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EUROCAE WG-51, SG-1, Meeting #5

ADS-B 1090ES MOPS Maintenance

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Total and Uncompensated Latency Requirements
First drafting, In Response to Action Item 27-02
Revision 1

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Summary

This Working Paper presents a first draft of the three main categories of requirements as a result of consensus reached at the Chicago meeting regarding total and uncompensated latency. The three categories are for extrapolating when T=0, extrapolating when T=1, and total latency of position data. This Working Paper outlines the changes to the document as a result of the redrafting of requirements, and concludes with future work.

1. Introduction

This document outlines the changes proposed to be implemented in DO-260B as a result of consensus at Meeting #27 in regards to latency issues. The changes presented are only for Airborne Position Messages and only for latitude. A first draft of requirements is provided for the working group's consideration, highlighting the changes to DO-260A. This document concludes with a plan to complete the work.

Text published in DO-260A is copied here in red. Proposed text for DO-260B is in blue.

2. Re-sectioning

The relevant sections in DO-260A regarding the "Encoded Latitude" subfield are outlined below:

2.2.3.2.3.7 "Encoded Latitude" Subfield in ADS-B Airborne Position Messages

2.2.3.2.3.7.1 Airborne Latitude Data Encoding

2.2.3.2.3.7.2 Airborne Latitude Position Extrapolation/Estimation (Precision Case, TYPE Codes 9, 10, 20 and 21)

2.2.3.2.3.7.2.1 GPS/GNSS Time Mark Coupled Case (Extrapolation, "TIME" (T) = "1")

2.2.3.2.3.7.2.2 Non-Coupled Case (Estimation, "TIME" (T) = "0")

2.2.3.2.3.7.3 Airborne Latitude Position Extrapolation/Estimation (non - precision)

2.2.3.2.3.7.3.1 Airborne Latitude Position Extrapolation Case (non - precision)

2.2.3.2.3.7.3.2 Airborne Latitude Position Estimation Case (non - precision)

2.2.3.2.3.7.4 Airborne Latitude Position Data Retention

The re-sectioning proposed for DO-260B is given below :

2.2.3.2.3.7 "Encoded Latitude" Subfield in ADS-B Airborne Position Messages

2.2.3.2.3.7.1 Airborne Latitude Data Encoding

2.2.3.2.3.7.2 GPS/GNSS Time Mark Coupled Case ("TIME" (T) = "1")

2.2.3.2.3.7.3 Non-GPS/GNSS Time Mark Coupled Case ("TIME" (T) = "0")

2.2.3.2.3.7.4 Airborne Latitude Position Data Retention

3. Draft of Requirements

3.1 Section "2.2.3.2.3.7.2 GPS/GNSS Time Mark Coupled Case ("TIME" (T) = "1")"

This section is left unchanged. Future work is to rewrite the commentary to be in keeping with the timing appendix.

3.2 Section "2.2.3.2.3.7.3 Non-GPS/GNSS Time Mark Coupled Case ("TIME" (T) = "0")

The proposed requirements for DO-260B are provided below in blue text:

When the ADS-B Transmitting subsystem is not capable of accepting and processing GPS/GNSS Time Mark information, the true time of applicability of the Latitude information provided to the appropriate variable data input interface (§2.2.5.1.7) is unknown. Thus, a pseudo-time of applicability is to be understood (possibly implicitly) by the ADS-B Transmitting subsystem in the extrapolation of the encoded latitude for transmission. The pseudo-time of applicability of the latitude field in an ADS-B Airborne Position Message is nominally taken to be the time that the Latitude information crossed the appropriate variable data input interface, plus the amount of time by which the data was extrapolated within the ADS-B Transmitting subsystem.

~~*Note: For an ADS-B Transmitting Subsystem whose navigation data source is GNSS based, providing position fixes once per second accurate at the GNSS TIME MARK, the pseudo-time of applicability of the data transmitted in an Airborne Position Message is equal to the time mark corresponding to the position fix used in the message, plus any extrapolation performed by the ADS-B Transmitting subsystem.*~~

Note: It is possible in some cases to estimate and compensate for the delay of the Latitude data in arriving at the appropriate variable data input interface, thus using a more accurate pseudo-time of applicability. Such implementations are permitted and exceed the requirements.

If "TIME" (T) = 0 (see §2.2.3.2.3.5) in an Airborne Position Message, then the latitude field of an ADS-B Airborne Position Messages **shall** contain an estimate of the latitude position such that the difference between the time of transmission of the Airborne Position Message and the pseudo-time of applicability of that data is not more than 100 ms. See Appendix X for more detail on this requirement.

