Introduction to Cosite Interference Mitigation for Mobile Platforms

The modern Software-Defined Radio (SDR) transceiver provides tremendous operational flexibility in terms of frequency band, waveform, and modulation characteristics. However, there are Radio Frequency (RF) performance trade-offs associated with such versatility. For instance, the transmit frequency response of a typical SDR exhibits significant spurious signals, harmonics, and broadband noise compared to purpose-built analog radios of the past. The receiver performance of an SDR is commonly susceptible to interference due to an open RF front end architecture lacking preselection filtering.

When multiple radios are co-located and operating concurrently, this can be considered a *cosite interference environment*. The unwanted effects from cosite interference – intermodulation, gain compression, reciprocal mixing, etc. – emanate from both co-located transmitters and receivers. Generally speaking, a preponderance of cosite interference effects can be attributed to nonlinearities in active devices caused by insufficient dynamic range. After all, modern SDRs are not inherently designed to operate in these cosite interference environments.

In Figure 1 we see a representative radio's transmit output spectrum in red. In addition to the transmit carrier signal, which is typically 30 dBm or greater, the spectrum also includes spurious, harmonics, and broadband noise. The sensitivity level of the receiver, which is typically -100 dBm or better, is represented by the dashed green line. Of note, the blue curve represents the interfering power level in which the receiver *loses* 3 dB of sensitivity due to interference. From an operational standpoint, keeping noise below the receiver's sensitivity level, and interference below the 3 dB desensitization curve, is critical to link stability and performance.

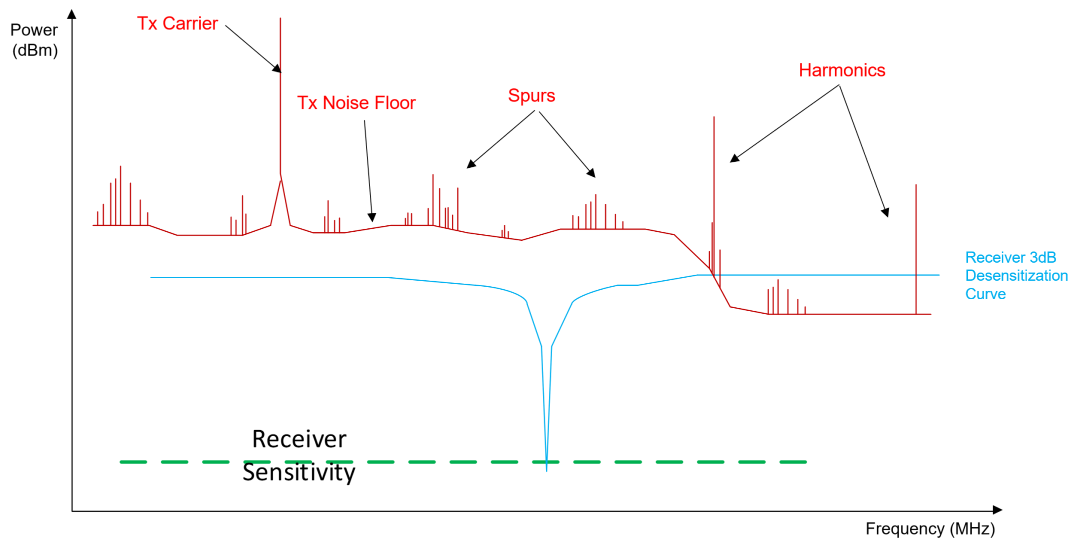

Figure 1: A transmitter's spectral output (red) overlaid with a receiver's sensitivity (green dash) and 3 dB desensitization curve (blue) across frequency.

As shown in Figure 2, the antenna isolation (or conversely, coupling) between radios provides a natural barrier of protection. Depending upon the vehicle platform type and size and the distance between antennas, isolation can be quite significant – usually in the 10's of decibels. That being said, antenna isolation alone is typically insufficient to overcome cosite interference. This is evidenced by the transmit spectrum still repeatedly exceeding the receiver's desensitization thresholds in the figure.

