

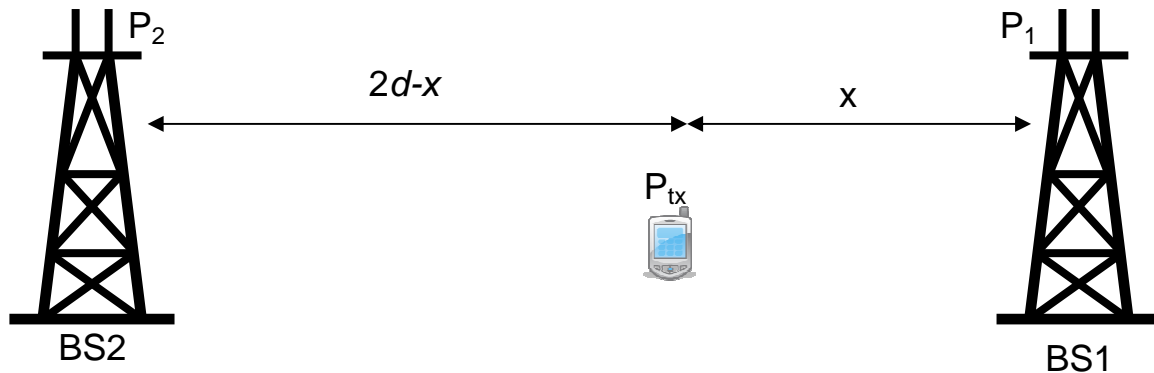
S-72.3275 Cellular Radio Network Planning and Optimization

Exercise Set 3

Deadline: 4.3.2008 at 16.00

## Handover4

In following task you investigate the handover operation in uplink only. Two base stations (BS1 and BS2) are  $2d$  apart from each other. Furthermore, between the two BSs there is a UE located at distance  $x$  ( $0 < x < 2d$ ) from BS1. The UE transmits with output power  $P_{TX}$  so that the signal is received at BS1 with power  $P_1$  and with power  $P_2$  at BS2 correspondingly.



1. Assume path-loss exponent  $PLE=4$ , and find the relation  $P_2/P_1$  with respect to  $x$  and  $d$ . Hint: PLE means that instead of calculating the powers in free space loss ( $PLE=2$ ), we assume a stronger distance dependent fading.

2. Now assume that the considered UE is the only terminal in the system. Furthermore, a large email attachment to BS1, of 1 Mbps, the  $E_b/N_0$  e.g. the  $P_1/P_n$  is e.g. rise over thermal  $RoT_1$  in future work, it might be useful to find out what is meant by  $RoT$ !

3. As you already know, due to the *cell breathing* property of WCDMA, the coverage area of a BS decreases as  $RoT$  (e.g. network load) increases. In microcells, a typical value of  $RoT$  limit, before the admission control starts to operate, is set to be 6 dB. Define the distance  $x$  leading to situation where the  $RoT_2$  of BS2 exceeds that threshold value.  $P_{tx}$  is determined so that the  $E_b/N_0$  target for 1 Mbps upload is satisfied. (Hint: Start from the power  $P_2$  yielding  $RoT_2$  of 6 dB... )

## Handover5

Consider a WCDMA mobile station being in soft handover.

1. Describe the differences between soft and softer handover on the uplink of WCDMA. Which are the predominant gain mechanisms in both cases?

2. Is there a difference between soft and softer handover on the downlink? Consider UE and node B sides separately.

3. On the uplink, the two base stations independently measure the received SIR of the mobile station. Consequently, they derive two power control commands and send them to the mobile station. Explain how the mobile station should react in case it receives two different commands, i.e., one "power up" and one "power down" command?

4. A hard one: Is it reasonable to modify the power control step size in a handover situation?

## Coverage 1

Define the increase in coverage area if a gain of 1, 3, or 6 dB is obtained on the link.  
Calculate for path loss exponents  $PLE=3.52$  and  $PLE=4.52$

Now, assume that you are an experienced WCDMA engineer working in product development and make an invention that increases the system performance by 1 dB. What is the CAPEX value of your invention, if network operator would build a network needing 500 base stations without your invention? Assume  $PLE=3.52$ . Comment the result, and keep it in your mind for your future salary negotiations!

In your analysis, assume following cost structure for CAPEX of one BS:

Sites survey and design	4000
Permits	1000
Civil and electricity work	10000
Mast	1000
Housing/Cabinet	5000
Antenna system & cables	2000
Base station equipment	15000
Radiotx	5000