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Proposed Changes to DO-260B to Reflect Duplicate Addresses In Response to Action Item 27-07

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Summary
This Working Paper addresses Action Item 27-07 to specify specific changes to DO-260B to account for possible Duplicate Addresses.

2.2.10.1.2 ADS-B Report Organization

a. All ADS-B Message receptions and Reports **shall** be organized (i.e., indexed) in accordance with the Participant Address (see §**Error! Reference source not found.**~~2.2.3.2.1.1~~) and the Address Qualifier (see §**Error! Reference source not found.**~~2.2.8.1.3~~).

Note: *The Participant Address, report element 1 in all ADS-B report structures is conveyed in the "AA" Address Field of all ADS-B transmitted messages. The Address Qualifier, report element 2 in all the ADS-B report structures, denotes whether the address is a 24-bit ICAO aircraft address or some other kind of address, and is conveyed in the combination of DF fields and, if DF=18, in the CF field in ADS-B transmitted messages.*

b. For the purposes of correlating received ADS-B Messages to existing Reports, separate Reports **shall** be maintained for the same Participant Address (see §**Error! Reference source not found.**~~2.2.3.2.1.1~~) and Address Qualifier (see §**Error! Reference source not found.**~~2.2.8.1.3~~) if DF 17 ADS-B Messages are received from one aircraft/vehicle and DF=18s from another aircraft/vehicle.

Note: *Duplicate address processing as per §2.2.10.7 helps protect against not detecting an aircraft/vehicle that is transmitting with the same 24-bit address. However, duplicate address processing is not required when addresses can be resolved when one aircraft/vehicle is from a Mode S transponder based transmitting system and the other is from a Non-transponder based transmitting system.*

c. The Participant Address and the Address Qualifier **shall** be required elements in all ADS-B Reports (see Table 2-81 Items 1 and 2, Table 2-88 Items 1 and 2, Table 2-94 Items 1 and 2, and Table 2-96 Items 1 and 2).

2.2.10.6 Reasonableness Tests for CPR Decoding of Received Position Messages

2.2.10.6.1 Reasonableness Test Overview

Although receptions of Position Messages will normally lead to a successful target position determination, it is necessary to safeguard against Position Messages that would be used to initiate or update a track with an erroneous position. A reasonableness test applied to the computed position resulting from receipt of a Position Message can be used to discard erroneous position updates. Since an erroneous Globally Unambiguous CPR Decode could potentially exist for the life of a track, a reasonableness test and validation of the position protects against such occurrences. Likewise, an erroneous Locally Unambiguous CPR Decode could result in an incorrect position that potentially remains incorrect for the life of the track.

2.2.10.6.2 Reasonableness Test Applied to Positions Determined from Globally Unambiguous CPR Decoding

A validation **shall** be performed to verify the Globally Unambiguous CPR decode established per §**Error! Reference source not found.**~~2.2.10.3.1~~, subparagraph "a" or §**Error! Reference source not found.**~~2.2.10.3.2~~, subparagraph "a," using the following steps:

a. Compute a second Globally Unambiguous CPR decode based on reception of a new "***odd***" and an "***even***" Position Message as per §**Error! Reference source not found.**~~2.2.10.3.1~~, subparagraph "a" for an Airborne Participant, or per §**Error! Reference source not found.**~~2.2.10.3.2~~, subparagraph "a" for a Surface Participant, both received subsequent to the respective "***odd***" and "***even***" Position Message used in the Globally Unambiguous CPR decode under validation.

b. Compare the position decode resulting from the Globally Unambiguous CPR decode as per subparagraph "a" above to the Locally Unambiguous CPR decode computed from the receipt of the current Position Message satisfying subparagraph "a" above,

Note: *The Locally Unambiguous CPR decode is based on the update of the position derived from the current Globally Unambiguous CPR decode established in §**Error! Reference source not found.**~~2.2.10.3.1~~, subparagraph "a," or §**Error! Reference source not found.**~~2.2.10.3.2~~, subparagraph "a."*

c. If the position decodes resulting from subparagraph "b" above are identical to within 5 meters for an airborne decode and 1.25 meters for a surface decode, then the validation is complete. Otherwise, the following subparagraph applies:

d. No State Vector Report is generated from the receipt of the current Position Message. The Report Mode for the given Participant Report Mode is reset to the Initialization State. All "***even***" and "***odd***" Position Messages received prior to the respective "***even***" or "***odd***" Position Message used in the Globally Unambiguous CPR decode in subparagraph "a" above are discarded.

