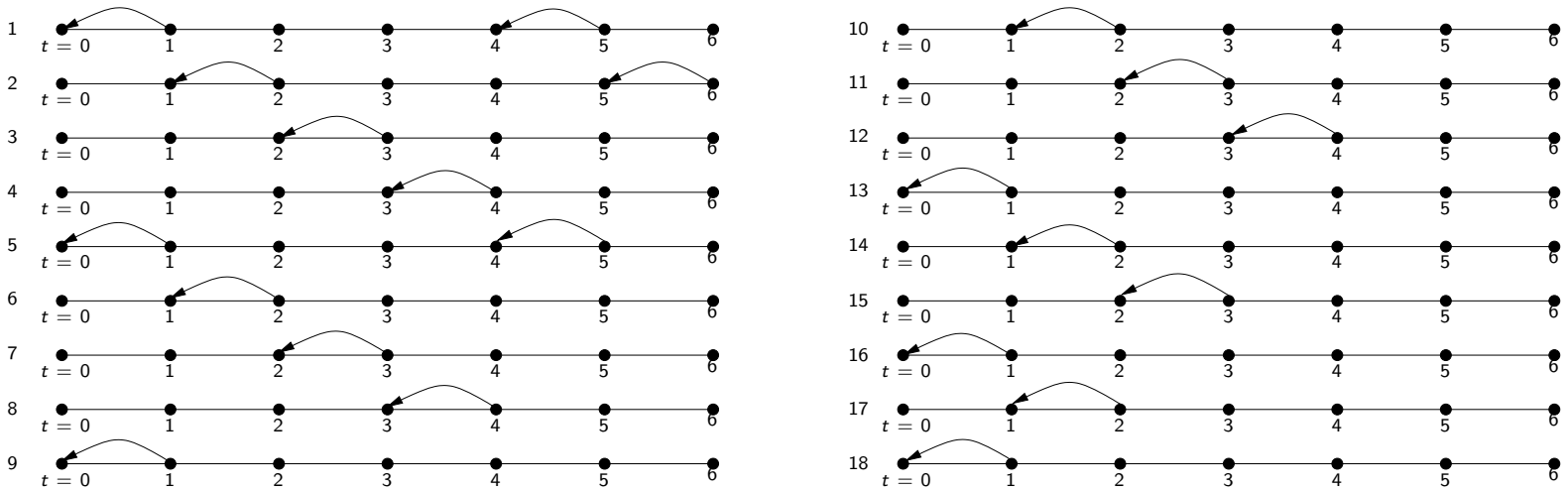

Figure: A gathering protocol in the path when $d_T = 1, d_I = 2$ and every vertex has one message to send to the sink $t = 0$.

Hardness

- In general: NP-complete
- Admits 4–aproximation [JCB, Ralf, Nelson, Stephanne]
- Good protocols for specific cases.

Gathering in the path

- Path P_n: $n-1$ nodes + BS
- BS at the end of the path
- Interesting case: path P_n, with $n > d_I + d_T$

Results

Theorem

- *Case: BS in an end vertex, unitary case*
  - *Calculate the optimal protocol is poly in the length of the path.*

Idea of the proof

- Simple Protocols
  - Any call transmit a message
  - Protocol only performs forward calls
  - Only loooong calls into the zone $BS \cdots d_l$ (size d_T)

Idea of the proof

Lemma

- *Given a simple protocol A for* $P_n \rightarrow$ *protocol B for* P_{n+1}*?*
  - *For* $d_T > 0$ *and* $d_I = pd_T + q$
  - $|A| = |B| + \begin{cases} p+1 \\ p+2 \end{cases}$

