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Interference between LTE and GPs measuring with Power Spectral Density

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ABSTRACT

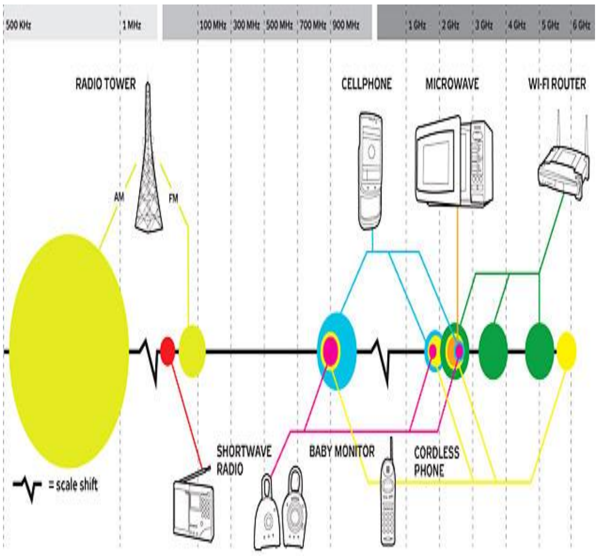
In this paper we are focus over the Adjacent-channel interference (ACI), in which we are coined latest big Lightsquare mishap and other ACI problems to prove and also checking the Power spectral Density of the GPS signal over LTE signal as adjacent channel. By simulating two adjacent channels which consist of GPS signal and LTE signal in the MATLAB environment one can come up with conclusion after all.

***Keywords*:-** LTE, PSD, Interference, GPS, ACI

I. INTRODUCTION

We can easily define Adjacent-channel interference (ACI), in which unnecessary power from a signal caused interference. ACI is not crosstalk. **[1, 2]** GPS signal increases its vulnerability to unwanted interference like out-of-band emissions. Same activity may be possible by telecommunication and electronic system that may be operating in adjacent bands.

Electromagnetic radiation lies behind everything from power full signal to visible light to slow signal. We have 30Hz to 300GHz bandwidth but we use only a portion of the spectrum for wireless communication, Range, antenna size and cost requirements conspire with stringent government regulations to relegate most personal electronics to an even narrower range of frequencies. It consist of cell phones, GNSS, FM Radio, Microwave oven, Bluetooth, Wi-Fi like so many technology in small span. And with so many gadgets hanging around in such a narrow range of frequencies, things can get crowded. Signals can get crossed, literally. For decades, the FCC has tried to prevent this.



[Figure: 1 when gadgets talk to each other unintentionally, the results can be a wireless mess.]

Radio-frequency interference occurs when the signal emitted by one device gets unintentionally picked up by another-—creating audible noise or a compromised connection. Some interference is due to badly shielded wires or components, but some is just the result of too many gadgets crowded into a limited spectrum. Placement also counts for a lot. When it comes to RFI, a little distance can go a long way. **[3]**

