Wireless Communication IC

Homework #6

(Due on 06/06)

Total points: 100 points

1. Check the autocorrelation property of GSM midamble. If one period *N* of the midamble is given by

   $\mathbf{s}=[s_0\ s_1\ s_2\ \ldots\ s_{15}]$

   $=[\ 1\ 1\ \text{-}1\ 1\ 1\quad \text{-}1\ 1\ \text{-}1\ \text{-}1\ \text{-}1\quad 1\ 1\ 1\ 1\ \text{-}1\quad 1],$

   Please calculate $\Phi(k)=\frac{1}{16}\sum_{n=0}^{15} s_n s_{[n+k]_{16}}$ for $-26 \le \mathrm{k} \le 26$ and draw it (10%),

   where $[\cdot]_{16}$ is modulo-16 operation.

2. Please download "HW6_2.mat" on the webpage. The received GSM signals of 149 samples are given as GSMRx in HW6_2.mat.
   (a) Assume that the channel impulse response has R taps, where $1 < R \le 6$, i.e.
   $$h[n]=\sum_{r=0}^{R-1} h_r \delta[n-r].$$
   The sample index and its position is given in the following figure. Assume the sample index is given by 1, 2,…, 149. Please identify the minimum and maximum index range that can be used for channel estimation without interference from user data in terms of R. (10%)
   (b) Write a program to perform channel correlation. Indicate the index range of GSMRx z_j and the sequence s_i, $a \le i \le b$ that you use for estimating h_0, h_1, …, and h_{R-1}, respectively (20%), and show your results of estimated channel impulse response. Note that you need to use the same sequence to correlate the different parts of GSM signals for obtaining channel estimates, respectively. (10%)
   (c) What is the value of R in this case? Please explain how you derive it? (10%)

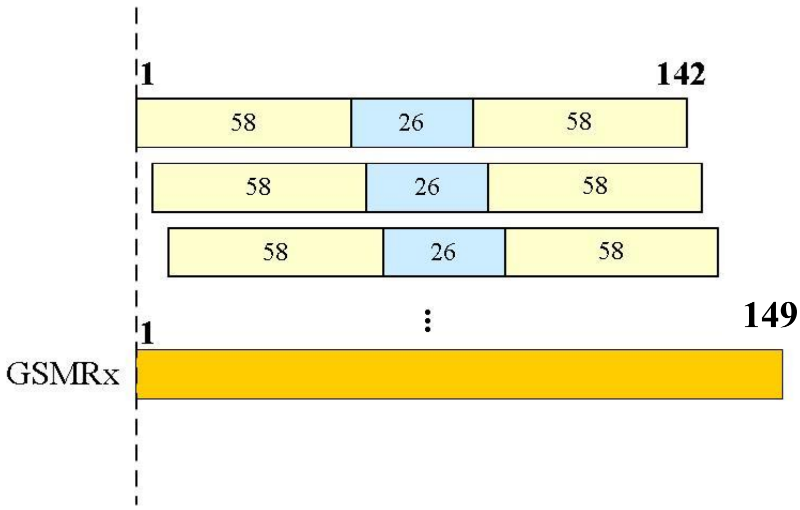

Fig. 1 Illustration of received GSM samples

3. Please download "HW6_3.mat" on the webpage. It contains two received time-domain OFDM waveforms with 80 sample (OFDMRx1, OFDMRx2). Among them, the first 16 samples are the cyclic prefix, and the remaining 64 samples are going to be processed by FFT. 16QAM constellation is adopted at the non-zero subcarriers.
   (a) Use OFDMRx1 and OFDMRx2. Remove the first 16 sample and perform the 64-point FFT. Draw the real part and the imaginary part of frequency-domain signals, respectively. (10%) (Using "stem" function)
   (b) For OFDMRx1, the frequency domain subcarrier index is counted from **0 to 63**. Assume the even-indexed subcarriers are modulated by -1-3j, and the odd-indexed subcarriers are modulated by 3+1j. Calculate the channel frequency response on each subcarrier. Draw the magnitude of channel frequency response $\left|H_k^{(1)}\right|$ versus subcarrier index k from 0 to 63. (10%)
   (c) For OFDMRx2, the frequency domain subcarrier index is counted from **0 to 63.** The frequency domain data of even-numbered subcarriers are zero. The data at subcarrier index of $4u+1$ are -1-3j, where u is an integer and $0 \leq 4u+1 \leq 63$. The data at subcarrier index of $4u+3$ are 3+1j. Now, use linear interpolation to interpolate the channel response at null subcarriers. Draw the magnitude of the complete channel frequency response $\left|H_k^{(2)}\right|$ versus subcarrier index k from 1 to 63. (10%).
   (d) Assume the same channel frequency responses are suffered for OFDMRx1 and OFDMRx2. Compare the difference $\left|H_k^{(1)} - H_k^{(2)}\right|$ for $1 \leq k \leq 63$. (10%)