Assignment 2

CSL 867

Due date: September 27, 2007 (Thursday)

1. Implement in matlab (or octave/scilab) an OFDM communication system with the following properties.

   (a) Data is spread over $N = 8$ channels. The channels are centered at frequencies $f_c + n/T_s$, $n = 0, 1, \ldots, N-1$ where the carrier frequency $f_c = 10^9$ Hz and symbol duration $T_s = 32 \times 10^{-9}$s.

   (b) The first 4 channels, that is those with center frequencies $f_c + n/T_s$ for $n = 0, 1, 2, 3$, employ QPSK and the rest use BPSK. All channels transmit the same amount of energy per symbol period.

   (c) The transmitter employs an inverse Fast Fourier Transform to form the transmitted signal. It also adds a prefix to each symbol. The prefix is of duration $T_s/4$.

   (d) The transmitted OFDM signal goes through a wireless channel whose impulse response is given by

   $$h(t) = \begin{cases} 1 - \frac{32t}{T_s} & ; \text{if } 0 \leq t \leq \frac{T_s}{32} \\ 0 & ; \text{otherwise} \end{cases} \tag{1}$$

   (e) The receiver discards the part of the signal corresponding to the prefix. In addition it modifies the received constellation points (QPSK/BPSK) by making appropriate use of the Fourier transform of the impulse response, $H(f)$, as discussed in class. It then decodes the data bits.

   Consider an OFDM signal for one symbol duration that is generated when the 12 input bits are [000111101010]. The first 8 bits are used to determine constellation points of the QPSK channels and the rest that of the BPSK channels.

   You may use complex exponentials throughout, for example `exp(j*2*pi*fc*t)` is a valid expression in matlab. You may also use standard functions available in matlab such as `fft, ifft, conv, reshape, zeros` etc. Note that you are implementing a system that is analog for the most part using matlab which is a digital tool. This can be done using samples of various analog signals.

   Submit the following.

   (a) A softcopy of your code that is commented well. You must not borrow code from any other student or lift code off the Internet.

   (b) Hardcopy of plots of (i) the signal sent out from the transmitter's antenna and (ii) the signal at the receiver's antenna after it has traversed the wireless channel.

   (c) List of bits decoded at the receiver when the receiver has full knowledge of $H(f)$.

   (d) List of bits decoded at the receiver when the receiver wrongly assumes that $H(f) = 1$ for all f.