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EUROCAE WG-51, SG-1

ADS-B 1090ES MOPS Maintenance

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Selection of "Aircraft Stopped" in the movement field of the surface position message

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Summary
This Working Paper reviews the different sections of the 1090 MOPS which may be impacted by the setting of "Aircraft Stopped" value in the movement field of the surface position message and proposes modifications to the 1090 MOPS to ensure that its selection is correctly specified in the MOPS.

1 Introduction

During meeting 29 when discussing Working Paper 1090-WP28-19 the group decided to force " aircraft stopped" value in the movement field of the surface position message when the criteria for low squitter rate is met.

A number a comments were received on this subject during the FRAC/WC review period of the 1090 MOPS. A first attempt to link the selection of the "aircraft stopped" with the selection of the low squitter rate was proposed during the review of the comments. However the low squitter rate can also be forced by an external Mode S command and there were doubts on the need to force "aircraft stopped" when low rate is selected by a ground command. This WP proposes changes to the different sections involved in the selection of "Aircraft stopped".

2 Proposal

Sections possibly impacted by the change:

The movement subfield message format is described in
2.2.3.2.4.2 "Movement" Subfield in ADS-B Surface Position Messages

the squitter rate selection is described in
2.2.3.3.2.3

The ADS-B Transmission and Message Formatting of ground speed is described in
2.2.5.1.9 Ground Speed Data

and tested in
2.4.3.2.4.2 Verification of "Movement" Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.2)

Proposed approach

It is proposed to put the requirement in section 2.2.5.1.9 and link this requirement with the criteria used to select the low squitter rate as described in 2.2.3.3.2.3.

For the testing it is proposed to improve section **2.4.3.2.4.2 Verification of "Movement" Subfield in ADS-B Surface Position Messages** rather than changing the squitter rate test.

1st step requirement in 2.2.5.1.9

2.2.5.1.9 Ground Speed Data

a. The ADS-B Transmitting Subsystem **shall** accept own vehicle Ground Speed information via an appropriate variable data input interface and use such data to establish the "Movement" subfield (see §2.2.3.2.4.2) in the Surface Position Message as specified in §2.2.3.2.4.2 except when the system has selected the "Low" squitter rate as per §2.2.3.3.2.3.

b. When the system has selected the low broadcast rate of surface position squitter as per §**2.2.3.3.2.3** then the device shall enter the value of ONE (1) (Aircraft stopped) into the Movement subfield specified in §2.2.3.2.4.2.

c. A low squitter rate forced by an external RCS command as described in RTCA DO-181D §2.2.23.1.6 (EUROCAE ED-73C) **shall** have no impact on the setting of the Movement subfield.

c. If Ground Speed data is not available to the ADS-B Transmitting Subsystem, then the device **shall** enter ALL ZEROs into the Movement subfield specified in §2.2.3.2.4.2.

d. Ground Speed may be used in conjunction with Ground Track data to arithmetically establish East/West Velocity Data (see §2.2.5.1.2) and North/South Velocity Data (see §2.2.5.1.3) if East/West and/or North/South Velocity Data is not available.

(1). When Ground Speed data is used as provided in subparagraph "c," the NACv (see §2.2.5.1.19) data reported by the ADS-B Transmitting Subsystem **shall** be consistent with the accuracy, range, and resolution that can be obtained by using Ground Speed data as the input data to the arithmetic computations necessary.

(2). When Ground Speed data is used as provided in subparagraph "c," but Ground Speed Data is not available to the ADS-B Transmitting Subsystem, then the device **shall** enter ALL ZEROs into all transmitted subfields that are computed based on Ground Speed data.

2nd step low rate requirement

2.2.3.3.2.3 ADS-B Surface Position Message Broadcast Rate

a. Once started, ADS-B Surface Position Messages **shall** be broadcast by the transmission device when in the On-Ground state using either the "High" or "Low" rate, which has been selected as follows:

(1). Switching from "High" rate to "Low" Rate:

(a). The broadcast rate **shall** be changed from "High" to "Low" when the navigation source position data has not changed more than 10 meters in any 30 second interval.

Note: *It is acceptable to compute the 10 meter distance using either rectangular or polar coordinates.*

(b). Upon selecting the "Low" rate, the transmission device **shall** save the Position data at the time that the "Low" rate was selected.

(2). Switching from "Low" rate to "High" Rate:

The broadcast rate **shall** be changed from "Low" to "High" when the position of the transmission device has changed by 10 meters or more since the "Low" rate was selected.

Note: *It is acceptable to compute the 10 meter distance using either rectangular or polar coordinates.*

b. If the "High" rate is selected, then the Surface Position Message **shall** be transmitted at random intervals that are uniformly distributed over the range of 0.4 to 0.6 seconds relative to the previous Surface Position Message.

