Eurecom

Digital Communications

Final Examination

Date: February 8th, 2021

Duration: 2 hours

You are to complete ALL of the following questions. All documents are allowed. All questions should be answered with short and precise statements

1 General OFDM

For the first set of questions consider a 5G OFDM system configuration with sampling rate 61.44 Msamples/s using a 1024-point DFT with bandwidth stemming from the use of 792 non-zero carriers (resource elements) carrying data and/or reference signals. Assume that the channel size is 50 MHz. The center carrier is not nulled out but the highest-frequency carriers are so that the non-zero carriers are equally spaced on both sides of the frequency spectrum. In total, there are 52 resource blocks containing 12 OFDM subcarriers (Reource Elements) each.   There are 56 OFDM symbols per 1ms period. Symbols 0 and 28 have a cyclic-prefix of length 104 samples, and the remaining 54 symbols have a cyclic prefix of length 72 samples. Slots contain 14 time-consecutive symbols.

   a) What are the two possible symbol durations and slot durations?
   b) How many slots are there per 1ms subframe?
   c) How many zero samples need to be inserted between subframes?
   d) What is the carrier-spacing?
   e) Assuming we use 256-QAM modulation, what is the the spectral-efficiency and maximum date rate of the system, assuming that we include the guard-band inside the channel?
   f) What is the maximum channel duration of the system?
   g) Would this system be more or less tolerant to multipath channel duration than the configuration we considered in the class lab sessions?

2 Understanding of the lab sessions

   a) What is the dimensionality and data-rate of the PSS transmission?
   b) In Lab1, we considered the random-delay to be an additional hypothesis. How many resulting hypotheses were there?
   c) What were we trying to see when we looked at the output of the PSS correlator around its peak?
   d) Explain why we converted the SSS channel estimates to the time-domain.
   e) How did we control the accuracy in measuring the frequency-offset of the receiver using the PSS?

f) What is the dimensionality and data-rate of the SSS trasmission?
g) Why would the SSS constellation after channel compensation be rotated?
h) In the third exercise, what was the purpose of the transmitting with a variable cyclic-shift of the PRACH waveform
i) Explain how the trade-off between the number of sequences and cyclic-shifts controls the ability of the receiver to cope with time-delay in detecting the PRACH preamble.
j) Why would the basestation receiver want to estimate the time-delay of the PRACH preamble?