S-72.3260 Radio Resource Management Methods 3 cr

Exam 13.12.2011

Part B: Open book

Problem B1

Consider the WCDMA uplink. The chip rate W=3.84 Mcps and maximum transmit power is 21 dBm. The total received interference power in the system is -103.33 dBm and the current uplink load is 0.4. The other-to-own cell interference ratio in the system is 0.55. The maximum noise raise in the system is 3 dB which corresponds to -102.96 dBm maximum received power.

The system serves voice calls having R=30 kbit/s data rate and SINR $10\log10(\Gamma) =$ 5dB. The voice activity factor is ν=0.67.

a) Determine the load factor of the voice call (2 p)
b) Detemine the increase in received power due admission of a single new call ΔI_{tot} (2 p)
c) How many new voice calls can be admitted to the system? (6 p)

Problem B2

Consider the downlink of an OFDM system. The number of subcarriers is N. Assume that sub-carriers are grouped into resource blocks having bandwidth R*B/N << coherence bandwidth. That is, all the subcarriers belonging to the same resource block r see the same channel gain $|H(r)|^2$, r=1,2,...,R. The system utilizes adaptive modulation and coding. Let Pr denote the total transmit power allocated to resource block r. The capacity of the system is given by

$$C = b\sum_{r=1}^{R}\log_2\left(1+\gamma_r P_r\right)$$

$$b = \frac{BR}{N}, \gamma_r = \frac{|H(r)|^2}{bN_0}$$

Consider the problem of minimizing the required transmit power under rate constraint:

$$\min \sum_{r=1}^{R} P_r$$

$$s.t.$$

$$\sum_{r=1}^{R} \log_2 (1+\gamma_r P_r) = c$$

Determine the optimal power allocation that solves the above problem. How does this solution compare to the water-filling solution? (10 p)

Problem B3

Consider opportunistic channel adaptive scheduling in HDR type of system in which the base station serves the users one-by-one. Consider the case, in which there are two users in the cell. The instantaneous data rate of the user i follows exponential distribution with mean $\bar{\mu}_i$. That is

$$\Pr\{\mu_i(t) \le \mu\} = 1 - \exp\left(-\frac{\mu}{\bar{\mu}_i}\right)$$

a) Determine the throughput in case the base station picks the user randomly at given instant of time. (4 p)

b) Determine the throughput in case the base station uses relative best channel adaptive scheduling. At given instant of time the base station selects the user that has the highest scheduling metric value

$$i^* = \arg\max \left\{ \frac{\mu_i(t)}{\bar{\mu}_i} \right\}$$

(4 p)

c) Determine the multi-user diversity gain. (2 p)

Problem B4

Consider the downlink direction of a two cell highway cellular system. The cells are symmetric and the inter cell site distance is 1 km. The first UE in each cell is assumed to be 100 m away from the base station and the second one is assumed to be 500 m away from the base station. Base station serves the UEs one by one using proportional fair scheduling. $P/(N_0 B)$ is assumed to be 120 dB. The bandwidth of the system is B and the noise density is N0 W/Hz. Co-channel interference is considered to be Gaussian noise (multi-user detection is not used). In case of reuse one is utilized the spectral efficiency (bit/s/Hz) of an user is

$$C_u = \frac{1}{2}\log_2\left(1 + \frac{d_{u1}^{-m} P}{d_{u2}^{-m} P + N_0 B}\right) \quad u = 1,2$$

where d_{ub} is the distance between UE u served by the cell 1 and base station b=1,2 and m is the pathloss exponent. Numerical solution gives

$$C_1 \approx \begin{cases} 3.18 \quad \text{bit/s/Hz} \quad m=2 \\ 5.98 \quad \text{bit/s/Hz} \quad m=4 \end{cases}$$

$$C_2 \approx \begin{cases} 0.5 \quad \text{bit/s/Hz} \quad m=2 \\ 0.48 \quad \text{bit/s/Hz} \quad m=4 \end{cases}$$

a) Determine the spectral efficiency for both users when reuse 2 is applied. (4 p)
b) Compare the total throughput of reuse 1 with reuse 2 when path-loss exponent is 2 and 4. What can you conclude? (2 p)
c) What could be done further to improve the aggregate throughput of the cell? (2 p)
d) What could be done further to improve the throughput on the cell edge? (2 p)

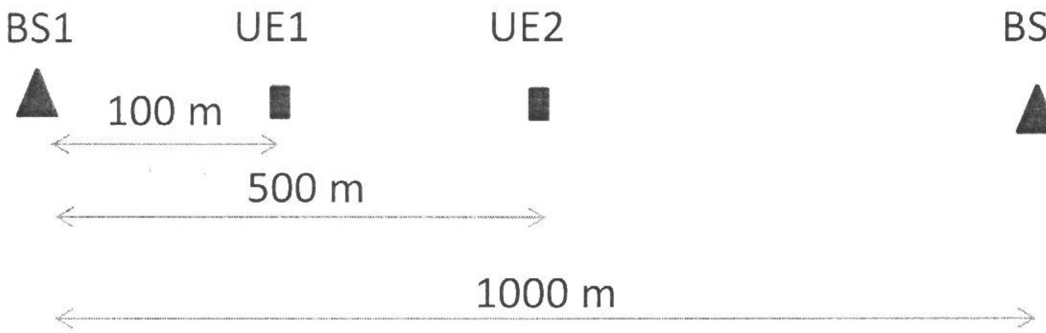

Figure 1. A two cell system