Note: *When the "High" squitter rate is selected based on the criteria defined in §2.2.3.3.2.3 a (2), the Movement subfield is provided by the Ground Speed data input as per §2.2.5.1.9 a.*

c. If the "Low" rate is selected, then the Surface Position Messages **shall** be transmitted at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds relative to the previous Surface Position Message.

Note: *When the "Low" squitter rate is selected based on the criteria defined in §2.2.3.3.2.3 a (1), the Movement subfield is set to "ONE" (Aircraft Stopped) as per §2.2.5.1.9 b*

d. If the transmission device loses its navigation source, the "High" rate **shall** be used as the default transmission rate.

e. Exceptions to these transmission rate requirements are specified in §2.2.3.3.2.9.

3rd step - Information in the movement field description

2.2.3.2.4.2 "Movement" Subfield in ADS-B Surface Position Messages

The "Movement" subfield is a 7-bit ("ME" bits 6 – 12, Message bits 38 – 44) field that **shall** be used to encode information regarding the status of "Movement" of the ADS-B Transmitting Subsystem in accordance with the coding provided in Table 2-18.

Table 2-18: "Movement" Subfield Code Definitions

Coding (Decimal)	Meaning	Quantization
0	No Movement Information Available	
1	Aircraft Stopped (Ground Speed = 0 knots)	
2	0 knots < Ground Speed ≤ 0.2315 km/h (0.125 kt)	
3 - 8	0.2315 km/h (0.125 kt) < Ground Speed ≤ 1.852 km/h (1 kt)	0.2700833 km/h steps
9 - 12	1.852 km/h (1 kt) < Ground Speed ≤ 3.704 km/h (2 kt)	0.463 km /h (0.25 kt) steps
13 - 38	3.704 km/h (2 kt) < Ground Speed ≤ 27.78 km/h (15 kt)	0.926 km/h (0.50 kt) steps
39 - 93	27.78 km/h (15 kt) < Ground Speed ≤ 129.64 km/h (70 kt)	1.852 km/h (1.00 kt) steps
94 - 108	129.64 km/h (70 kt) < Ground Speed ≤ 185.2 km/h (100 kt)	3.704 km/h (2.00 kt) steps
109 - 123	185.2 km/h (100 kt) < Ground Speed ≤ 324.1 km/h (175 kt)	9.26 km/h (5.00 kt) steps
124	324.1 km/h (175 kt) < Ground Speed	
125	Reserved for Aircraft Decelerating	
126	Reserved for Aircraft Accelerating	
127	Reserved for Aircraft Backing-Up	

Notes:

1. The data encoding represented in Table 2-18 represents a non-linear encoding: therefore, encoding is performed exactly as specified in the table.

2. The last three movement encodings (125, 126, 127) are reserved to indicate high levels of ground speed change, etc. The precedence of the codes is not defined yet as inputs that would be required are not currently available.

3. The "Aircraft Stopped" encoding is selected when the low squitter rate is selected (§2.2.5.1.9 b) based on the criteria defined in §2.2.3.3.2.3 .

2.4.3.2.4.2 Verification of "Movement" Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.2)

Purpose/Introduction:

This test procedure will verify that the ADS-B Transmitting Subsystem correctly outputs Surface Position Messages with the correct " Movement" subfield data encoded, in accordance with the encoding provided in Table 2-18, in DF=17 Messages for Transponder-Based Systems, and DF=18 Messages for Non-Transponder-Based Systems.

Measurement Procedure:

Step 1: " Movement" Verification - Part 1

Configure the ADS-B Transmitting Subsystem to transmit Surface Position Messages by providing position information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set up the system to enable broadcast of Surface Position Messages at the nominal rate. Set the ADS-B Transmitting Subsystem to "On Ground" status. Provide valid, non-zero "Movement" data to the ADS-B System. Discontinue the "Movement" data and verify that when "Movement" data is not provided to the ADS-B Transmitting Subsystem, the " Movement" subfield is set to ZERO (binary 000 0000).

Step 2: " Movement" Verification - Part 2

Set up the ADS-B Transmitting Subsystem as above and set the "Movement" input to represent a "Movement" of greater than or equal to Zero knots, but less than 0.125 knots. Verify that the "Movement" subfield is set to TWO (binary 000 0010). Increase the "Movement" input to a value greater than 0.126 knots and less than 0.270 knots and verify that the "Movement" subfield is set to THREE (binary 000 0011).

Step 3: " Movement" Verification - Part 3

Continue to increase the "Movement" input in increments equal to those identified in Table 2-18 for values greater than or equal to ONE knot and less than 175 knots. Verify that for each such increment, the encoding of the "Movement" subfield is equal to that specified in Table 2-18. Increase the Ground Speed input data to a value greater than 175.1 knots and verify that the "Movement" subfield is set to 124. Continue increasing the Ground Speed data input for values greater than 175 knots and verify that the "Movement" subfield continues to be set at 124.