Example incremental protocol

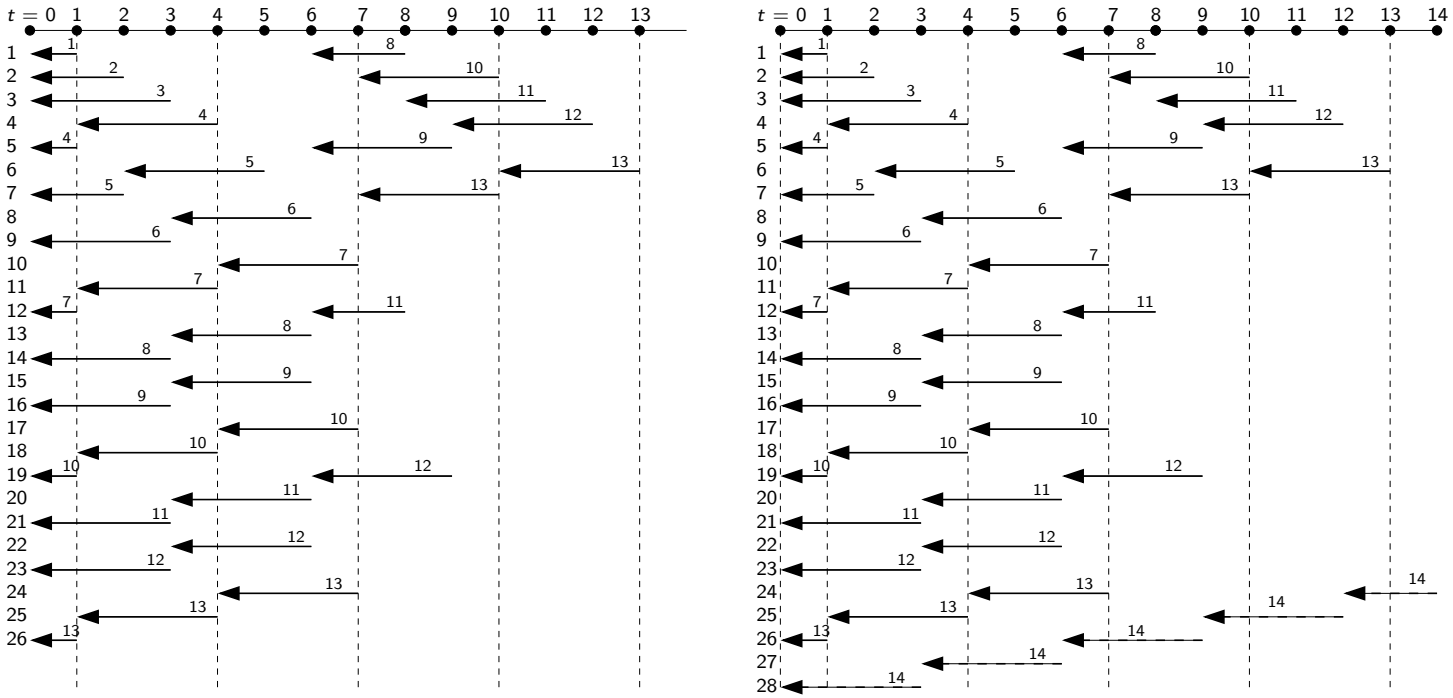

Figure: Incremental Protocol for P_{15} starting from P_{14}. $d_I = 4$, $d_T = 3$. $p = 1$

Idea of the proof

- For P_{n_0}, with $n_0 = d_I$, compute all the posibilities of SIMPLE protocols
- We increment the protocol from P_{n_0} to P_{n_0+1} and so on...

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Model

- Goal: Collect information into the BS
  - 2D-grid with BS in $(0, 0)$.
  - subset of nodes with messages.
  - no buffering $\leftarrow$ hot-potato routing.

Hardness

- NP-hard for general graphs
  - 2-approximation [Florens et al.]
- Best algo known for grids: 3/2-approximation [Revah & Segal]
- Our result: +1-approximation

Lower Bound

Lemma (Florens et al)

$$LB = \max_{min\mathcal{M}} d(m, BS) + |\{u \in \mathcal{M} \mid d(u, BS) \geq d(m, BS)\}| - 1$$

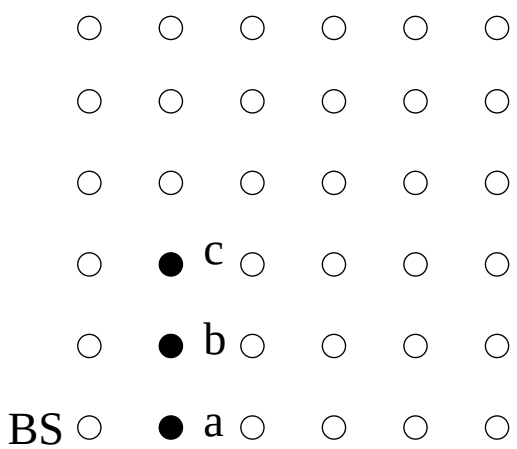
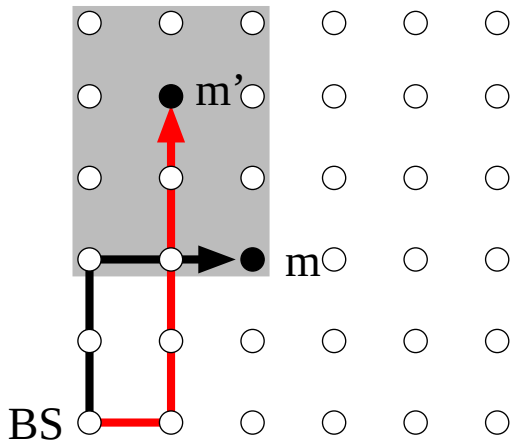


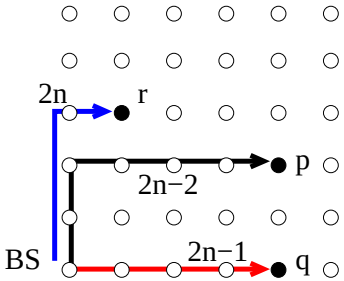
Figure: $LB = 3$

+2–approx

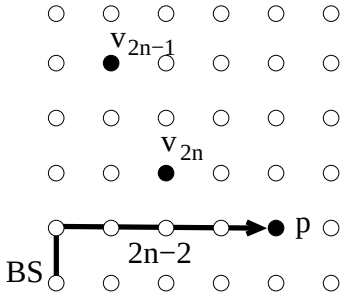
- Gathering ← Personalized Broadcasting.
- Start the process from the furthest messages.
- Avoid collisions between two consecutive messages



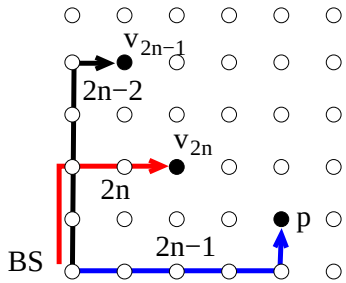
Possibilities



(a) $\{q, r\} = \{m_{2n-1}, m_{2n}\}$ and q strictly lower than r.



(b) Both m_{2n-1} and m_{2n} are higher than p.



(c) New scheduling in Case of previous figure

Figure: $2n-2$ messages have been scheduled, finishing with the one to $x \in \{v_{2n-2}, v_{2n-3}\}$. When the next two messages must be scheduled, two cases occur according to the position of v_{2n-1} and v_{2n} relatively to x. In the figures, an arrow with label i represents the route of the i^{th} message.

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Round Weighting

- We are only interested in the number of rounds needed, not in the order.
- To use a fraction of a round is allowed.

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On the complexity of bandwidth allocation in radio networks.
Theoretical Computer Science, 2008.
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Bandwidth allocation in radio grid networks.
Algotel, 2008.