Brief Announcement: Opportunistic Information Dissemination in Mobile Ad-hoc Networks: adaptiveness vs. obliviousness and randomization vs. determinism

Martín Farach-Colton\textsuperscript{1} Antonio Fernández Anta\textsuperscript{2} Alessia Milani\textsuperscript{3}
Miguel A. Mosteiro\textsuperscript{4} Shmuel Zaks\textsuperscript{5}

\textsuperscript{1}Department of Computer Science, Rutgers University & Tokutek Inc.
\textsuperscript{2}Institute IMDEA Networks
\textsuperscript{3}LABRI, University of Bordeaux 1
\textsuperscript{4}Department of Computer Science, Rutgers University & LADyR, GSyC, Universidad Rey Juan Carlos
\textsuperscript{5}Department of Computer Science, Technion

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Mobile Ad-hoc Network (MANET)

- Mobile set of nodes (processors with radio)
- No stable communication infrastructure
- Multihop network

E.g.
Opportunistic Communication

Thanks to mobility and asynch activation, communication between $x$ and $y$ is feasible even if a path never exists! (a *chrono-path*)
The Dissemination Problem

Some information held by a given source node $x$ at time $t$, must be disseminated to some set of nodes $S \subset V$.

In order to prove lower bounds we use Geocast.
Model

- **Network:**
  - \( n \) mobile nodes deployed in \( \mathbb{R}^2 \)
  - slotted time steps:
    - slot length dominated by communication time
    - same for all nodes

- **Node:**
  - unique ID in \([n]\)
  - may start/fail at any time slot
  - radio communication:
    - unique radio channel \( \implies \) collisions
    - background noise \( \equiv \) collision noise \( \implies \) no collision detection
    - no simultaneous reception & transmission
    - limited range \( r \implies \) multihop network
Model

- **Adversary:**
  - initial position and movement
  - de/activation schedule *(lower bounds don’t use it!)*

limited by three parameters:

- a maximum speed \( v_{\text{max}} > 0 \)
- the system must be \((\alpha, \beta)-\text{connected}\), \(\alpha, \beta \in \mathbb{Z}^+\)

**Definition \(((\alpha, \beta)-\text{connectivity})\)**

While moving at \( \leq v_{\text{max}} \) speed, \( \forall \) non-trivial partition \((S, \overline{S})\),

\[ \exists \leq \alpha \text{ consecutive steps without a } \beta\text{-stable edge between } S \text{ and } \overline{S}. \]

(an edge is \(k\)-stable at time \(t\) if it exists for \(k\) consecutive steps \([t, t + k - 1]\))
Model

$(\alpha, \beta)$-connectivity, for the partition defined by the information
Randomized Protocols:

- **oblivious** [C’01]: protocol access sequence of random variables at each node, independent of execution and mutually independent.

- **locally adaptive**: same but rv’s may be mutually dependent. (still independent of the execution)

- **fair** [C’01]: all nodes transmit with same probability in any given time step. (orthogonal def)
### Results

<table>
<thead>
<tr>
<th></th>
<th>randomized</th>
<th>deterministic [FMMZ’10]</th>
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<tbody>
<tr>
<td><strong>l.b.</strong></td>
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<td>adaptive</td>
<td>$\Omega (\alpha n + n^2 / \log n)$ exp.</td>
<td>$\Omega (\alpha n + n^2)$</td>
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Conclusions

- local adaptiveness \( \Omega \left( \alpha n + \frac{n^2}{\log n} \right) \exp \)
  
  does not help w.r.t. obliviousness \( O \left( \alpha n + \left( 1 + \frac{\alpha}{\beta} \right) \frac{n^2}{\log n} \right) \) whp.

- linear separation between oblivious randomized \( O \left( \alpha n + \left( 1 + \frac{\alpha}{\beta} \right) \frac{n^2}{\log n} \right) \) whp
  
  and oblivious deterministic \( \Omega \left( \alpha n + \frac{n^3}{\log n} \right) \).

- log separation between adaptive randomized \( O \left( \alpha n + \left( 1 + \frac{\alpha}{\beta} \right) \frac{n^2}{\log n} \right) \) whp
  
  and adaptive deterministic \( \Omega \left( \alpha n + n^2 \right) \).
Thank you