Note: *The last three encodings (125, 126, 127) of the "Movement" subfield in Table 2-18 are reserved to indicate high levels of ground speed change, etc. The precedence of the codes is not defined yet, as inputs that would be required are not currently available.*

Step 4: Setting " aircraft Stopped" when Low squitter Rate is selected as specified in 2.2.5.1.9 b.

Ensure that the equipment is set to the "On the Ground" condition and that the appropriate valid ADS-B Surface Position data is provided such that the position is changing at a rate of 10.1 meters in any 30 second interval. Provide valid, non-zero "Movement" data to the ADS-B System. Verify that the "Movement" subfield is set to a value greater than or equal to 2.

Input new ADS-B Surface Position data with the position data changing at a rate of 9.9 meters in any 30 second interval. At least 61 seconds after the inputting of the new data, Verify that the "Movement" subfield is set to 1 "Aircraft Stopped."

Input new ADS-B Surface Position data such that the position is 10.1 meters away from the previous position. One (1) second after inputting the new data, verify that the ADS-B Surface Position Messages "Movement" subfield is set to a value greater than or equal to 2.

For transponder based system send a command to switch to low squitter rate and verify that Surface Position Messages “Movement” subfield is transmitted with a value greater than or equal to 2.

3 Action

The meeting is invited to consider this proposal and close the following FRAC/WC comments:

#	Commentor Last Name	Paragraph/ Section	Comment	Suggested Resolution	
6	CASCADE	2.2.5.19	Missing requirement on when movement shall be set to "aircraft stopped"	add bullet d in 2.1.5.9 d. When low broadcast rate of surface position squiter is selected then the device shall enter the value of 1 (Aircraft stopped) into the Movement subfield specified in §2.2.3.2.4.2.	Done in 2.2.5.1.9 a and b
52	AIR-130 (Bulger)	2.2.3.2.4.2	Thought we were adding a requirement that said that the movement field must =1 (0 knots) if the aircraft is on the surface and transmitting at the lower once per 5 sec rate.	Consider adding a requirement:	Done in 2.2.5.1.9 a and b
53	Saffell	2.2.3.2.4.2	There should be an indication that the low squitter rate is applied when the aircraft is stopped or there is no indication that it is moving	Add the following Note 3: ***Note 3:*** *When the "Movement" encoding is "0" or "1", the surface position message should be broadcast at the low rate. (See §2.2.3.3)*	2.2.3.2.4.2 a note 3 added however not exactly the same content
56	CASCADE	2.2.3.2.4.2	Explanatory note to be added the "aircraft stopped" condition, i.e. when transitioning to LOW broadcast rate.	See comment.	Done see note 3below the table
57	CASCADE	2.2.3.2.4.2	Movement encoding ambigous. It has been agreed to add an indication when an aircraft has determined itself to be stationary (and therefore also reduced the surface position squitter rate) that shall be indicated in the surface movement indicator. The current description of the encoding could mislead implementors to believe that this state (Coding=1 in Table 2-18) should be encoded based on the onboard derived ground speed information while infact the determination of stationary mode is based on change of position over a period of time (10 meters in 30 seconds).	Clarify in Table 2-18 that the Aircraft stopped state (Coding=1 in Table 2-18) shall be based on the method to determine stationary state based on position change over time (10 meters in 30 seconds)	Done in 2.2.5.1.9

108	Saffell	2.2.3.3.1.2	There should be an indication that the low squitter rate is applied when the aircraft is stopped or there is no indication that it is moving	Then, in DO-260B §2.2.3.3.1.2, Table 2-77. In the third row, fourth column for Surface Position Low Rate___add a fourth line as follows: "(See Note 3)". Then add the following Note 3 to the table notes: Note 3: When the "Movement" encoding is "0" or "1", the surface position message should be broadcast at the low rate. (See §2.2.3.3)	Not done
116	Pagano	2.2.3.3.2.3	In order to prevent surface applications from improperly extrapolating position when receiving at the low squitter rate, the Movement filed is required to be set to ONE when transmitting at the low squitter rate. The suggested resolution adds this rqt.	1) In 2.2.3.3.2.3 c., at the end of the last sentence, add "When in the "Low" rate, the Movement subfield shall be set to "ONE". *Note: When in the "High" squitter rate, the Movement subfield is provided by the Ground Speed data input as per §2.2.5.1.9"* *2)* In 2.2.5.1.9 a., at the end of the sentence in a, add ", exept when in the "Low" squitter rate as per 2.2.3.3.2.3 c."	Done see proposed 2.2.5.1.9 a and b