Note: *Completion of validation requires reception of both an additional "even" and "odd" Position Message subsequent to the Position Messages used to satisfy the Globally Unambiguous CPR decode in Acquisition State. In the case of Airborne Participants, since reception of an Airborne Velocity Message causes a transition from Acquisition State to Track State, as per §**Error! Reference source not found.**~~2.2.10.4.1.1~~, then validation may not be completed until the Airborne Participant is in the Track State.*

2.2.10.6.3 Reasonableness Test Applied to Positions Determined from Locally Unambiguous CPR Decoding

A validation **shall** be performed to verify the Locally Unambiguous CPR decode established per §**Error! Reference source not found.**~~2.2.10.4.1.2~~, subparagraph "a.(1)" for Airborne Participants, or §**Error! Reference source not**

found.~~2.2.10.4.2.2~~, subparagraph "a.(1)" for Surface Participants, using the following steps:

a. Compare the Locally Unambiguous CPR decode computed from the reception of a new "***odd***" or "***even***" Position Message as per §**Error! Reference source not found.**~~2.2.10.4.1.2~~, subparagraph "a.(1)" for an Airborne Participant, or per §**Error! Reference source not found.**~~2.2.10.4.2.2~~, subparagraph "a.(1)" for a Surface Participant, to the current position that was computed from the previously received Position Message.

b. If the difference between the TOMRs of the previously received Position Message and the most recently received Position Message is 30 seconds or less, and the difference in the position decodes resulting from subparagraph "a" above are less than or equal to **X** NM

where:
X=6 for Airborne Participants receiving Airborne Position Messages, or
X=2.5 for Airborne Participants that have received a Surface Position Message, or
X=2.5 for Surface Participants that have received an Airborne Position Message, or
X=0.75 for Surface Participants receiving Surface Position Messages,

then the validation is successful and complete, and the position ~~**can**~~ **shall** be used to update the track. Otherwise, the validation is failed and:

1) the most recently received position **shall not** be used to update the track.

2) the received position **shall** be used ~~.~~ to initiate or update a candidate duplicate address track or update a duplicate address track in accordance with §2.2.10.7.

Note: *If no duplicate address or candidate duplicate address Report exists for this 24 bit address, the position message is used to initiate a candidate duplicate address Report. If a candidate duplicate address Report exists, the position message is used to update the candidate duplicate address Report. Otherwise, the position message is used to update the duplicate address Report unless the position message fails this validation test (see §2.2.10.7).*

Note: *The position threshold value is based on the assumption of a maximum aircraft velocity of **V** knots (where **V**=600 for Airborne and **V**=50 for Surface) over a maximum time period of 30 seconds. This yields a maximum positional difference of approximately 5 NM for Airborne, and 0.5 NM for Surface. An additional measure of 1 nautical mile for Airborne, and 0.25 for Surface are added to account for additional ADS-B positional measurement uncertainty. The position threshold of 2.5 nautical miles between surface and airborne participants was derived from the assumption of 250 knots maximum speed for a target transitioning from the surface state to an airborne state over 30 seconds – yielding approximately 2 nautical miles – with an additional 0.5 NM being added to allow for positional errors.*

2.2.10.7 Duplicate Address Processing

The 24-bit address transmitted in each ADS-B Message is used to identify and associate the messages for a particular aircraft/vehicle. Though each aircraft/vehicle should have a unique 24-bit address, there may be occasions on which more than one aircraft/vehicle is transmitting the same 24 bit address. It is important for ADS-B applications that receive 1090ES ADS-B Reports to have knowledge of aircraft within receiving range. The requirements in the following subparagraphs enable detection of a duplicate address aircraft/vehicle when horizontal position separation is outside of the local CPR reasonableness test criteria of §2.2.10.6.3.

