S72-238 WCDMA systems
Tutorial 6 22.01.2002.

Solutions

1.
Let assume a WCDMA receiver operating in a (static) multipath environment. The relative strength a_i and delays τ_i of the propagation paths (with respect to the line of sight (LOS) path) are as follows

a_i	1	0.3	0.6	0.2	0.5	0.2
τ_i $[\mu s]$	0.0	0.2	0.3	0.7	2.4	3.1

We assume that - when perfectly in code synchronisation - a signal processing branch is the receiver produces the relative power 1 (unit) for relative path strength 1 (unit) at the output of the matched filter before eventual path combining. When not in code synchronisation, a path is assumed to produce $\frac{1}{N}$ of this power, where N is code gain of the WCDMA system.

Calculate the SIR ratio (signal power to multipath interference ratio) for the following cases (other interfering signals and noise is not taken into account):

a) No RAKE reception; the receiver synchronises only to the LOS signal component. The channel bit rate is 32 $kbps$ (Note user bit rate undefined), N=128.
b) 4 finger RAKE reception with Equal Gain Combining, N=128.
c) 4 finger RAKE reception with Maximum Ratio Combining, N=128.
d) 4 finger RAKE reception with Maximum Ratio combining. In this case, however, the channel bit rate is 512 $kbps$, N=8.
e) 6 finger RAKE reception with Maximum Ratio Combining, N=128.

Calculate the percentage of the arrived signal energy that the 4 finger RAKE receiver utilise for decoding.

2.
In a spread spectrum system are three users. For all users the spreading factor N is 128 and the system uses a spread bandwidth 3.84 MHz. The cross correlation factor between the spreading codes is $\frac{1}{\sqrt{N}}$. We compare the system performance for different received powers for different users.

a) If in the system are three users what is the received signal to noise ratio for each user when no multi-user detection is applied and:

- The received signal powers are $P = \begin{bmatrix} 0.372 & 0.209 & 0.0233 \end{bmatrix} \cdot 10^{-13}$ $[W]$.
- The received signal powers are $P = \begin{bmatrix} 0.233 & 0.233 & 0.233 \end{bmatrix} \cdot 10^{-14}$ $[W]$.

b) Assume now that a decorrelating receiver is used what is the received SNR for both cases presented above.

3.

The WCDMA radio network has been planned for $75\ \%$ load. In case the system does not have accurate information about the external interference level there can be significant capacity loss. Assume that $15\ \%$ of the loading is caused by external interference, how much capacity is reduced in terms of number of speech users:
Assume single link $SIR = 6\ dB$.
$R = 15\,\frac{kbit}{s}$ with voice activity factor 0.67.
Other to own cell interference ratio $i = 65$.
Chip rate is $3.84\ \frac{Mchip}{s}$.

4.

Diversity reception is used to improve the sensitivity of a basestation receiver. Assume, that in average the diversity gain is $2\ dB$, how much is the UL loading reduced when comparing non diversity and diversity case? Assume that the diversity is applied at all the cells in the network. What is the gain in the radio link budget?
Assume single link $SIR = 6\ dB$.
$R = 15\,\frac{kbit}{s}$.
Other to own cell interference ratio $i = 65$.
Chip rate is $3.84\ \frac{Mchip}{s}$.
In the cell are $35\ 100\ \%$ active users.

5.

How big is the handoff region of a cell, assuming that the handoff may occur when the signals from two base stations to mobile station differ less than a) $6\ dB$ b) $3\ dB$. Consider a hexagonal cell structure and radio wave attenuation exponent a) 3.5 b) 4 c) 4.5.