ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Distributed Computing

HS 2010 Prof. Dr. Roger Wattenhofer, Philipp Sommer, Johannes Schneider

Ad Hoc And Sensor Networks
Exercise 7

Assigned: November 8, 2010
Due: November 15, 2010

1 Slotted Aloha

In this exercise we want to analyze 'Slotted Aloha' for the case that the number of stations n is not exactly known. We assume that in each time slot each station transmits with probability p. In the lecture you saw that the probability that the slot can be used (i.e. the probability that exactly one station transmits) is

$$\Pr(\text{success}) = n \cdot p(1-p)^{n-1}.$$

If n is fixed, we can maximize the above expression and get the optimal p as shown in the lecture. Now assume that the only thing we know about n is $A \leq n \leq B$.

a) Which value p maximizes Pr(success) for the worst $n \in [A, B]$?

b) What is this 'worst case optimal' value for p if $A = 100$ and $B = 200$?

2 Broadcast

Three students discuss the broadcasting problem with collision detection in graphs of constant diameter.

Student A claims that there is a deterministic protocol that allows to broadcast messages of length l in time $O(l)$. He says that it is possible since all nodes act synchronously and can detect collisions, which allows to transmit information one bit per round(slot) using the collision detection mechanism, i.e. detecting a transmission or collision in a slot means bit 1, detecting a free channel means 0.

Student B says that this is not possible because he can proof a lower bound of $\Omega(logn)$ for deterministic algorithms, which can be much larger than the length of a message l in general. He says that this can be done in the same way as for the lower bound of n for the deterministic broadcast without collision detection for graphs of diameter 2, i.e. using golden and blue nodes in the middle layer.

Student C claims that A's idea works in principle but all nodes need to know the length l of the message.

Who is right?

a) If you believe A is right, give an algorithm that performs the broadcast.

b) If you believe B is right, give a proof.

c) If you believe C is right, describe an algorithm given that all nodes know the message length l and explain why the message length l is needed.