RTCA Special Committee 186, Working Group 5

UAT MOPS

Meeting #2

BAE Double sideband Transmitter / RAKE-like Receiver for Protection Against L-16 / JTIDS Interference

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SUMMARY
BAE, as part of the Interference Protection Working Group, has defined a Robust UAT Solution to L-16/JTIDS and DME pulsed interference. The approach is based on simultaneously transmitting the UAT Signal on two frequencies. On receive a RAKE-like UAT receiver non-coherently combines the energy from the two frequency channels, when there is no detected interference on either channel, and uses only the clear channel when the other is corrupted with interference.

Robust UAT
Double Sideband Transmit / RAKE-Like Receiver Solution

Background:
Current UAT is susceptible to pulsed interference from L-16/JTIDS and DME equipment. At the December UAT WG-5 meeting a subcommittee was formed to recommend potential solutions to the interference problem. MITRE and BAE SYSTEMS accepted action items to recommend possible solutions.

Candidate Solution Summary
MITRE's proposal attacks the problem with stronger FEC, resulting in increased message length for the same payload (ADS-B) or smaller payloads for the same message length (Ground up-link). The short ADS-B Message is increased in length by 8-bits, the long ADS-B message is increased by 40 bits. Mutual interference increases. The Ground to Air Up-Link message length stays the same, but FEC and CRC overhead is increased from 368 bits to 1008 bits, reducing the Up-Link Payload by 640 bits. To further aid in coping with the interference problem, an Interleaver function is added.

BAE's proposal enhances the robustness of the UAT Data Link by transmitting each pulse (symbol) on two Sidebands or Frequencies simultaneously. The Receive function is somewhat analogous to a RAKE Receiver. Functionally, after reception, if neither sideband is corrupted with interference, the energy from both sideband receivers are non-coherently summed. If one or the other sideband is corrupted, the companion sideband receiver is used to collect the data. With the 100% TSDF Single Net Jamming Scenario defined by the UAT community, one receiver channel will always be free of interference. With this approach only a small amount of FEC is required, maximizing the amount of thru-put. The decision logic to combine or not to combine receiver channels is analogous to what is done in JTIDS Double Pulse operation for the last 25 years.

L-16/JTIDS Interference Definition
The interference model for UAT is currently specified as a 258 pulse message in 100% of the JTIDS time slots (100% TSDF). In practice it can be much higher than this. Stacked Net operation, Contention Access techniques and Packed-4 (444 pulses) messages can dramatically worsen the interference environment to UAT. Each Stacked Net can double the interference of the Single Net L-16 community. The military talks about a minimum of 2 to 4 Stacked Nets. Contention Access also doubles the number of apparent interferes for each member contending for access to a JTIDS time slot. Lastly the Packed-4 message almost doubles the interference on a Ground Up-Link Message over the standard 258 pulse Message that the UAT Community is presently testing against.

BAE's Proposal
BAE's Proposed Double Sideband/RAKE-like Transceiver Architecture stands up to the combined effects of the above L-16/JTIDS and other pulsed interference. The basic principal is that there is "always" one clear receiver channel available to receive the UAT

message. In the Stacked Net case, the probability of 2 to 4 independent JTIDS nets simultaneously choosing the two UAT operational Frequencies at the same 6.4 micro-sec interval of time is very small, as is the case for Contention Access. Even when adjacent channel interferes are considered, for the above cases, the probabilities still remain low that both UAT operational frequencies will be corrupted with L-16/JTIDS interference. For the cases where both frequencies are corrupted with interference, a low overhead FEC is assumed. Something like that in the current UAT equipment.

Performance Analysis of the proposed BAE UAT Transceiver

As part of the 4 member Pulsed Interference Team, BAE briefed Johns Hopkins APL on the approach. Questions concerning range performance when the transmit power is split on two frequencies was discussed and analyzed. BAE showed that with no net increase in power (3db down on each transmit Frequency) and Non-Coherent Received Signal Combining, only 0.7 db of range (not 3 db) would be lost for the same binary Signaling Alphabet used by Current UAT. No range degradation would be realized if the Signaling Alphabet were increased to 16-Ary or 32- Ary. Based on the above positive performance facts, and the robustness of the Double Sideband/RAKE-like Receiver architecture, BAE suggests this approach be evaluated by WG-5 and perhaps become the UAT baseline.

Issues to be Addressed by WG-5

There are two additional FAA / FCC issues to be addressed if the subject approach is to be carried forward: Dealing with a slightly wider Frequency Spectrum for the more robust Signaling Alphabet, and finding an additional frequency allocation for the required 2^{nd} frequency. If UAT is to survive over the next 25 years, WG-5 needs to make it co-exist in present and future interference environments.

Implementation and Cost trades

BAE's solution preserves the entire UAT Timing and Message Processing structure. The RF hardware is the only thing affected. This solution preserves the 8-bit Symbol interface to the existing UAT FEC Encoder/Decoder, and allows all existing Airborne and Ground based UAT software can remain identically the same.

The Double Sideband/RAKE-like Transceiver function can be added to an existing UAT as a single card drop in Retrofit Kit. Solutions for implementing the RF linear Power Amplifier Combining function are readily available, low risk, and low cost.

Action Items

BAE looked at the MOPS and MASPS outlines and work to date. Only 2-3 % of the documents address the RF functionality. If WG-5 should pursue the BAE proposal, drafts of the affected RF sections could be developed and presented by BAE at the April Meeting.

The approach needs to be validated by Johns Hopkins. If WG-5 should pursue this approach, BAE’s Double Sideband/RAKE-like Transceiver Simulation Model can be ported to Johns Hopkins APL Network Simulator with relative ease. Preliminary discussions already took place.