Enhancing Spectral Usage Through Full Duplex Communication

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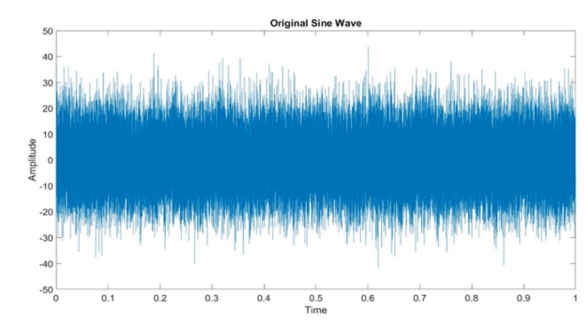
Introduction

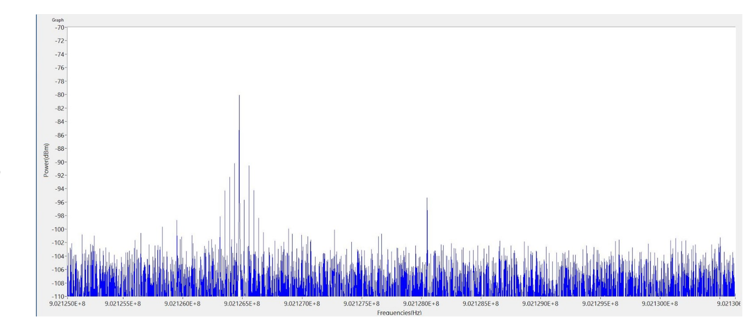
In the upcoming years, the amount of information being transferred wirelessly will continue to exponentially grow due mostly to what is known as the internet of things. The internet of things is the idea that daily devices, for example a coffee maker, will be connected to a network and therefore will be sending and receiving data. As a consequence, the radio spectrum, the highway in which the data navigates through, will become congested. Furthermore, the radio spectrum is a limited resource and therefore cannot increase in size. Fortunately, the radio spectrum is not being used to its full potential and can be optimized so that congestion is not a problem in the years to come. In my project, I was asked to identify underutilized frequencies in order to help us understand how the spectrum is used today and how it can be optimized in the future.

Acquiring the Signals from a Software Defined Radio (SDR)

The SDR allows me to scan through radio spectrum by receiving the signals through the antenna and transferring the data to a computer.



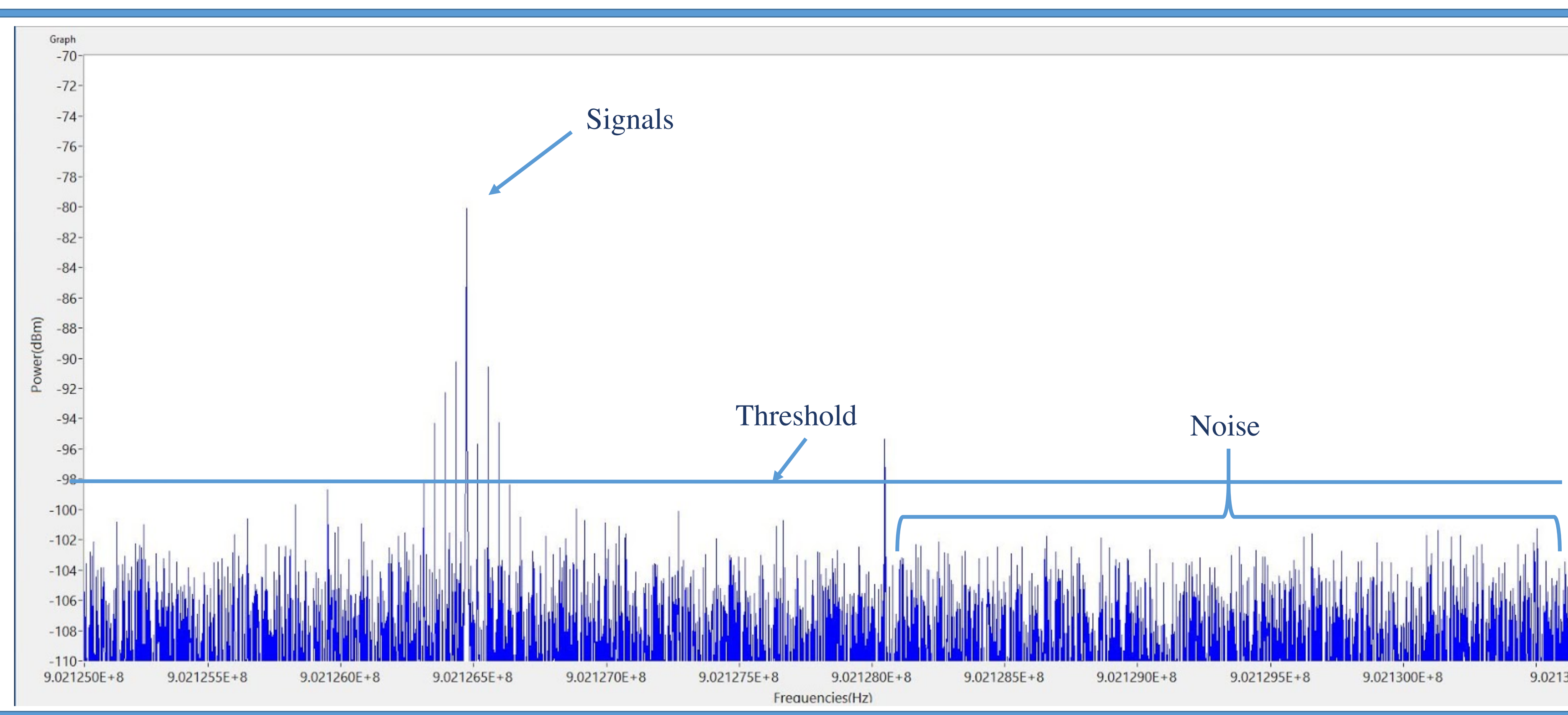
Using a combination of Matlab and LabView, the signal is then converted a graph of amplitude over time.



