GIRD Systems, Inc.
Engineering Research and Development

NORTHROP GRUMMAN
Electronic Systems
XETRON

RF Solution to Narrow In-Band Interference in UHF SATCOM Channels

SPAWAR
Systems Center San Diego

Technology in Development:

- SPAWAR Phase I SBIR awarded June 2004
- SPAWAR Phase II SBIR awarded February 2006
- Hardware demonstration using captured signal data – Fall 2007
- Real-time over-the-air hardware demonstration – early 2008

General Description:

GIRD Systems, in collaboration with Northrop Grumman Xetron, is developing a novel Interference Mitigation System (IMS) for mitigation of narrowband interference from UHF SATCOM channels. Operating as a stand-alone processor, the IMS can be quickly integrated into virtually any SATCOM platform.

By exploiting *a priori* knowledge of the nominal Signal-Of-Interest (SOI) characteristics, GIRD's signal processing algorithms can better separate the interference and SOI, relative to conventional linear prediction and linear equalization approaches. Low algorithmic and hardware latencies ensure operation of the IMS is transparent to the receiver.

When the DAMA terminal's IF signal is not available, the IMS is augmented with a Radio Frequency Front End (RFFE) which performs downconversion to IF. Following digitization and processing, the signal is regenerated at the RF frequency specified by the terminal's tune word.

In some applications, the SATCOM receiver's 70 MHz IF signal is available for direct processing. In this case, the IF is digitized by the IMS, the mitigation performed, and the processed signal regenerated at IF. Operating in this manner, the IMS requires no side information about the SOI.

Example Scenario:

Figure 2 illustrates one potential interference scenario. Two narrowband interferers are corrupting a 9600 bps BPSK transmission over a 25 kHz SATCOM channel. Without interference mitigation, the receiver BER is very nearly 50% because the interference energy causes complete failure of the receiver's carrier tracking and equalization loops.

Figure 3 illustrates the effectiveness of GIRD's interference mitigation algorithm. Following mitigation, the receiver BER is <1% at -10.3 dB SINR.

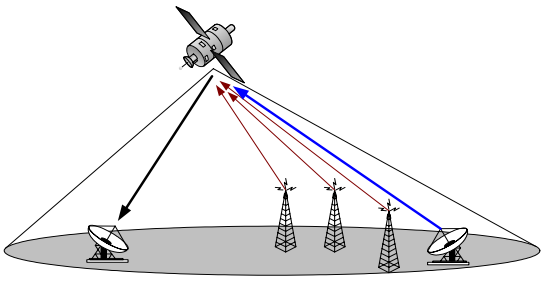

Figure 3 – Narrowband interference (incidental or intentional) often corrupts DAMA SATCOM signals because of the satellites' wide beams. Terrestrial emitters' signals couple into the satellite uplink and are downlinked along with the signals of interest.

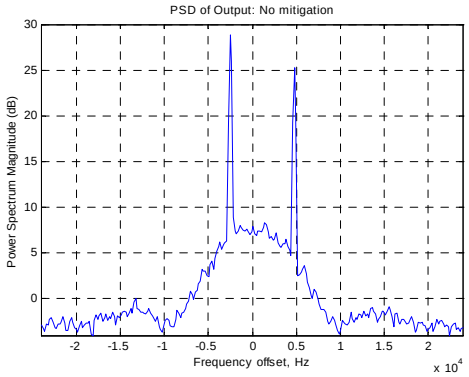

Figure 3 – 25 kHz DAMA SATCOM SOI corrupted by two CW interferers. The Signal to Interference power Ratio (SIR) is -10 dB, and the Signal to Noise power Ratio (SNR) is 2 dB. Pre-FEC BER = 5×10^{-1}.

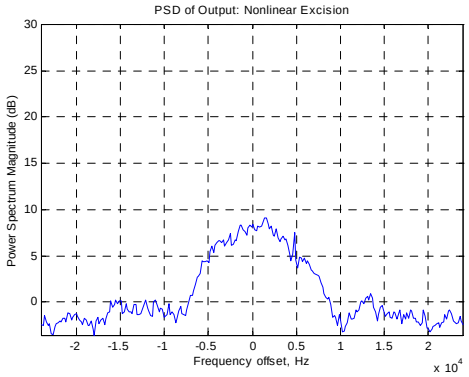

Figure 3 – Power spectrum of the burst following mitigation. The interference has been almost completely removed. Pre-FEC BER = 2×10^{-3}.

