RTCA Special Committee 186, Working Group 3

ADS-B 1090ES MOPS

Meeting #20

Teleconference

Additions to the Proposed "Change 1" to RTCA/DO-260A Identified Since Meeting #19 (WP19-06)

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SUMMARY

This Working Paper identifies five (5) additions to the proposed text of a potential "Change 1" document to RTCA/DO-260A, based upon the set of changes that were reviewed during Meeting #19 as Working Paper WP19-06.

Additions include: **(1)** a correction to typos identified by Thales ATM, **(2)** a proposal to increase the required output power of Class A3 1090ES equipment to 200W to be consistent with the ICAO 1090ES SARPs, **(3)** an addition to the *Note* proposed for the "SIL" sections after a review of the original proposed *Note* by the ICAO SCRSP Technical Subgroup, **(4)** addition of some guidance material *Notes*, and some new requirements and test procedures, related to longitude zone boundary conditions while calculating CPR, and **(5)** Test Procedures modified for the Preamble tests in §2.4.4.4 that were identified and discussed during Meeting #19 in WP19-10.

(1) A Correction to two typos as identified by Thales ATM:

At Thales Gorgonzola, Luca Saini and Paolo Gervasoni found a bug in a formula in DO-260A that would have significant impacts on Surface reported positions by aircraft, or in general ADS-B transmitting mobile vehicles. This bug was discovered during their implementation activities on their Mosquito vehicle ADS-B transmitter.

Reference RTCA/DO-260A, sections §2.2.3.2.4.8.2.1 and §2.2.3.2.4.8.3.1, in the "Commentary:" section of each paragraph, the definition of the mathematical symbol Phi (ϕ) was stated incorrectly using "longitude" instead of correctly using "latitude." In DO-260A, replace the definition for Phi in both sections, as follows:

ϕ = approximate latitude (the latitude, ϕ_{fix} at the time of the fix may be used)

(2) Proposal to Increase the Required Output Power of Class A3 1090ES Equipment

During the development of the DO-260A MOPS, 1090 MHz Extended Squitter simulation results became available that indicated the value of having increased airborne minimum RF transmitter power levels for supporting longer range air-to-air ADS-B services. Since Class A3 airborne systems are intended to support such longer air-to-air ranges there was discussion within SC-186 WG-3 at that time of increasing the required RF peak power output for this class of systems. However, for DO-260A the required output power, as defined in §2.2.2.1.1.4 of DO-260A, was left at 21 dBW and a *Note* was added recommending a minimum value of 23 dBW and indicating: "… *This 2 dB increase from the 21 dBW minimum RF peak power specified in these MOPS and RTCA DO-181C may be required in order to support longer range air-to-air applications (e.g., flight path de-confliction), especially when over-flying moderate to high traffic density airspace.*"

A summary of the simulation results are presented in Appendix P of DO-260A. For these simulations conducted by John Hopkins University Applied Physic Laboratory the transmit RF peak power level for the Class A3 was assumed to be consistent with the recommended minimum level of 23 dBW and with a uniform distribution between 23 dBW and 26 dBW (as described in paragraph P.2.1.1). The Class A1 and A2 systems were assumed to have a minimum RF output peak power level of 21 dBW with a uniform distribution between 21 dBW and 24 dBW. For the simulated Los Angles 2020 future traffic environment the predicted air-to-air ranges for ADS-B reception meeting the ADS-B MASPS (DO-242A) update requirements are summarized in Table P-1. The results presented for the A2-transmit-to-A3-receive would be more representative of the performance than could be expected for Class A3-to-A3 if the MOPS lower limit of 21 dBW is applied while the performance reported for the Class A3-to-A3 is representative of what could be expected if the recommended increased lower limit of 23 dBW is applied.

The results of the simulations indicate in increase from 50 NM to 70 NM for the air-to-air range for which the State Vector updates satisfy the DO-242A MASPS requirements. Of course the air-to-air range would be greater in lower density, lower interference operational environments.

Subsequent considerations within the ICAO SCRS Panel resulted in that group adopting a 23 dBW minimum RF peak output power requirement for Class A3 systems. It is expected that the update to the 1090ES ICAO SARPs incorporating this change will become effective in 2007. It is proposed to incorporated a similar increased minimum transmit RF peak power requirement for Class A3 systems into DO-260A, Change 1.

In DO-260A, paragraph §2.2.2.1.1.4 change:

"21.0 dBW (135 W)"

-TO-

"23.0 dBW (200 W)"

and delete the existing *Note*.

(3) <u>Proposed Modification to the "SIL" Note that was supposed to indicate that Manufacturers should not set SIL=0</u>

The proposed Change 1 to DO-260A was reviewed by the ICAO SCRSP Technical Subgroup (TSG) during their meeting 2-10 February 2006. During the specific review of the *Note* that was originally proposed in the draft of TSO C166A, and the Change 1 to DO-260A that was reviewed during Meeting #19 of WG-3, it was suggested by the TSG to make some minor clarifying additions to the text of the actual SIL requirements, and changes to the *Note* to clarify it for the International community. Note that the last sentence of the previous *Note* was replaced by text taken from the current draft of the STP MOPS.