After plotting the time domain graph, it is converted into a frequency domain graph using the Fat Fourier Transform (FFT) through Matlab, giving us power(dBm) over frequency (Hz).

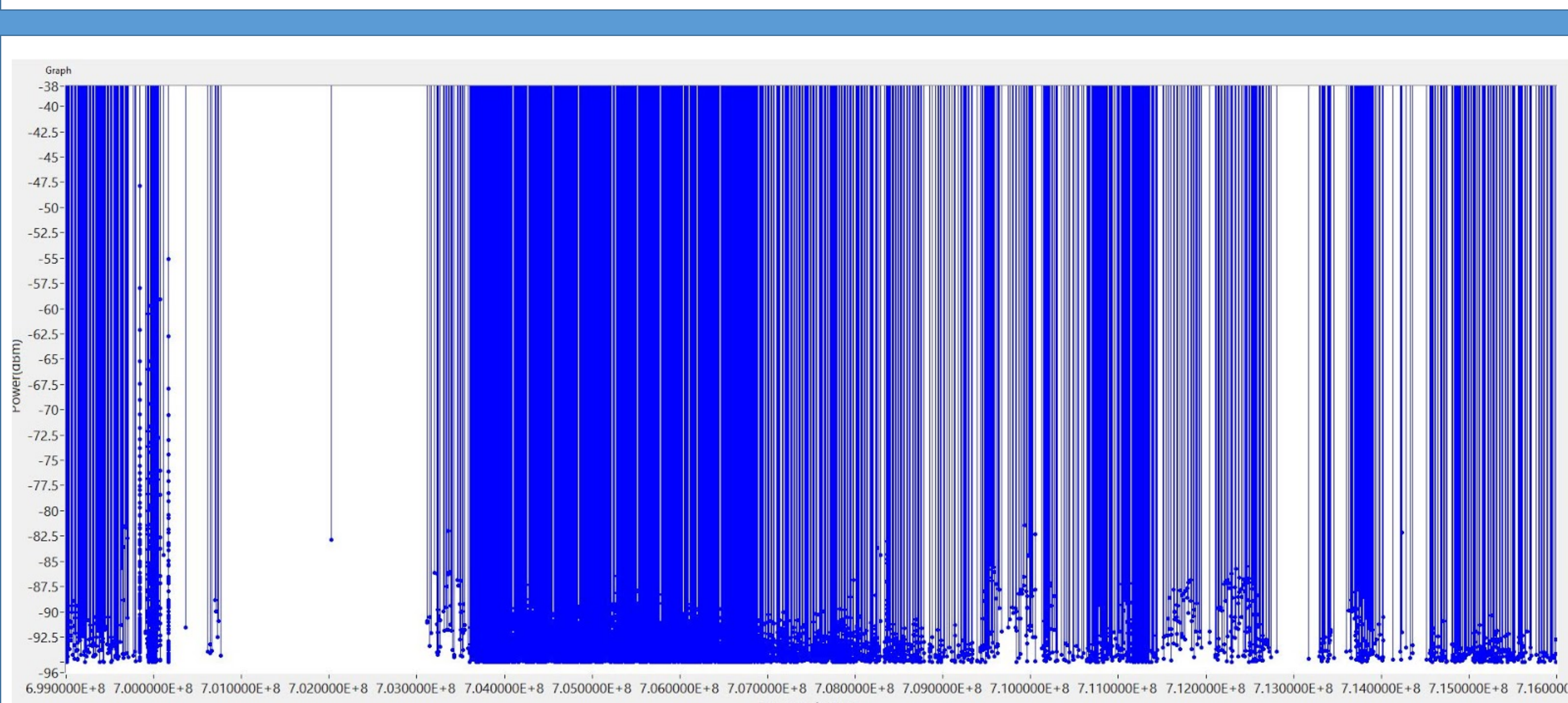
Detecting the Presence of a Signal

The FFT of a signal demonstrates the signal and the corresponding power. Each spike corresponds to a signal, except for the vast amount of spikes at the bottom. That is what is referred to as noise. Noise usually comes from the hardware and can randomly increase or decrease the power of a signal.

