Eidgenössische Technische Hochschule Zürich
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Distributed Computing Group

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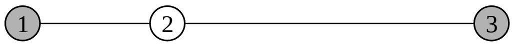
Ad Hoc And Sensor Networks
Exercise 9

Assigned: December 3, 2007
Due: December 10, 2007

1 Positioning

Let's assume a simple network topology consisting of three nodes as depicted below. Communication links exist between nodes 1 and 2 and nodes 2 and 3, respectively. The exact positions of nodes 1 and 3 are assumed to be known. Their coordinates are (0,0) and (0,2), respectively. Furthermore, the measured distances $d(1,2)$ and $d(2,3)$ are both 1. We want to embed this graph with a simple spring embedder. Nodes 1 and 3 are thereby anchor points and the initial placement of node 2 is set according to the figure below at (0,0.6).



a) As seen in the lecture, the force at node i is given by $F_i = \sum_{\forall j_1} F_{ij}$. The spring embedder moves node i in the direction of the superposition of all forces by $\rho * F_i$, where ρ is the attenuation factor. What happens if ρ is set equals to 1?

b) How long does it take node 2 to move to its actual position—which is obviously (0,1)—if ρ is set to 0.9? What is the ideal attenuation factor for this example?

2 Time Synchronization

In the lecture we have seen the two algorithms TPSN and RBS which directly change clock values of devices in order to achieve synchronization in the network. Using this approach clocks may be synchronized perfectly at the moment of the synchronization event. However, in the interval between two sync events the quality of the synchronization degrades linearly as the various clocks still tick at different rates.

a) When computing a precise future rendezvous time between two nodes (e.g. the beginning of a slot in a TDMA schedule) this degradation may become a problem. To improve the clock synchrony in between to synchronization events we therefore want to add clock drift prediction. In order to do so we assess the difference in the clock rates of two neighboring nodes and incorporate this knowledge in the computation of the future timestamp. We still use TPSN or RBS to set the current clock values. Describe a simple additional drift prediction algorithm which could be applied to a two-node network in order to get a better synchronization between two executions of the TPSN or RBS protocol.

b) Assume your drift prediction algorithm is executed only once every two hours. Can you think of a scenario where your system performs worse than a vanilla version of TPSN or RBS?