RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #4

Use of FEC Decoder for Message Length Determination

Author: T. Mosher, UPS AT

SUMMARY
Discusses experimental results of using the FEC decode process to identify the received message length, as an alternative to the "Length ID" field used in the prototype UAT. This paper is in response to UAT-WP-4-02, Issue #1.

Introduction:

The present prototype UAT message format utilizes an 8-bit field referred to as the "Length ID", which codes the type of message being received. The Length ID field is set to one of two unique patterns by the transmitter (0x0F and 0xF0), so that the receiving unit can perform a correlation to determine the message block length, and therefore know which type of RS decoding to perform for that message. The Length ID field is outside the FEC block. In effect, the Length ID field creates an extension to the 36-bit Frame Sync pattern, so that differentiation can be made between the two message lengths.

The Length ID method has been shown to perform acceptably, but has the drawback of consuming 8 bits of payload to communicate a binary value (Basic vs. Long). This paper reports on the preliminary evaluation of a method to process the Basic and Long messages without inefficient use of payload bits.

Using FEC Decoding to determine message length

Reed Solomon codes can be designed that have very low Probability of Undetected Message Error (PUME). This makes it possible to rely on the RS decode process to discriminate between messages of different length. The PUME for the comparatively weak FEC codes used in the prototype UATs is not sufficiently low to assure the required message integrity. The following table summarized the present and proposed Reed Solomon codes. Note that other RS codes are also being considered, so this represents only an example of the technique.

	Basic Codes	**PUME**	**Long Codes**	**PUME**
Present Codes	RS(25,19)	1.36e-4	RS(41,35)	6.28e-4
Proposed Codes	RS(27,17)	7.21e-8	RS(45,33)	2.83e-8

The reader is referred to UAT-WP-4-06 for further analysis of UAT message error rates.

Experimental data:

Bench tests were performed using present UAT digital processor hardware. Random message blocks (consisting of random payload + parity bytes) were generated of both Basic and Long lengths. Each random block was passed through the FEC decoder process, with a count maintained of the number of blocks rejected or accepted. Each test run was terminated on the first instance of a block being accepted as correct after FEC decoding (indicating an undetected error). Detection of the 36-bit Sync pattern was not included in the experiment.

# of msgs	Corrected msgs	Undetected Error Rate
8.1164E+06	1	1.23207E-07
5.6940E+06	1	1.75623E-07
8.9929E+06	1	1.11199E-07

The aggregate PUME for these three experimental data sets was 8.8e-8 (= 3 / 22.8 Million). This is not an exhaustive set of data, but is representative of expected performance.

Conclusion:

The technique of using RS decoding to determine the length of a received airborne ADS-B message has been demonstrated. In this limited experimental trial, the probability of an undetected error was shown to be acceptably low with this set of proposed codes (8.8 e-8). These codes have sufficient excess PUME capability to meet the 10e-6 message requirement integrity found in the ADS-B MASPS as well as determine message length.

If the experiment is modified to require detection of an airborne 36-bit Sync pattern prior to operation of the FEC decode process, the PUME for the entire UAT reception system can be expected to be reduced even further, by several orders of magnitude. Refer to Figure 2 of UAT-WP-4-12 for further data on synchronization probability.