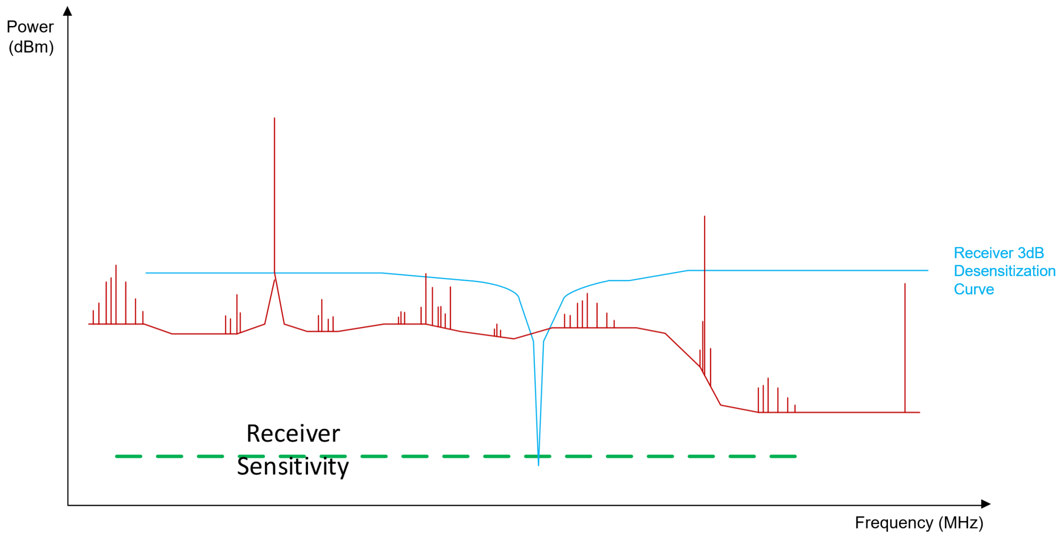

Figure 2: Antenna isolation lowers the transmit spectrum relative to the receiver.

There are several different ways to mitigate cosite interference. First, one may elect to insert a bandpass filter in-line with the radio that is receiving, as depicted in Figure 3. While this helps offset interference effects outside of the passband of the filter, it does not provide complete protection for the receiver.

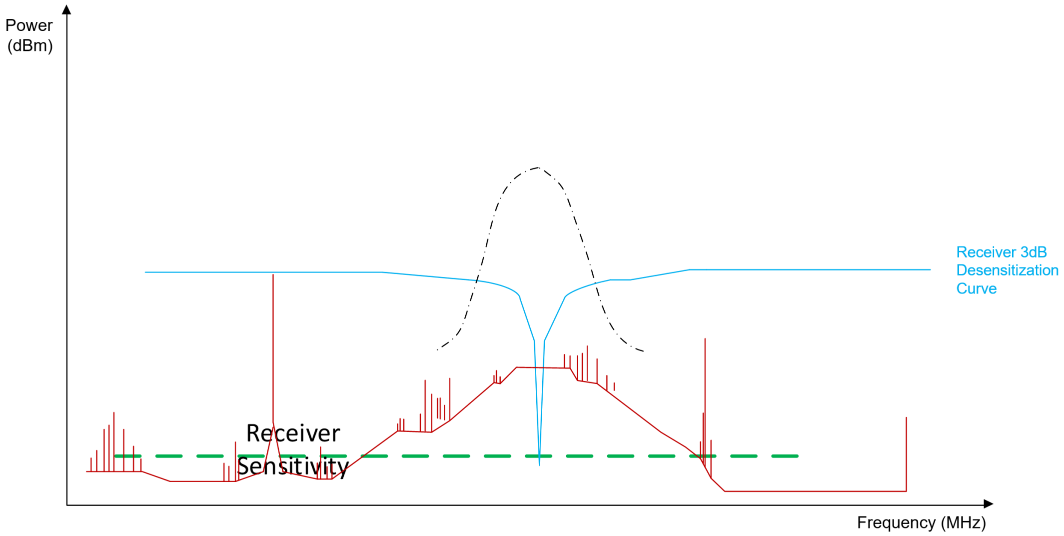

Figure 3: The addition of a bandpass filter on the receiver side (the filter response is represented by the black dashed line) improves performance by reducing the severity of cosite interference effects from the transmitter, however interference still desensitizes the receiver.

