S-72.3260 Radio Resource Management Methods 3 cr

Exam 10.1.2012
Part B: Open book tasks (4 tasks)

There are four problems in this part, out of which three best are taken into consideration in the grading.

You are allowed to use any literature that you feel useful.

Problem B.1

Consider the single frequency wireless sensor network shown in Figure 1.

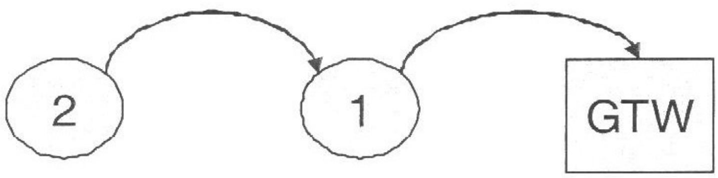

Figure 1.

The network utilizes contention free MAC protocol based on time division and dynamic scheduling. Let x_i, i=1,2 denote the throughput from node i to the gateway (GTW). Since, node 1 needs to share the capacity with node 2, the overall throughput constraint in the system is given by $x_1 + 2x_2 \leq C$ where C denotes the maximum air interface capacity.

Assume that each node generates packet of size s. The effective packet delay is inversely proportional to the throughput $d_i = s/x_i$.

a) Determine the throughput values when scheduling is α-Proportional fair. (5 p)
b) Determine the total transmission time when convergast transmission is utilized. That is, determine the minimum time

it takes for all the data to be transmitted to GTW. How does the convergast transmission compare to the α-Proportional fair scheduling? (5 p)

Problem B.2

Consider the two cell cellular system shown in Figure 2. The link gains are shown in the figure. Assume that the noise power at the receiver is -110 dBm.

a) Assume that both users transmit with fixed 21 dBm power. Determine the received SINR for both base stations. (2 p)
b) Determine the theoretical maximum common SINR that can be supported when power control is utilized. (4 p)
c) Assume that the required SINR is 4 dB. Determine the transmission power vector $\mathbf{p}^*$ such that the power consumption is minimized while the SINR-target is met. (4 p)

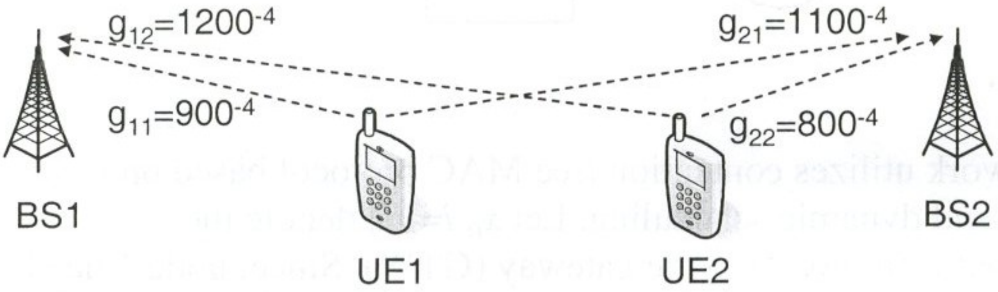

Figure 2.

Hint:

$$A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}, \quad \det(A) = a_{11}a_{22} - a_{21}a_{12}$$

$$A^{-1} = \frac{1}{\det(A)} \begin{bmatrix} a_{22} & -a_{12} \\ -a_{21} & a_{11} \end{bmatrix}$$

Problem B.3

Consider an uplink of an OFDM system. A particular user has been given 2 resource blocks (RBs). The overall power budget of the terminal is 10 mW. Assume that the coherence time is long compared to the transmission time interval and that the coherence bandwidth is equal to the bandwidth allocated to a single resource block. Assume further that the channel state information (complex channel response when RB i is utilized H_i is fully known by the transmitter and are given by $|H_1|^2=1$, $|H_2|^2=0.01$. Determine the optimal power allocation per RB P_i that maximizes the spectral efficiency C_{eff} when the mean received SNR is 0 dB and 20 dB.

$$C_{eff} = \sum_{i=1}^{2} \log_2\left(1+\gamma|H_i|^2 P_i\right)$$

How do the results compare with equal power allocation $P_i = 5$ mW ?

Problem B.4

A femto base station is a small-sized cellular BS with transmission power less than or comparable with a user terminal's transmission power. Considering, for instance, third generation (3G) High Speed Packet Access (HSPA) networks, the FBS contains some radio network controller functionalities and it is designed for use in residential or small business environments. The FBS device is about the same size as a typical digital subscriber line (DSL) or cable modem and provides indoor wireless coverage to mobile terminals whilst using the existing broadband Internet connection (xDSL, fiber, cable etc.) for connectivity to remote a femto gateway. In femtocellular systems, multiple user terminals connected separately to adjacent private femtocells share the same radio spectrum and handover between the femtocells is prohibited, which leads to co-channel interference. Figure 3 illustrates one particular configuration of a system consisted of one macro cell and two femto cells.

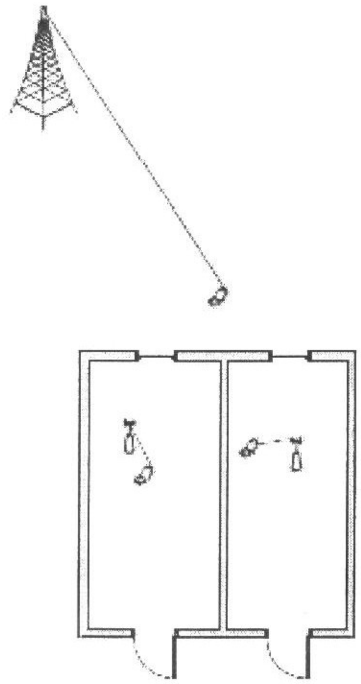

Figure 3. One possible configuration of a network consisted of single macro cells and two user deployed femto cells.

Discuss the interference problems that arises in multi-cell femtocellular systems sharing the band with macrocellular overlay. Draw pictures. (10 p)