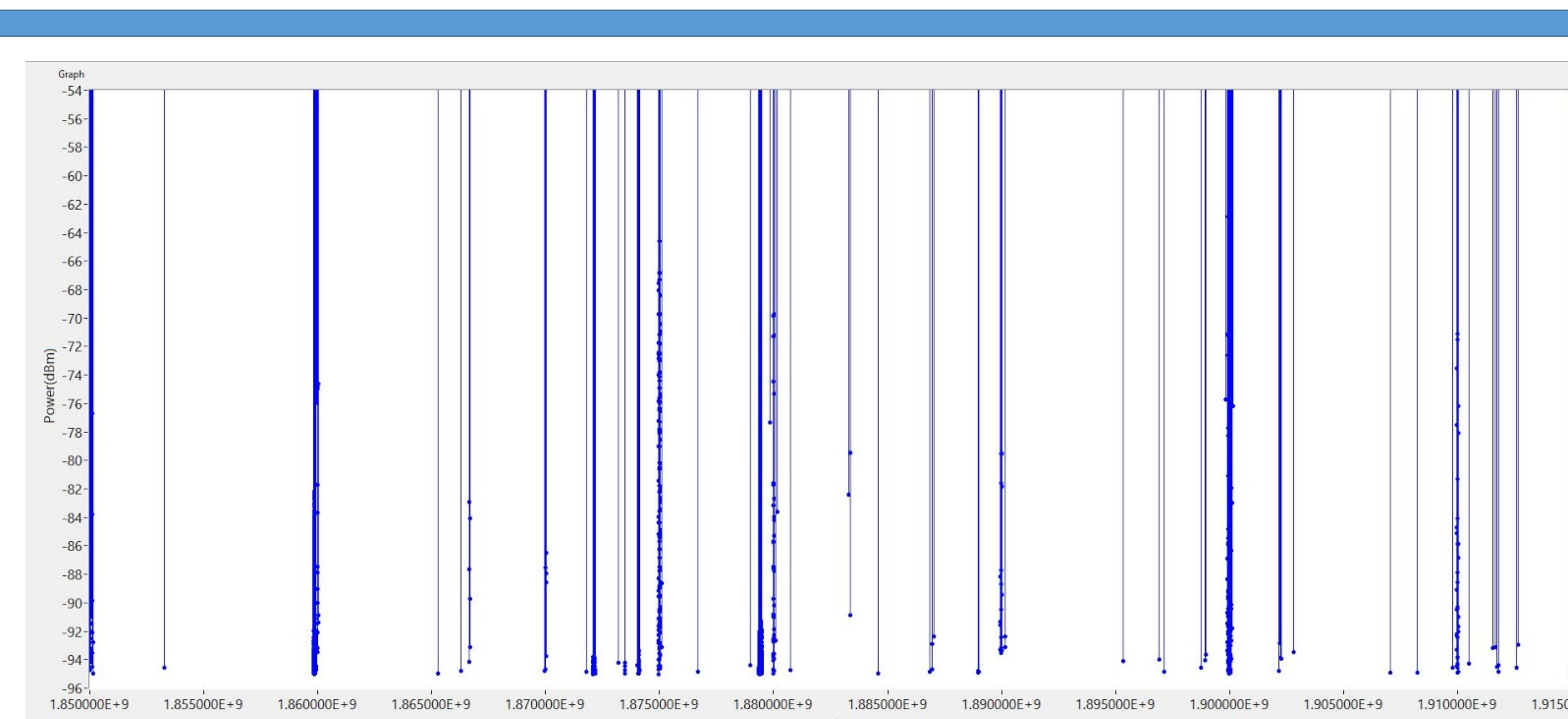


Once the FFT is computed, I calculate a threshold to determine what frequencies are signals and which are noise. Anything above the threshold is a signal and anything below is noise. The problem is that noise increases and decrease randomly, therefore, noise can go above the threshold or it can cause a signal to fall below the threshold , giving a false positive and false negative. The only solution to this is increasing the amount of samples.