Similarly, one may insert a bandpass filter on the radio that is transmitting to help purify the spectrum and reduce broadband interference effects impacting co-located receivers, as shown in Figure 4.

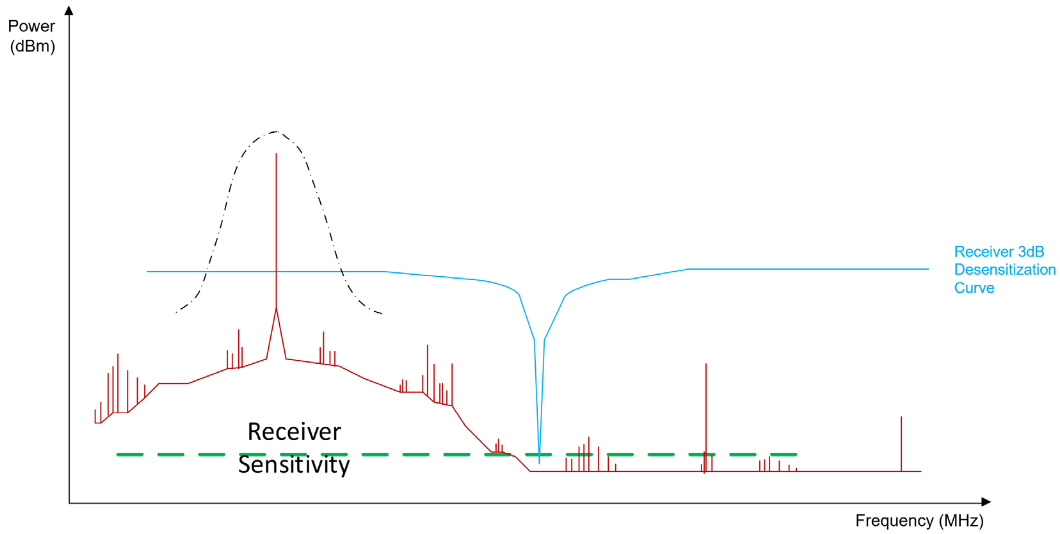

Figure 4: The addition of a bandpass filter on the transmitter purifies the spectrum and reduces cosite interference effects on co-located receivers, but is not a complete panacea.

There are obvious benefits to inserting bandpass filters on each co-located SDR, such that transmit spectra are purified and the receivers are protected from the most severe out-of-band interference. This approach of filtering alone may be satisfactory given the specific operational environment of the platform and/or the mission requirements. However, certain platforms and/or missions may require that the radios operate nominally in the presence of moderate-to-severe cosite interference. We will explore this scenario next.

Comprehensive cosite interference mitigation solutions exist to provide enhanced radio link performance in moderate-to-severe cosite environments. For instance, MPG Solutions' Integrated Cosite Equipment (ICE™) product line includes *Filter/Amplifier* and *Canceler* solutions that support line of sight (LOS) waveforms, including frequency hopping spread spectrum (FHSS), and satellite communications (SATCOM) waveforms. These ICE solutions offer varying degrees of RF performance (i.e., adjacent channel filter selectivity or cancellation depth), and size, weight, power, and cost (SWaP-C).

For simplicity, we will highlight a traditional ICE™ Filter/Amplifier architecture in Figure 5. This approach leverages tunable bandpass filters and high-dynamic-range amplifiers in a cascade to mitigate cosite interference effects in both transmit and receive modes. ICE™ Filter/Amplifiers also provide high-power amplification for transmitting at or near the radio's original RF output level, harmonic filtering, and direct radio interfaces for receiving keyline and tuning data from the radio itself.