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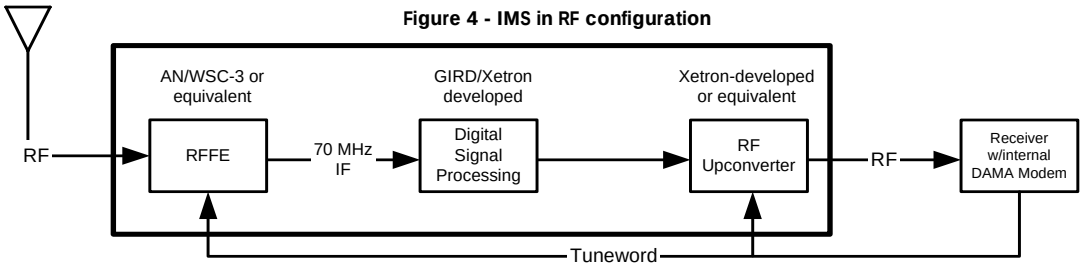
Hardware Mitigation Approach:

At the heart of the Interference Mitigation System lies the digital processor. GIRD's proprietary algorithms use signal processing to achieve improved rejection of the interferer prior to the signal reaching the receiver's carrier tracking and equalization algorithms. In this way, the IMS can offer improved performance relative to post-detection algorithms, which rely on successful carrier acquisition. By utilizing reconfigurable logic to perform the signal processing, the GIRD interference mitigation system will also allow rapid prototyping and evaluation of other interference mitigation algorithms.

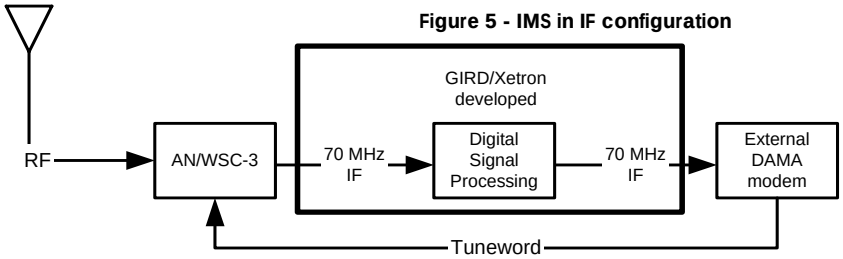
While the ultimate implementation depends upon the target SATCOM radio, normally an RF front end will be used to downconvert to IF. This downconversion can be accomplished with a conventional receiver (i.e. WSC-3), a COTS UHF Receiver, or a custom RFFE. In the prototype hardware platform, a COTS receiver is used in conjunction with custom RF low-noise amplifiers and filters. Following downconversion, the signal is filtered, digitized, and processed so that the sanitized signal (without interference) is regenerated at the output of the digital processor, upconverted to RF and fed into the receiver as shown in Figure 4.

Figure 4 - IMS in RF configuration



Where an IF input to the IMS is directly available, as in the case where an external modem is employed, or can be made available by tapping into the radio circuitry itself, an IF system configuration such as shown in Figure 5 would save the added size, weight, and expense of the RFFE and RF upconverter.

Figure 5 - IMS in IF configuration



A hardware platform for a prototype implementation is shown in Fig. 6 to the right.

Software Mitigation Approach:

Since the mitigation algorithm relies on digital signal processing techniques, the technology is also applicable to software-based radio platforms that can be upgraded to accommodate new processing techniques. The interference mitigation algorithm developed for this program can easily be integrated into most software-defined radio without requiring excessive memory or processor usage.

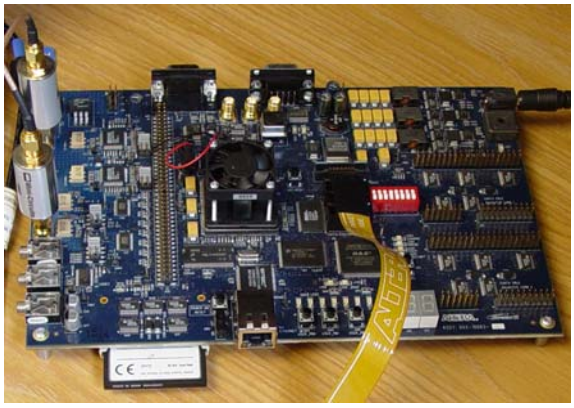


Figure 6 – Hardware platform