Objective

The objective of this experiment is to understand Time/Frequency/Space/characteristics of wireless signals. The students will be familiar with the following items:

- Spectral measurements (power spectrum, spectral masks, spectral flatness, frequency selectivity), temporal measurements (power versus time, transient behaviors, temporal selectivity of signals), spatial measurements (angular spread, space selectivity), etc.

- Relationship between the multi-dimensional characteristics of the signals and exploring the dualities among various dimensions.

- Transient analysis of non-stationary signals (understanding and measuring transient behaviors of signals)


- Code domain analysis

Pre-lab

- Understand short time Fourier transform and spectrogram

- Understand the TDMA and CDMA techniques that are used in GSM and CDMA system.
**Procedure**

In this experiment, the signals will be generated by the TAs using a signal generator. All of the benches will be required to capture the transmitted signal and analyze it in multiple domains (dimensions).

**I. MODULATION ANALYSIS**

a) Tune your VSA around 913 MHz carrier frequency with a span of 1 MHz.
   - Identify the BW (3dB and 10dB) and the actual carrier
   - The same as above but now we have multiple carriers. Identify the center frequency of each carrier as well as 3dB and 10dB bandwidths.

b) Tune your VSA to exactly 913 MHz carrier frequency with a span of 100 kHz. Turn the digital modulation analysis mode.
   - Now, the signal is generated exactly at 913 MHz. Adjust the Demod. Properties to the following:
     - The symbol rate to 30 KHz
     - RRC filter with alpha of 0.35
   - Identify the transmitted modulation.
   - The TA will now change the modulation to different types; each time you will have to identify the modulation type used

c) The same as above. Identify the SNR from spectrum graph and EVM.

d) Tune your VSA to exactly 913 MHz carrier frequency with a span of 100 kHz. Go to the digital modulation analysis mode. The transmitted signal is conventional NADC signal with an unknown roll-off factor (alpha) is. You are required to identify alpha.
II. TIME-FREQUENCY ANALYSIS (USING GSM SIGNAL)

a) Tune your VSA to 915 MHz carrier frequency with a span of 2 MHz. The transmitted signal is GSM. Identify:
   - How many carriers are use
   - Estimate relative power levels in each carrier
   - Identify the noise floor and approximate SNR in each carrier
   - In each carrier for each frame you observe:
     1. How many burst you observe (note that the total number of possible ON bursts is 8 in GSM).
     2. Identify the relative power levels of each burst.

Note that each frame starts with an “ON” burst and the first burst is more powerful than the others in this specific example. When you are investigating time and frequency separately, you need to set the analyzer settings of time span and frequency span properly so that you can see multiple bursts over the capture time. Therefore, when you are analyzing the time signal, you might have to reduce the frequency span significantly to be able to see multiple bursts.

Optional: Alternatively, you can download the signal into Matlab, and analyze it in Matlab

III. CODE DOMAIN ANALYSIS (CDMA ANALYSIS)

a) In this experiment, a CDMA signal is generated. Open modulation analysis using the specific CDMA standard indicated by the TA. TAs will provide specific information needed to be able to analyze the CDMA signal.

   - Comment on the CCDF
   - Identify how many codes are active.
   - Observe the constellation and polar plot of the composite signal

b) Repeat the above with the new settings put in effect by the TA
IV. JOINT TIME FREQUENCY ANALYSIS (FREQUENCY HOPPING)

The objective of this part is to analyze a Bluetooth signal in joint time and frequency domains using Matlab. You will be using a built-in function (spectrogram.m) that enables you to see the change in frequency with time. (Refer to the TA)

References

- Lecture notes
- Read the supplementary data.
- Search the internet to understand the TDMA in GSM and the CDMA in CDMA system.