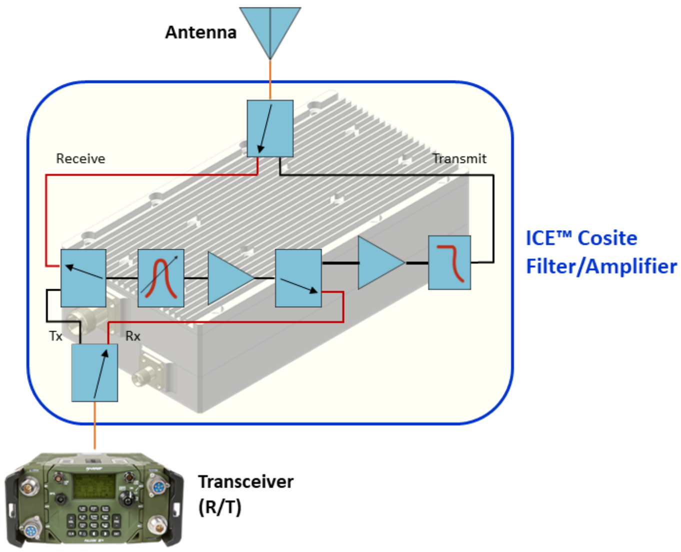

Figure 5: An ICE™ Filter/Amplifier, inserted between the radio and the antenna, features a cascade of filters and amplifiers and provides a comprehensive solution for overcoming cosite interference.

Now, by employing a comprehensive cosite interference mitigation solution on each co-located radio, one may achieve a level of interference mitigation that enables each radio to operate nominally at range and with the anticipated link margin. The performance gains of this holistic approach are represented in Figure 6 in which interferers no longer breach the receiver's 3 dB desensitization curve.

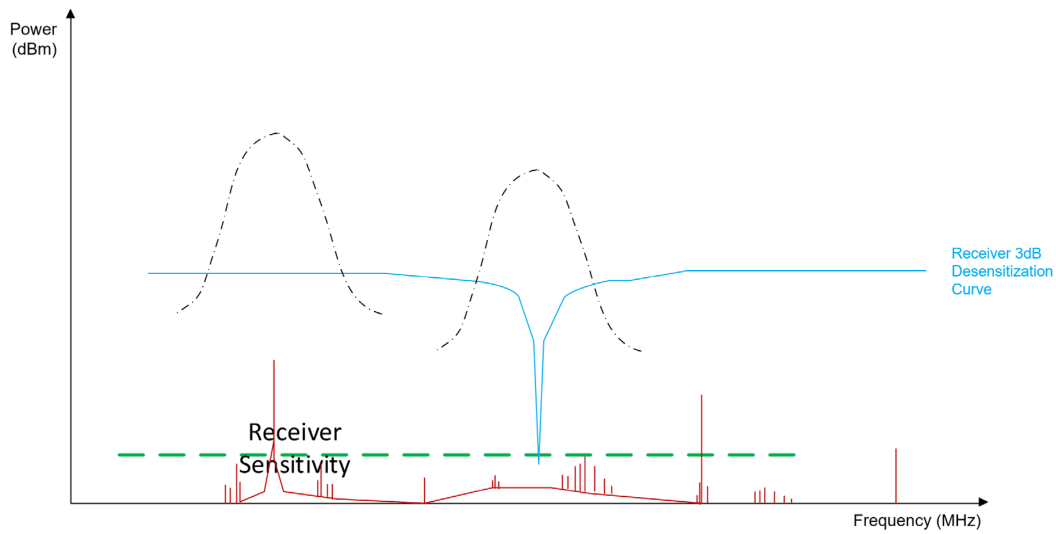

Figure 6: Comprehensive cascaded filtering and amplification can virtually eliminate the deleterious effects of cosite interference, thus preserving the original performance of the radio.

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