ETH
Eidgenössische Technische Hochschule Zürich
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Distributed Computing Group

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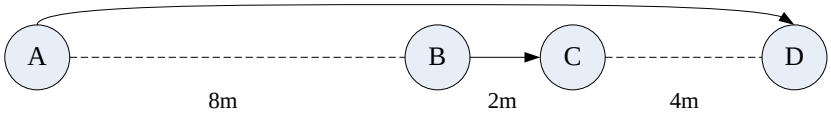
Ad Hoc And Sensor Networks
Exercise 10

Assigned: December 1, 2008
Due: December 8, 2008

1 MAC Layer with Power Control

A MAC layer protocol with an adaptive transmission power control is employed for simultaneous data transfer between multiple nodes. During the same time slot Node A sends data to Node D while Node B sends data to Node C. The physical layer is modelled using the Signal-to-Noise-plus-Interference ratio (SINR) model with a path-loss exponent of $\alpha = 3$ and background noise of 0.001mW. Furthermore, the SINR ratio β has to be at least 2 in order to guarantee a successfull message reception.



a) Initially, both senders are sending with a transmission power of 10dBm. Are both receivers able to decode the correct data stream from their corresponding sender node?

b) Now we assume that Node A continues sending with 10dBm. What is in this case the optimal transmission power setting for Node B?

c) What are the transmission power settings for Node A and Node B which guarantee reliable data transmission while minimizing the overall power consumption?

2 Capacity Limits in Sensor Networks

A sensor network consisting of n nodes placed on a grid is used to gather temperature data over a large area. Radio communication is modelled using the *Protocol Model*. Each node can communicate with its direct neighbors on the grid and causes interference within its 2-hop neighborhood. The radio chip of a sensor node can transmit up to W bit/s.

a) Sensor readings are continuously forwarded towards the sink node which is placed in one of the grid corners. What is the maximum capacity of the sensor network?

b) Now we consider a different traffic pattern for the network. Each sensor node sends its sensor readings to another randomly chosen node in the network. What is the maximum achievable capacity for the whole sensor network in this scenario?

3 The Blue and Red Points Problem

In the lecture we have seen the *Blue-Dominant Centers Lemma*. It says that, given two disjoint sets of blue points B and red points R with $|B| > 5|R|$, there exists a blue node b^* that has strictly more blue than red nodes in a circle of radius r around b^*. Can you give an example which shows that there exists no such point b^* if $|B| = 5|R|$?