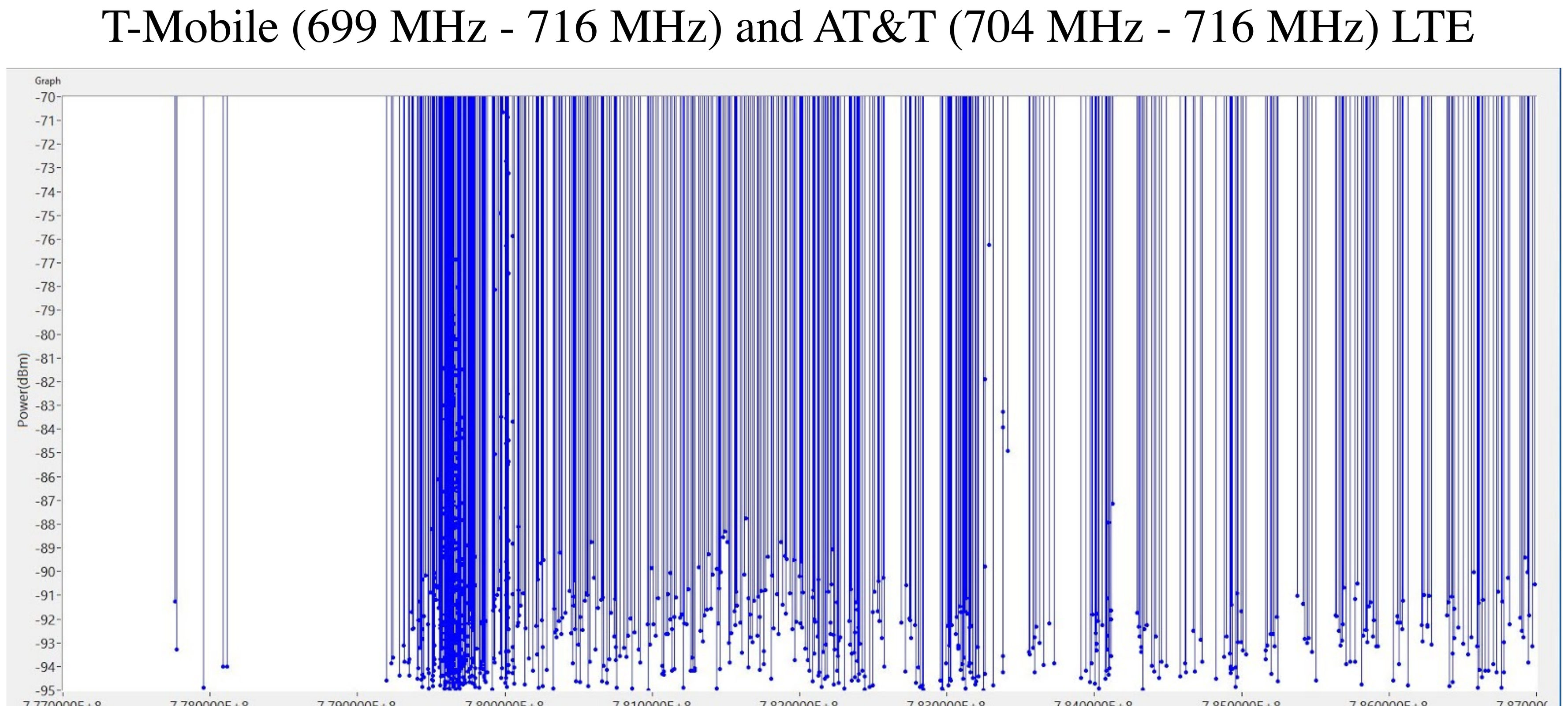
Results



T-Mobile (699 MHz - 716 MHz) and AT&T (704 MHz - 716 MHz) LTE



Sprint LTE (1850 MHz – 1915 MHz)



Verizon LTE (777 MHz – 787 MHz)

Conclusion

Provided that each graph is a stem plot of frequencies over the threshold, we can observe that each LTE band has a range of frequencies that are not used frequently. T-Mobile, as an example, uses very little of the frequency range 700MHz - 703MHz. Sprint being the carrier with the biggest band, uses a only a small portion of it. From this, we cannot reallocate the radio spectrum since my project only looks at a small portion of the highway. However, the graphs gives us an idea of the ranges of frequencies being underutilized in the LTE bands.

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