Principles of Wireless Communcations

Lab 3

OFDM

Due 4/8/2016

Overview

Orthogonal Frequency Division Multiplexing (OFDM) is the modulation scheme of choice for modern wireless data communications systems such as WiFi and LTE. This scheme offers simple and accurate methods for channel equalization by splitting a wide bandwidth into a set of narrow subchannels which have flat fading. In this assignment, you will implement an OFDM system on an SDR platform.

The Assignment

1. *Implement an OFDM system using the USRPs. For simplicity, you should pre-generate a data file with transmit samples, and collect samples at the receiver followed by pre-processing, as you did in Lab 1.*

2. *There are no data rate requirements in this assignment (getting an OFDM system to work should be challenging enough), so it would be most helpful to stick to BPSK samples on each subcarrier.*

3. *Please follow the frequency assignments you used in Lab 1.*

A report with a block diagram of your system, achieved data rate, a brief description of OFDM, the timing synchronization algorithms you used, channel equalization methods you used, and a listing of all you code is due by 5 p.m. on April 8.

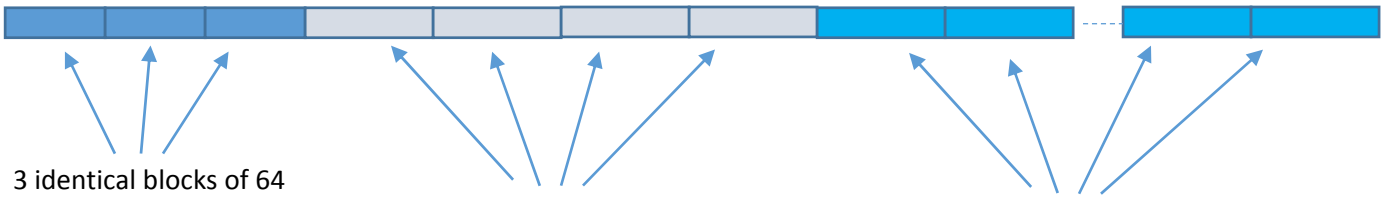
Some helpful hints:

Use 64 point FFTs, 16 sample cyclic prefixes (CPs), and 2 – 4 pilot tones. This is in line with the wifi standard which uses 64 point FFTs, 16 sample CPs and 4 pilot tones per symbol. The pilot tones should be loaded with known values, e.g. 1.

You should organize your OFDM symbols into OFDM frames, where each frame consists of a header, followed by a number of OFDM symbols (the first 10 or so can be training symbols which you can use for channel estimation).

For detecting the start of the packet, as well as for carrier frequency offset synchronization, you may wish to use the Schmidl-Cox algorithm. This algorithm depends on the transmission of 2-3 identical training sequences back to back. For instance, you can generate 64 point vectors of +- 1 values and

repeat this 3 times. This will be your header. Note that in wifi, 2.5 such sequences are used, and this sequence is called the Long-Training Sequence (LTS). The following is a diagram of a suggested frame format for and OFDM implementation.



3 identical blocks of 64 pseudorandom values used for frequency sync/detecting start of packet.

~4 known OFDM symbols, 80 samples including cyclic prefix. This is used for channel estimation and equalization

~10 - 20 Payload OFDM symbols