3.3 Section "2.2.5.2.1 Airborne Position Message Latency"

Part d. improperly allows for changes in the CPR format to not be reflected in the next scheduled Airborne Position message depending on when the change occurs:

CPR Format changes at 0.2 second intervals or more often as specified in §2.2.3.2.3.6. A change in the CPR Format **shall** be reflected in the CPR Format subfield of the next scheduled Airborne Position Message transmission provided that the change occurs at least ***"X"*** milliseconds prior to the next scheduled Airborne Position Message transmission. The time ***"X,"*** **shall** be dependent upon the NAC_P (see Table 2-71, §2.2.3.2.7.2.7 and §2.2.8.2.12) provided to the transmission device as follows:

(1). ***"X"*** is equal to 200 milliseconds if $NAC_P \leq 8$

(2). ***"X"*** is equal to 50 milliseconds if $NAC_P > 8$

Note: *All efforts must be made to allocate the time necessary to update the actual transmission buffer within the 200 millisecond time frame allocated to the CPR Format changes. That is that no additional time can be added to the 200 milliseconds already allocated*

The F bit simply needs to be properly set according to the encoding of the position in the Position Message. There is already a requirement in section 2.2.3.2.3.6 ensuring this is so:

The "CPR Format" (F) subfield is a 1-bit ("ME" bit 22, Message bit 54) field that **shall** be used to indicate which Compact Position Reporting (CPR) Format type ("**even**" or "**odd**") is used to encode the latitude and longitude data (See §2.2.3.2.3.7 and §2.2.3.2.3.8). The bit **shall** be set to "ZERO" to indicate the "**even**" encoding of such data, or to "ONE" to indicate the "**odd**" encoding of such data.

Part d. is proposed to be deleted in DO-260B.

Part e is worded to depend upon the NAC_P:

e. Encoded Latitude (specified in §2.2.3.2.3.7) must be extrapolated in accordance with §2.2.3.2.3.7.2 for precision systems. Likewise, Encoded Latitude must be updated in accordance with §2.2.3.2.3.7.3 for non-precision systems. Any change in the Encoded Latitude **shall** be reflected in the Encoded Latitude subfield of the next scheduled Airborne Position Message transmission provided that the change occurs at least ***"X"*** milliseconds prior to the next scheduled Airborne Position Message transmission. The time ***"X,"*** **shall** be dependent upon the NAC_P (see Table 2-71, §2.2.3.2.7.2.7 and §2.2.8.2.12) provided to the transmission device as follows:

   (1). ***"X"*** is equal to 200 milliseconds if $NAC_P \leq 8$

   (2). ***"X"*** is equal to 50 milliseconds if $NAC_P > 8$

   Note: *All efforts must be made to allocate the time necessary to update the actual transmission buffer within the 200 millisecond time frame allocated updating the Encoded Latitude. That is, that no additional time can be added to the 200 milliseconds already allocated*

Total latency is not NAC_P dependent. Proposed text for DO-260B is (note it is part d. now due to the deletion of the CPR format part previous):

d. Own Position Latitude Data (specified in §2.2.5.1.7) **shall** be reflected in the Encoded Latitude subfield (specified in §2.2.3.2.3.7)of the next scheduled Airborne Position Message transmission, extrapolated in accordance with §2.2.3.2.3.7.2 or §2.2.3.2.3.7.3, provided that the data is provided through the appropriate variable data input interface at least 100 milliseconds prior to the next scheduled Airborne Position Message transmission.

3.4 Section "2.2.5.1.6.2Case, where TIME ("T") = 1"

This section falls under "2.2.5.1.6 Time Data and Time Mark Pulse". DO-260A sets the following requirement:

The PVT data **shall** be provided by the navigation data source no later than 200 milliseconds after the leading edge of the GPS/GNSS Time Mark pulse, or equivalent.

Pursuant to previous discussions, we cannot set requirements outside of the ADS-B subsystem. We propose to weaken this to an assumption in DO-260B:

The PVT data is expected to be provided by the navigation data source no later than 200 milliseconds after the leading edge of the GPS/GNSS Time Mark pulse, or equivalent.

4. Future Action

The following should be accomplished and reviewed before the next meeting:

- If this Working Group agrees to the proposed changes, copy them throughout the appropriate sections (i.e. Airborne/Surface and Latitude/Longitude).
- Draft the appendix on timing issues, including definition of the notation used during this Working Group's discussion of latency.
- Rewrite the commentaries under T=0 and T=1 to be consistent with the appendix.
- Draft the test procedures.
- Ensure changes are also identified in Appendix A.