Final exam in

Modern Wireless Systems - LTE and Beyond (ETTN15)

on October 22, 2012, 14–19.

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- During this final exam, you are allowed to use a calculator and the course book.
- Each solution should be written on a separate sheet of paper.

  Please write Your name on each sheet, and number each sheet.
- Show the line of reasoning clearly, and use the methods presented in the course.

  If You use results from the course book, add a reference in Your solution.
- If any data is lacking, make reasonable presumptions.

Good Luck!

Problem 1:

Determine for each of the five statements below if it is true or false.
Observe! As always, motivations to your answers should be given.

a) "In LTE it is assumed that communication links are highly frequency-selective within a 15 kHz frequency interval. "

b) "In LTE all the transmitted sub-carrier signals in an OFDM signal are orthogonal."

c) "In LTE downlink at least eight reference signals are sent in every resource-block pair"

d) "In LTE, L1/L2 control signals are sent in the beginning of every sub-frame."

e) "In LTE all terminals support at least 2x2 uplink MIMO."

(10 points)

Problem 2:

a) Give at least six important examples of what an LTE terminal needs to know, so that it can create and transmit the PUSCH.

b) How is the knowledge required in a) obtained in the terminal?

c) Give at least six important examples of what an LTE terminal needs to know,to be able to demodulate and recover the data on the data on the PDSCH.

d) How is knowledge about the uplink channel obtained in the base station?

(10 points)

Problem 3: Consider a cell where several LTE-terminals (Release 8/9) are active (data-communication is on-going).

Let us study three of these terminals within this cell. Terminal 1 (T_1) is far from the base station and close to the cell edge (close to the cell border to neighboring cell A).The current cell has four neighboring cells, denoted A, B, C and D. The channel conditions to and from terminal 1 are poor. Terminal 2 (T_2) is close to the base station, and the channel conditions to and from terminal 2 are very good. The channel conditions to and from terminal 3(T_3) are clearly better than for terminal 1, but clearly worse than for terminal 2.

Let us now assume a situation such that for the downlink, during a specific subframe, 14 resource block pairs can in total be allocated to these three terminals.

a) Suggest, based on the channel conditions, a reasonable downlink allocation of the 14 resource blocks among the three terminals.

b) Suggest reasonable downlink transmission methods to the three terminals, respectively.

c) Consider OFDM interval number 10 within a subframe (the numbering starts with 1). Calculate how many coded bits that are sent per second within this interval to the three terminals, respectively. Use your answers in a) and b).

d) Explain possible situations which may be unfavorable concerning the uplink from terminal 1.

(10 points)

Problem 4: Consider Figure 10.17 on page 165 in the course book. Let us consider a situation with four transmitting, and four receiving, antennas. Furthermore the matrix W has size 4x4, and M is assumed to be M=24.

a) Use the notation in the figure and show in detail (i.e. at sub-carrier level) what values are sent in the transmitted OFDM signals.

b) From the DFT outputs in the receiver, construct a standard MIMO model valid for the k:th sub-carrier.

c) Would the channel estimates be better if cover codes where used instead?

(10 points)

Problem 5: Consider downlink communication to two specific terminals, T_1 and T_2, within a cell. The received signal to noise ratios are estimated to be $(S/N_0)_1$ and $(S/N_0)_2$, respectively, and $(S/N_0)_1$=$2(S/N_0)_2$.

It is desired to deliver the same bit rate to the two terminals.

One way to get some guidance how to allocate resources, i.e. $(BW)_1$ and $(BW)_2$, to achieve this is to use the basic SISO Shannon capacity formula with C held fixed.

a) Investigate what the capacity formula tells us concerning how to allocate resources to the two terminals to keep the capacity the same. It is also given that the bandwidth efficiency $C/(BW)_2 = 1$. The more precise your answer is, the better.

b) A person claims that it is more realistic in a) to assume that $C/(BW)_1 = 1$. Determine if the person is correct, or not.

(10 points)
