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Duplicate Address Processing on 1090 MHz Extended Squitter

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Summary

This Working Paper discusses the processing of potential duplicate ICAO 24-bit addresses in the 1090 MHz Extended Squitter (1090ES) receivers, in response to ASSAP Action Item #79.

Duplicate address processing is currently not included in a 1090 MHz Extended Squitter (1090ES) receiver system.

The assumption when the 1090ES Messages and formats were developed was that every aircraft has a unique 24-bit ICAO address. The proper operation of a 1090ES receiver which assembles information into ADS-B Reports depends on this concept.

Airborne 1090ES aircraft can transmit various separate Message Types as follows:

1) Position Messages,
2) Velocity Messages,
3) Aircraft Identification and Category Messages,
4) Aircraft Operational Status Messages,
5) Extended Squitter Aircraft Status Messages,
6) Target State and Status Messages, and
7) Test Messages (containing the Mode 3/A 4096 code).

Each 1090ES Message contains the 24-bit ICAO address of the aircraft that transmitted the message. ADS-B Reports are generated and output by a 1090ES receiver for an aircraft that information is received from after a track has been established.

To establish an ADS-B Report, a global position must be determined through the Compact Position Reporting (CPR) algorithm from encoded positions contained in two separate Position Reports (one "even" format and one "odd" format within 10 seconds). The receiver holds information for each individual 24-bit ICAO address and updates this information by associating the incoming 1090ES Message based on the 24-bit ICAO address contained in that 1090ES Message. Therefore, if more than one aircraft is transmitting a given 24-bit ICAO address, the information from each aircraft is used to update a single ADS-B Report in the receiver.

The only information that has somewhat of a protection mechanism is the position information. Upon receipt of a 1090ES Position Message, the previous position that was updated by the last received and accepted Position Message, is compared to the position that would result from the newly received Position Message. This function is called a "reasonableness test" and it <u>discards</u> a position that is received within 30 seconds from the previously received Position Message, AND is greater than 6 nautical miles (0.75 NM if it is a surface position) from the previous position. This reasonableness test was added in Change 2 to DO-260A which was published in December 2006.

Therefore, an aircraft that begins broadcasting a duplicate address that is MORE THAN 6 NM away would typically be output something like the following, assuming a current active and established track exists for a 24-bit ICAO address, and 1090ES Messages from the duplicate address begin to be received:

1) 1090ES Position Messages from the duplicate address would not produce an output of an ADS-B Report from the receiver,

2) information contained in all other 1090ES Message types would be output in an ADS-B Report for that ICAO 24-bit ICAO address from the receiver upon receipt from <u>either</u> aircraft.

Summary

In summary, the second aircraft would not be known to the receiver but information from the second aircraft, except for position which is protected within the bounds of the reasonableness test, would corrupt the information from the first aircraft.

There are other situations that this description does not cover. For example, there could be a case where a receiver is activated and two aircraft are transmitting a duplicate address, thereby potentially causing difficulty in establishing either position depending on the reception probability of the aircraft at the receiver location. Also, even an aircraft that begins transmitting while on-the-surface that transmits a duplicate address of an airborne aircraft could corrupt the information (except for position within the bounds of the reasonableness test) of the airborne aircraft.

Potential Solutions

Because of the information pieces that are transmitted in the various 1090ES Messages, there is no elegant solution to cleanly handle duplicate address situations. However, the following offer some alternatives to potentially address the problem.

1) The tracking function in the ASSAP MOPS could attempt to monitor the output of a 1090ES receiver and identify data that should not be changing at a rate that would result when two aircraft are transmitting data (e.g., Flight ID). However, the position of a second aircraft cannot be determined since this information is never output. Given that position is the most important information, this solution offers little benefit.

2) Modify the 1090ES MOPS (by producing Change 3 to DO-260A) to incorporate duplicate address processing. We could leverage off of the requirements contained in the FAA ADS-B Surveillance and Broadcast Services (SBS) Critical (downlink) Specification which addresses position outliers and duplicate addresses for ground-based 1090ES receivers. The extent of the processing that would be levied on the airborne 1090ES receiver in the MOPS would need to be considered. It may be better to output all information received, flag it as data from a duplicate address, and allow additional processing in the ASSAP MOPS tracking function to attempt to correlate the information to the proper aircraft.

3) Take no further action on duplicate addresses. Recently, the ICAO Aeronautical Surveillance Panel, which produced the International standards and recommended practices (SARPs) for 1090ES, discussed this duplicate address issue, and basically decided that no provisions would be added to the International SARPs to handle it since the system operates on the premise of unique 24-bit ICAO addresses. The following note was added to the 1090ES Detailed Technical Requirements Manual (ICAO Doc 9871) to allow additional processing to attempt to derive a position of a duplicate address. Before the note was added, position of a duplicate address was required to be discarded as a consequence of the reasonableness test.

   Note 2 – Although the 24-bit aircraft address for every aircraft is required to be unique, if situations arise where multiple aircraft within range of a receiver are transmitting the same 24-bit aircraft address, loss of detection of aircraft can result from performing the above reasonableness test. To safeguard against this, the position data that failed the reasonableness test can be used to support detection and reporting of a duplicate address track. Since data transmitted from aircraft with duplicate addresses can not always be easily and reliably distinguished, receivers that support detection and tracking of duplicate addresses are expected to appropriately identify these as duplicate address reports.

Conclusion

There are currently no plans in SC-186 Working Group 3 to add duplicate address processing to DO-260A. A decision to add duplicate address processing to the 1090ES receiver should be based on a Safety and/or Hazard Analysis for air-to-air applications. The requirement to add duplicate address processing to the 1090ES receiver would need to be initiated at the RTCA SC-186 Committee Plenary level in order to task WG-3 to incorporate that functionality.