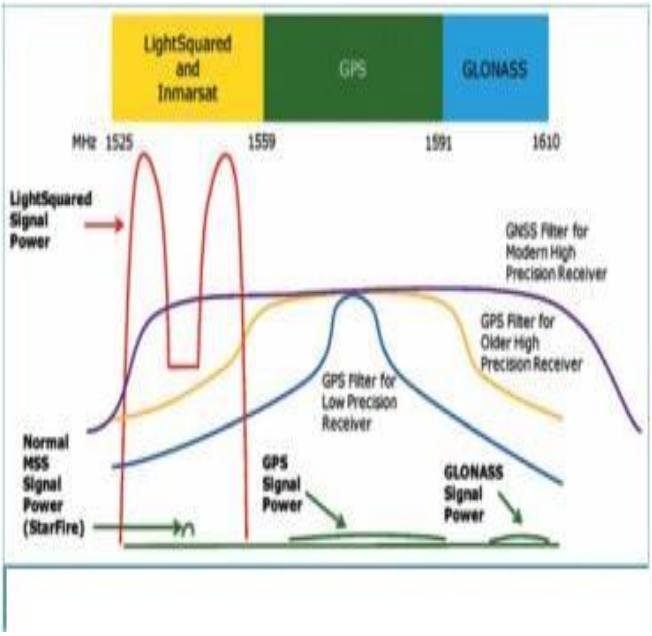
II. ADJACENT CHANNEL INTERFERENCE

The adjacent-channel interference which GPS receiver experiences from a transmitter LTE is the sum of the power that LTE emits into GPS 's channel—known as the "unwanted emission", and represented by the ACLR (Adjacent Channel Leakage Ratio)—and the power that GPS picks up from LTE's channel, which is represented by the ACS (Adjacent Channel Selectivity). LTE emitting power into GPS's channel is called adjacent-channel leakage (unwanted emissions). It occurs for two reasons. First, because RF filters require a roll-off, and do not eliminate a signal completely. Second, due to intermodulation in LTE's amplifiers, which cause the transmitted spectrum to spread beyond what was intended. As per over last paper we can state that GPS is more specious to then LTE. Now we are here try to simulate both technology as adjacent neighbour and simulate how much GPS is vulnerable by LTE. **[4]**

III. POTENTIAL ISSUE OVER THE ADJACENT CHANNEL

As we conclude in previous paper GPS is more vulnerable to any random interference **[5]** now we focus here how much 4g LTE mobile communication technology affects as adjacent channel. Our motivation behind this research when FCC granted Lightsquare's company to start LTE network that would use L-band spectrum adjacent to the L1 frequencies occupied by GPS. But Lightsquare's company can't prove that signals cause no interference to GPS.

Let's see some brief case note of LightSquare & GPS. The LightSquared frequency plan has been presented in the 3GPP LTE Release downlink and uplink frequency ranges are 1525 MHz to 1559 MHz and 1626.5 MHz to 1660.5 MHz, respectively, and the band can accommodate both 5MHz and 10MHz RF channel bandwidths.



[Figure 2: LTE bands and neighbour signals to LTE and GPS L1]

Figure 2, illustrates the neighbouring signals to GPS L1 and highlights the new potential interference source from LightSquared.

What has concerned the GNSS community especially is that until now the downlink band has been reserved for non-terrestrial Mobile Satellite Services (MSS) as shown in **Figure 2**, where spectral power densities in the typical operating environments for GPS are low. Current GPS receivers have not been designed with such a "noisy neighbour" to consider.

There are two types of interference that could be associated with these signals:

a) LightSquared signals at receiver receive with a power level up to -10 dBm and another side GPS receiver receive it with a power level can be low as -160 dBm. So these big differences in power levels at receiver create Interference.

(b) GPS interference can outcome from an unwanted response created by the collaborating of an LTE signal with the local oscillator (LO) of a GPS receiver. **[6]**

V. POWER SPECTRAL DENSITY CHARTS (PSD)

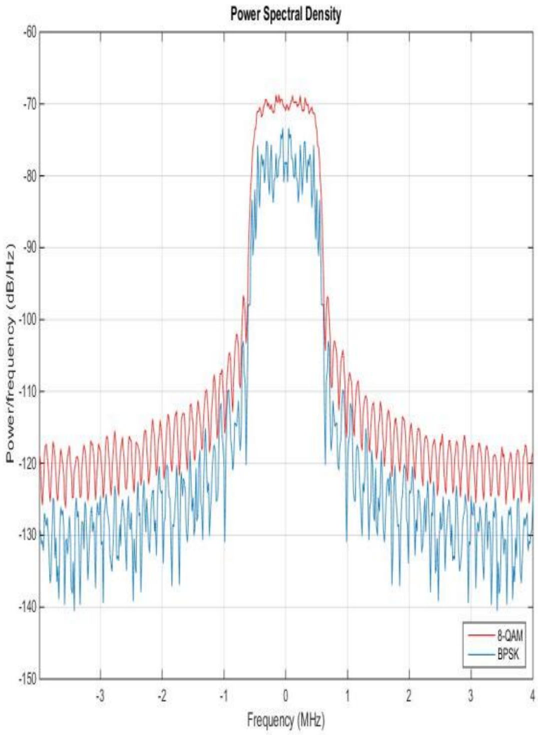
Power in band measures the total power within any specified frequency range or band. Power in band is characterized by the following equation:

$$Power\ in\ Band = \sum_{f_l}^{f_h} X(f)$$

where X is the input power spectrum from a specified band, f_l is the low bound of the frequency band, and f_h is the high bound of the frequency band. The low and high bounds of this band can be determined from the centre frequency. **[8]**

VI. PEAK SEARCH

A spectral peak search algorithm determines the levels and frequencies of peaks in a specified band. The algorithm uses interpolation to precisely locate frequency peaks in the amplitude or power spectrum in any units or scaling. You can also specify whether to locate a single maximum peak or multiple peaks that exceed a specified threshold.



