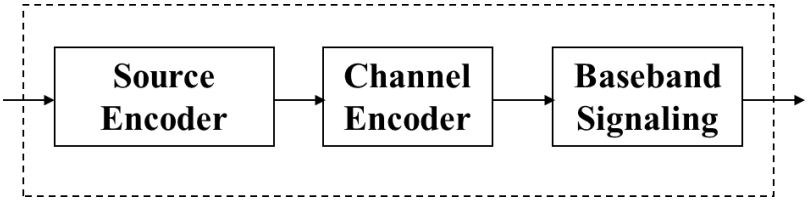
ESE 471 Assignment #3

Baseband Signaling: Physical Signal Mapping

Assigned Date: March 29, 2016

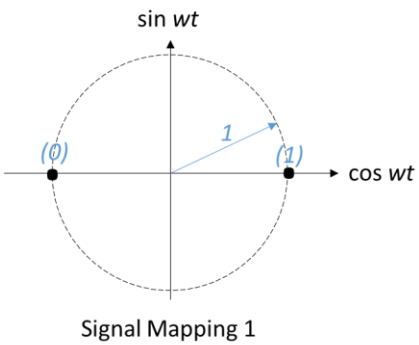
Due Date: April 11, 2016 in class.

Continuing on with various components inside the transmitter, we are now at the last box in the transmitter diagram, which is labeled as the "baseband signaling."

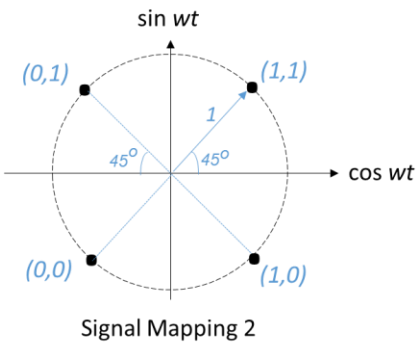


Note that the source encoder was assignment 1, the channel encoder was assignment 2, and now assignment 3 is for the baseband signaling. Recall that at the output of the channel encoder is a long sequence of binary bits corresponding to the source encoded and channel encoded NY Times article.

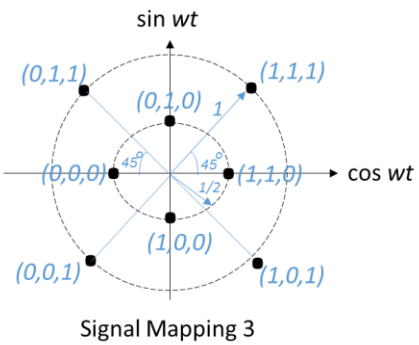
In the baseband signaling step, the chanel-encoded bits are mapped to physical signals that can be transmitted into the channel. A popular ways of mapping binary bits to the physical signals is based on what is known as the signal constellation, some of which are shown below.



Signal Mapping 1



Signal Mapping 2



Signal Mapping 3

In signal mapping 1, there are two positions (noted by dots) in the constellation. The position marked as "(0)" is used for transmitting a single bit "0." That is, if bit "0" is to be transmitted, the corresponding physical signal is noted in the constellation at $-\cos(wt)$. Similarly, for bit "1," the corresponding physical signal is noted in the constellation at $\cos(wt)$.

Looking at signal mapping 2 above, there are four positions in the constellation. That means each position in the constellation can be used to transmit two bits. For example, if bits "11" need to be transmitted, the corresponding physical signal in the constellation is $\frac{1}{\sqrt{2}}\cos(wt)+\frac{1}{\sqrt{2}}\sin(wt)$, for bits "10," $\frac{1}{\sqrt{2}}\cos(wt)-\frac{1}{\sqrt{2}}\sin(wt)$, for bits "00," $-\frac{1}{\sqrt{2}}\cos(wt)-\frac{1}{\sqrt{2}}\sin(wt)$, for bits "01," $-\frac{1}{\sqrt{2}}\cos(wt)+\frac{1}{\sqrt{2}}\sin(wt)$.

For signal mapping 3, there are eight positions in the constellation, each corresponding to a three-bit sequence. You can figure out the corresponding physical signals for the constellation positions.

Of note, signal mapping 1 is a type of binary phase shift key (BPSK), signal mapping 2 is a type of quadrature phase shift key (QPSK), and signal mapping 3 is a type of quadrature amplitude modulation (QAM), in particular 8QAM. Each of these signal mapping methods are used in your 3G/4G smart phones.

To do:

Your group will use the NY Times article from the last two assignments, which your group has source-encoded and then channel-encoded. Take the first twelve bits from the channel-encoded bit sequence. Assume these twelve bits are to be transmitted in 12 microseconds. Map these twelve bits to each of the signal mapping methods above. Sketch the resulting signal waveforms in time, for example, using the Matlab. Discuss the possible pros and cons associated with each of the signal mapping methods.