Note: Without duplicate address detection, an aircraft/vehicle that enters the range of the receiver with the same 24-bit address as that of an existing ADS-B Report would go undetected and message data from the undetected aircraft/vehicle could be erroneously associated with the existing ADS-B Report.

2.2.10.7.1 Candidate Duplicate Address Report

A candidate duplicate address Report **shall** be initiated when a position message is received for a 24-bit address that fails the local CPR reasonableness test validation of §2.2.10.6.3b and no candidate duplicate address Report or duplicate address Report is currently active for the received 24-bit address. If initiated, the candidate duplicate address Report is set to Initialization State as per §2.2.10.2 and the position message is stored for this candidate duplicate address Report. The ADS-B Report for which the position message did not pass the validation test of §2.2.10.6.3b, the local CPR reasonableness test, is the primary ADS-B Report for this 24-bit address. Once a candidate duplicate address Report is initiated, association of subsequent position messages with this 24-bit address **shall** be first attempted on the primary ADS-B Report for this 24-bit address. If the position message does not pass the validation test of §2.2.10.6.3b on the primary ADS-B Report, the position message **shall** be used to update the candidate duplicate address Report.

Note: TIS-B Reports and ADS-R Reports are separate and distinct from ADS-B Reports as per §2.2.17 and §2.2.18 so there is no duplicate address issues between these Report types and ADS-B Reports.

2.2.10.7.2 Duplicate Address Condition

A duplicate address condition **shall** be declared for a 24-bit address when a global CPR decode is completed by the receipt of both an even and odd position message within 10 seconds for the candidate duplicate address and passes the global CPR reasonableness test. Once declared, a duplicate address condition **shall** result in the Duplicate Address Flag in the State Vector Report set to "ON" in the ADS-B Report upon output of either ADS-B Report in the duplicate

address condition. ADS-B Position Messages **shall** be associated with the ADS-B Report in the duplicate address condition that passes the local CPR reasonableness test in §2.2.10.6.3 (b). Each ADS-B Report in the duplicate address condition **shall** be updated upon receipt of other Extended Squitter Messages containing the duplicate 24-bit address since there is no means to associate these messages with the correct aircraft.

ADS-B Position, Velocity, Aircraft Identification and Category and Emergency / Priority Status (Subtype=1) Messages from aircraft/vehicles with 24-bit addresses identified as Duplicate Addresses **shall** be processed as Version ZERO (0) format Messages. Since Target State and Status Messages can be associated with the appropriate MOPS Version Number based on the Subtype and Operational Status Messages contain the MOPS Version Number, these messages can be decoded directly.

Notes:

1. *The Duplicate Address Flag is used to indicate to ADS-B applications that information associated with that address can not be correctly associated with either ADS-B Report in the duplicate address condition. Additionally, the correct MOPS Version Number for each of the aircraft/vehicles can not be readily determined so interpretation of message data defaults to Version 0.*
2. *The update and output of both ADS-B Reports when Extended Squiteer Messages are received with the duplicate 24-bit address results in additional overhead since output of both ADS-B Reports possibly occurs upon message reception. However, this approach gives ADS-B applications the ability to associate information with the correct ADS-B Report if they choose to attempt to correlate using the additional provided information.*

The duplicate address condition **shall** be cleared after 60 seconds has elapsed with no Position Message update for a Participant with an ADS-B Report identified in the duplicate address condition. The relevant ADS-B Report for the Participant **shall** be deleted from the Report Output Storage Buffer. Output of the remaining ADS-B Report **shall** contain a State Vector Report with the Duplicate Address Flag set to "OFF".

Note:

After clearing the duplicate address condition, the ADS-B Report for the aircraft/vehicle that continues to receive Position Messages that pass the local CPR reasonableness test, as well as other 1090ES ADS-B Messages, is retained and updated as per §2.2.10.4.