COMM.SYS.450

Multicarrier and Multiantenna Techniques

Exercise 3

Familiarizing with the task before attending the session is strongly recommended, and some work to finalize the code may be needed afterwards. For the exercise bonus, it is required to return the solution script to Moodle by the following Tuesday at 23:00. A model solution will be available on Moodle once the submission is closed. For any inquiries regarding the grading of the exercise returns please contact Karel Pärlin (karel.parlin@tuni.fi).

The third exercise task consists of implementing a whole OFDM transmission link, that is, an OFDM transmitter, a multipath propagation channel and the corresponding OFDM receiver.

For the transmitter we consider an OFDM system with 20 active subcarriers, 15 kHz as subcarrier spacing and BPSK symbols as subcarrier modulation. Let us assume for now that the CP has a length of ¼ of the OFDM symbol duration.

This time, the transmission is carried-out over a multipath channel, therefore, the received signal is a combination of the original OFDM symbol and its delayed replicas, and as a result, the multipath channel will introduce some inter-symbol interference unless the cyclic prefix is capable of coping with it. On top of that, the channel is frequency selective, and hence, different subcarriers will experience different amplitude scaling and phase rotations that will have to be compensated for by means of a zero-forcing channel equalizer. After you have correctly implemented the whole system, we are going to investigate the effect of additive noise in the performance of the system.
We are going to assume three different transmission scenarios

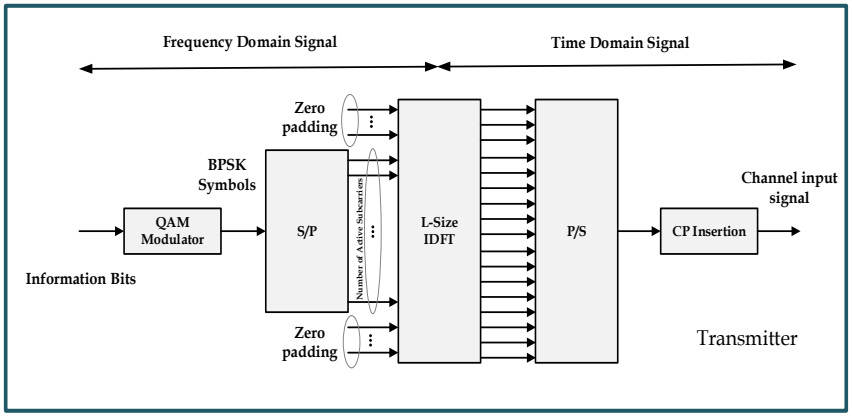
- Additive Gaussian noise is not considered at the receiver side.
- Additive Gaussian noise with an SNR of 20 dB with respect to the OFDM symbol.
- Additive Gaussian noise with an SNR of 40 dB with respect to the OFDM symbol.

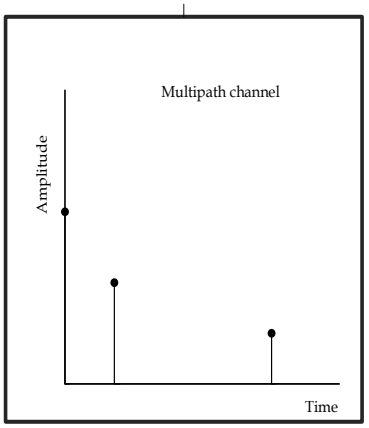
After you have implemented all the processing blocks of your receiver, check if the received BPSK sequence corresponds to the one that was transmitted for the three different transmission scenarios.

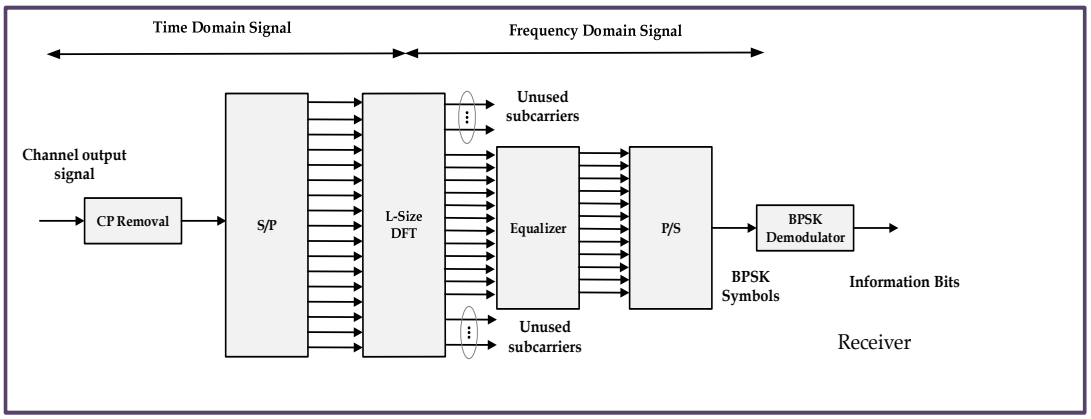
Repeat the transmission without considering additive noise, but now change the CP length to 1/16 of the symbol duration and check the received BPSK sequence. Repeat the analysis without considering CP.

Some further notes about the receiver side. For the receiver side, you will need to follow pretty much the same approach as in previous week; however, some further processing will be required to obtain the BPSK sequence that was originally transmitted. You basically have to undo the effect of the multipath channel. The CP will be able to remove the ISI if its duration is long enough, while the phase rotation and amplitude scaling of each subcarrier will be compensated for by means of a zero-forcing equalizer. The zero-forcing equalizer is implemented once we are back in the frequency domain.

The block diagram is shown in the figure below.







Use the Matlab template Ex3.m that is provided on Moodle to write your code. More detailed explanations about how to do the coding are given there.

What to submit: a zip file containing the following

1) **Matlab script with the solution.**
2) **PDF with a short explanation of the main concepts reviewed in the exercise and figures returned by the script, if any.**