Brief Announcement: Opportunistic Information Dissemination in Mobile Ad-Hoc Networks*:

Adaptiveness vs. Obliviousness and Randomization vs. Determinism

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Abstract. In the context of Mobile Ad-hoc Networks (MANET), we study the problem of disseminating a piece of information, initially held by a source node, to some subset of nodes. We use a model of MANETs that is well suited for dynamic networks and opportunistic communication. We assume that network nodes are placed in a plane where they can move with bounded speed; they may start, crash and recover at different times; and they communicate in a collision-prone single channel. In this setup informed and uninformed nodes may be disconnected for some time, but eventually some informed-uninformed pair must be connected long enough to communicate. We show negative and positive results for different types of randomized protocols, and we contrast them with our previous deterministic results.

A MANET is a network of processing nodes that move in an environment that lacks any form of communication infrastructure. In this paper we revisit a class of MANETs that is well suited for opportunistic communication. Specifically, nodes are placed in a plane, in which they can move with bounded speed, and communication between nodes occurs over a collision-prone single channel. Our model includes a parameter α that mainly characterizes the connectivity and a parameter β that models the stability properties of the network, provided that

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nodes move, may crash and recover and may be activated at different times. These parameters characterize *any* model of dynamic network, and affect the progress that a protocol *may* achieve in solving basic tasks. Our model is formalized in [2] and it is slightly weaker than the one presented in [1]. In this context, we consider the problem of information dissemination. Formally,

Definition 1. *Given a MANET formed by a set V of n nodes, let $\mathcal{P}$ be a predicate on V and $s \in V$ a node that holds a piece of information I at time t_1 (s is the source of dissemination). The* Dissemination *problem consists of distributing I to the set of nodes $V_{\mathcal{P}} = \{x \in V :: \mathcal{P}(x)\}$. A node that has received I is termed* covered*, and otherwise it is* uncovered*. The Dissemination problem is solved at time slot $t_2 \geq t_1$ if, for every node $v \in V_{\mathcal{P}}$, v is covered by time slot t_2.*

The Dissemination problem abstracts several common problems in distributed systems, e.g. Broadcast, Multicast, Geocast, Routing etc. To solve the Disseminationproblem we consider three classes of randomized algorithms: *locally adaptive* randomized algorithms where the probability of transmission of a node in a step of an execution may depend on its own communication history; *oblivious* randomized protocols where the probability of transmission of a node in a step of an execution depends only on predefined parameters; and *fair* randomized protocols, in which at each step all nodes transmit with the same probability.

Our Results. We have determined the minimum values for parameters α and β under which randomized protocols to disseminate information with large enough probability exist; we have studied the time complexity in relation with the maximum speed of movement and the probability of failure, and we have put the results obtained here in perspective of our results in [1] highlighting the impact of fundamental characteristics of Disseminationprotocols, such as determinism vs. randomization, and obliviousness vs. adaptiveness, on dissemination time. These results are extensively presented in [2] and summarized in Table 1. These results show that there is no gap between oblivious and locally adaptive protocols and that randomization reduces the time complexity of the problem in a linear factor in the oblivious case and in a logarithmic factor in the adaptive case (for reasonably small values of α).

Table 1. Oblivious and fair lower bounds to achieve success probability $p \geq 2^{-n/2}$. Locally adaptive lower bound in expectation. Upper bounds with probability $p \geq 1 - e^{-(n-1)/4}$.

		randomized	deterministic [1]
lower bounds	oblivious	$\Omega\left(\alpha n + n^2/\log n\right)$	$\Omega\left(\alpha n + n^3/\log n\right)$
	locally adaptive	$\Omega\left(\alpha n + n^2/\log n\right)$	$\Omega(\alpha n + n^2)$
	fair	$\Omega\left(\alpha n + n^2/\log n\right)$	–
upper bounds	oblivious	$O\left(\alpha n + (1+\alpha/\beta)\, n^2/\log n\right)$	$O(\alpha n + n^3 \log n)$
	locally adaptive	–	$O(\alpha n + n^2)$
	fair	$O\left(\alpha n + (1+\alpha/\beta)\, n^2/\log n\right)$	–

References

1. Fernández Anta, A., Milani, A., Mosteiro, M.A., Zaks, S.: Opportunistic Information Dissemination in Mobile Ad-hoc Networks: The Prot of Global Synchrony. In: Lynch, N.A., Shvartsman, A.A. (eds.) DISC 2010. LNCS, vol. 6343, pp. 374–388. Springer, Heidelberg (2010)
2. Farach-Colton, M., Fernández Anta, A., Milani, A., Mosteiro, M.A., Zaks, S.: Opportunistic Information Dissemination in Mobile Ad-hoc Networks: adaptiveness vs. obliviousness and randomization vs. determinism. Tech. rep. arXiv:1105.6151v1 (2011), http://arxiv.org/abs/1105.6151