[Figure -3: Power Spectral Density of adjacent 8QAM and 8PSK as LTE and GPS signal]

From the above graph we can easily deduce that interference is there when lte's QAM-8 and GPS's BPSK modulation adjacent.

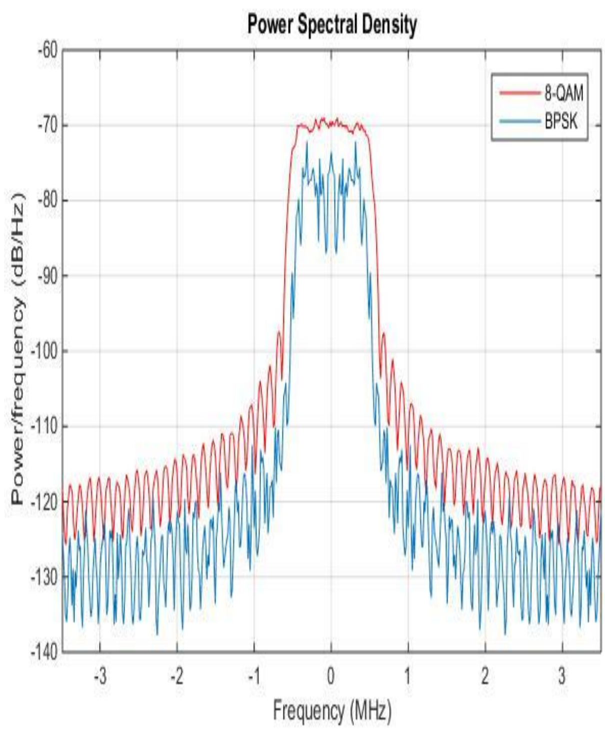
Adjacent channel power (ACP) measures the way a particular channel and its two adjacent channels distribute power. This measurement is performed by calculating the total power in the channel and also the total power in the surrounding upper and lower channels.

Figure 3 illustrates a typical ACP measurement and the centre frequency, bandwidth, and spacing that describe the channels.

BPSK		QAM-8	
Frequency in MHz	Power/Frequency(dB/Hz)	Frequency in MHz	Power/Frequency(dB/Hz)
-4	-126.4	-4	-119.4
-3	-132.3	-3	-118.9
-2	-129	-2	-117.6
-1.5	-120.9	-1.5	-114.8
-1	-120.7	-1	-112.8
-0.6	-94.5	-0.6	-94.5
0	-87.38	0	-71.42
0.6	-94.5	0.6	-94.5
1	-120.7	1	-113.3
1.5	-120.9	1.5	-114.6
2	-129	2	-118
3	-132.3	3	-119.1
4	-133.3	4	-119.3

[Table: 1 Power/Hz data when BPSK and 8QAM both adjacent]

From the above table we can check and deduce the interference at -0.6 of we can find the same power/frequency is -94.5 dB/Hz getting interfere with each other.
After this we have done some other iterative simulation to get some more result form that we can set the conclusion easily.



[Figure -4: Power Spectral Density of adjacent 8QAM and 8PSK as LTE and GPS signal]

BPSK		QAM-8	
Frequency in MHz	Power/Frequency(dB/Hz)	Frequency in MHz	Power/Frequency(dB/Hz)
-3.5	-125.3	-3.5	-118.5
-3	-129.2	-3	-119.5
-2	-125.1	-2	-118
-1.5	-128.5	-1.5	-114.8
-1	-114.3	-1	-112.9
-0.5	-91.73	-0.5	-73.81
0	-81.4	0	-72.14
0.5	-91.71	0.5	-73.85
1	-114.3	1	-113.9
1.5	-128.5	1.5	-115.2
2	-125.1	2	-118.7
3	-129.4	3	-119.8
3.5	-127	3.5	-118

[Table: 2 Power/Hz data when BPSK and 8QAM both adjacent]

VII. CONCLUSION

From the PSD simulation of LTE and GPS Signal as adjacent figure and Data and Real issue case study we can reach a conclusion LTE is really interference when GPS signal adjacent. After finding truth about interference, we have to move towards finding solution of interference by detecting, mitigating or avoiding.

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