This *Note* for the SIL parameter is identified in the proposed Change 1 to DO-260A in three (3) places in DO-260A. The modifications proposed by the TSG would apply to all three locations for clarifying changes to the *Note* as well as the requirement. The text of the *Note* is shown below, with modifications highlighted in yellow:

> *Since the SIL is intended to reflect the integrity of the navigation source of the position information broadcast, the SIL value transmitted should be indicative of the true integrity of the ADS-B position data. A problem for installations that include currently available GNSS receivers and FMS systems is that SIL is not output by these systems. With the lack of SIL information being provided by the navigation source, implementers should not arbitrarily set a SIL value of zero indicating unknown integrity. It is suggested, that unless there is a tightly coupled navigation source where SIL can be unambiguously determined and set dynamically, the ADS-B Transmitting Subsystem should provision for the static*

setting of SIL as part of the installation procedure. Most implementers are expected to determine SIL by off-line analysis of the installed configuration. This off-line analysis can be performed on the various primary and alternate means of determining the reported position. SIL is a static value for each of these configurations.

The TSG proposed adding the following text (highlighted in yellow) to the beginning of the last sentence of the basic requirement for SIL which identifies the data lifetime of the data. This change is duplicated in §2.2.3.2.7.1.3.13, §2.2.3.2.7.2.9, §2.4.3.2.7.1.3.13, §2.4.3.2.7.2.9, §A.1.4.9.14, and §A.1.4.10.9:

For installations where the SIL value is being dynamically updated, if an update has not been received from an on-board data source for SIL within the past 5 seconds, then the SIL subfield **shall** be encoded as a value of ZERO (0), indicating "Unknown."

(4) Addition of some guidance materials related to longitude zone boundary conditions while calculating CPR

In a report by Air Services Australia in January 2006, on problems related to both their Sensis and Thales ground stations, they have observed several occurrences of a situation where the reported ADS-B position shows a significant jump in longitude. This problem has also been seen in New Zealand. At the time of the report, they had only observed these position jumps on aircraft that were equipped with transponders from Rockwell Collins. Therefore a collection of data was forwarded to Rockwell Collins for analysis. Detailed analysis of the problem shows that it occurs at transition latitudes in the CPR algorithm. These are latitudes at which the number of longitude zones (NL), and hence the longitude zone size (Dlon) changes. As a result, the XZ-position within the zone reported by the aircraft will vary somewhat from the sequence of previous reports.

It appeared from the initial analysis that the airborne CPR encoding process was not correctly identifying that a transition latitude has been crossed. The transponder therefore reports the XZ-position corresponding to the previous longitude zone.

All of the collected data was forwarded to Bob Saffell of Rockwell Collins and he produced what has been offered as Working Paper 1090-WP20-03, which has been returned to Air Services Australia for their review. In the Working Paper, Bob analyzes in deep detail how this problem happens and suggests that materials be created for the 1090ES SARPs, and the 1090ES MOPS, as guidance materials for ensuring that this problem can be recognized and tested for. During the meeting of the ICAO SCRSP Technical Subgroup (TSG), 2-10 February 2006, another working paper was submitted suggesting *Notes* that could be added to the CPR definitions in the 1090ES SARPs as guidance materials. Following additional discussions, it was also agreed that requirements were necessary for checks at the zone boundaries. The *Notes* and suggested requirements are detailed in red text in Working Paper 1090-WP20-04. Test Procedures were then written for insertion in DO-260A §2.4 as tests of the new requirements.

(5) Proposed Modifications of Preamble Tests Resulting from Problems Previously Defined and Discussed in 1090-WP19-10

After conducting test procedures as defined in ADS-B MOPS DO-260A section §2.4.4.4, Verification of Enhanced Squitter Reception Techniques, it has been determined that some of the test procedures contain errors. The errors were found in section §2.4.4.4.2.2, Four-Pulse Preamble Detection Tests, and section §2.4.4.4.2.3, Preamble Validation Tests. The test procedures defined in these sections were conducted both at the FAA Technical Center and JHU APL to test Enhanced Squitter Reception Techniques that were developed according to the DO-260A MOPS, Appendix I. Some of these test procedures resulted in common failures with both decoder implementations. Analysis revealed that the decoders were acting properly and that the test procedures were in error. Working Paper 1090-WP19-10 presented the data from conducting the tests and an analysis of why the tests were in error.

The Proposal to replace the Test Procedure sections §2.4.4.4.2.2 and §2.4.4.4.2.3, in their entirety, is presented in Working Paper 1090-WP20-05.