RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #26
11 – 13 August 2009

Proposed Clarifying Notes to be added to Section 2.2.2.6 and Section 2.2.6.2.1

Revision 1

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SUMMARY

This paper proposes that two explanatory notes be added to DO-282B as follows:

A third note should be added to Section 2.2.2.6 in order to clarify a potential ambiguity in the UAT transmit spectrum requirement.

The second note in Section 2.2.6.2.1 should be augmented in order to clarify the method for choosing MSOs. Also, some words in the main requirement should be altered.

During the testing of MITRE's developmental, miniaturized UAT transceiver, the testers felt that the requirement stated in §2.2.2.6 was not entirely clear. There was apparently an ambiguity as to whether the measurement applied to only the "Active" part of the UAT bursts (as portrayed in Figure 2-1), or to the entire burst --- including ramp up and ramp down times included in the space between the designated "Active' and "Inactive" times. During the writing of DO282 it was the intention of Working Group 5 that the spectrum requirement was supposed to include entire bursts, in order to capture any adverse spectral spreading due to turning bursts on and off too rapidly.

To make this clear, it is suggested that a third note be added to the two notes under Figure 2-2:

> *3. The mask shown in Figure 2-2 should be verified by measuring the spectrum over the entire message transmission, including any ramp up and ramp down transmission outside the Active interval shown in Figure 2-1.*

During the same development effort, there was some confusion as to how the Latitude and Longitude were supposed to be used to help generate the MSO value needed each second. In the algorithm, the purpose of using the position is to ensure randomization of the MSO selection; so there is a degree of flexibility in how the position information can be processed. Note that it is *not* necessary that all UAT designs use the same method. This flexibility can be used to simplify particular UAT designs.

It is suggested that §2.2.6.2.1 be amended as shown below. The proposed changes are shown in red.

2.2.6.2.1 The Message Start Opportunity (MSO)

ADS-B Messages **shall** be transmitted at discrete Message Start Opportunities (MSO) chosen by a pseudo-random process. The specific pseudo-random number (*R*) chosen by an aircraft depends on the ~~aircraft's current~~ most recent valid position estimate available at the beginning of each second and on the previously chosen random number *R(m-1)*. Let:

N(0) = 12 L.S.B.'s of the most recent valid "LATITUDE"
N(1) = 12 L.S.B.'s of the most recent valid "LONGITUDE"

where the "LATITUDE" and "LONGITUDE" are as defined in §

Using *N(0)* and *N(1)* the procedure below **shall** be employed to establish the transmission timing for the current UAT frame *m*.

When $m = 0$, $R(0) = N(0) \bmod 3200$

When $m >= 1$, $R(m) = \{ 4001\, R(m-1) + N(m \bmod 2) \} \bmod 3200$

1. When in the first frame after power up, and whenever the Vertical Status is determined to be in the AIRBORNE condition, the transmitter **shall** be in the *full MSO range* mode, where the MSO is determined as follows:

   MSO = 752 + R(m)

2. Under all other conditions the transmitter **shall** be in the *restricted MSO range* mode, where the MSO is determined as follows:

   MSO = 752 + R* + R(m)mod800

   With R* = R(k) – R(k)mod800, where "k" is the frame just prior to entering the *restricted MSO range* mode.

Notes:

1. *Retention of N(0) and N(1) in non-volatile memory is required to prevent common MSO selections amongst A/Vs when no valid latitude and longitude is currently available.*

2. *The latitude and longitude alternate in providing a changing "seed" for the pseudo-random number generation. In most cases the most recent valid "LATITUDE" and "LONGITUDE" available at the very beginning of each second is the position from the previous second. (If the navigation source is temporarily unavailable, the available position data might be older.) Other acceptable definitions include (1) the position from the previous second extrapolated to the current second, (2) the position estimate from the current second (if available at the time of MSO determination) or (3) any equivalent.*

3. *The restricted range MSO mode makes the choice of MSO more nearly periodic in order to support certain surface applications.*