**RTCA Special Committee 186, Working Group 3**
**EUROCAE WG-51, SG-1**

**ADS-B 1090ES MOPS Maintenance**

**Meeting #25**

**Eurocontrol Headquarters, Brussels Belgium**
**17 – 20 February 2009**

# Proposed Swapping of the NIC Supplement with Single Antenna Flag

**Revision 1**

**Christophe Maily**
**Airbus**

| Summary |
| --- |
| This Working Paper is in response to Action Item 24-16 and addresses review of the issues related to 1090-WP24-07R2, Change Item #25, "Swapping Single Antenna Flag and NIC Supplement," and goes through the 1090ES MOPS and indicates what changes would be required. |

# NIC supplement swapping with Single Antenna flag

## 1 Introduction

### *1.1 ADS-B Airborne position message*

During the ADS-B RAD SPR/INTEROP document development, there have been some questions regarding the integrity indication related to the position information.

In particular, it was agreed that each airborne message should give an unambiguous indication of the integrity of the position.

The type code in each airborne position message represents the integrity value, however there is still an ambiguity for some values of integrity. This ambiguity is linked to the value of NIC supplement, a one-bit field in BDS 6.2 or 6.5 (as defined in DO-260A).

This NIC supplement will imply different integrity values as defined here-after:

- For format type code 11
    - NIC supplement 0: Horizontal Integrity < 0,1 NM
    - NIC supplement 1: Horizontal Integrity < 75m (and VPL < 112m)
- For format type code 13
    - NIC supplement 0: Horizontal Integrity < 0,5 NM
    - NIC supplement 1: Horizontal Integrity < 0,6 NM
- For format type code 16
    - NIC supplement 0: Horizontal Integrity < 8 NM
    - NIC supplement 1: Horizontal Integrity < 4 NM

One of the requirements of the RAD document is that each position is transmitted with the complete Integrity value.

In order to have position and full integrity value in a single message, the Type code together with the NIC supplement should be implemented in the same ADS-B message, i.e. BDS 05.

### *1.2 ADS-B Surface position squitter*

This issue seems to be less important for Surface applications (ATSA-SURF, ATSA-SURF IA), as the integrity seems to be of a lower interest compared to the Accuracy parameter (NACp).

The current work done on the RFG ATSA-SURF OSED/OSA does not highlight the integrity and NIC Supplement to be of such importance as for the En-route/TMA ADS-B OUT applications, where separation criteria are used. Indeed, when a/c separation is involved, there is a strong need to have a good integrity of the positional data, however on the surface operations (awareness or alerting), the accuracy is of larger interest compared to integrity.

The NIC supplement for ADS-B Surface position squitters implies the following differing integrity values:

- For format type code 7
  - NIC supplement 0: Horizontal Integrity < 0,1 NM
  - NIC supplement 1: Horizontal Integrity < 75m

As a consequence, there is no clear need identified to have the NIC supplement together with the type code in the surface position squitter (BDS 0.6).

# 2 Technical proposal

It is proposed to treat this issue by removing the Single Antenna Flag bit from BDS 0.5 and replace it by the NIC supplement, in ADS-B Airborne position message.

This does not prevent the transmission of this NIC supplement in BDS 6.5, in order to maintain as much as possible the compatibility with existing receiver/user, that are making use of the NIC supplement in BDS 6.5.

The Single Antenna flag, which is indicating that the transmitter has only one antenna, is not supposed to be changing during a given flight, and it is seen as acceptable that this single bit is transmitted with a lower update rate in BDS 6.5 than the 0.5 second from the BDS 0.5.

## *2.1 Changes to DO-260A Volume 1*

In RTCA DO-260A, replace Figure 2-3 with the following figure.

| **Airborne Position Message "ME" Field** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MSG BIT #** | 33 -37 | 38 ---------- 39 | 40 | 41 ----- 52 | 53 | 54 | 55 ---- 71 | 72 ---- 88 |
| **"ME" BIT #** | 1 – 5 | 6 ---------- 7 | 8 | 9 ----- 20 | 21 | 22 | 23 --- 39 | 40 --- 56 |
| **FIELD NAME** | **TYPE [5]** | **SURVEILLANCE STATUS [2]** | **NIC SUPPLEMENT [1]** | **ALTITUDE [12]** | **TIME (T) [1]** | **CPR FORMAT (F) [1]** | **ENCODED LATITUDE [17]** | **ENCODED LONGITUDE [17]** |
| | MSB LSB | MSB LSB | | MSB LSB | | | MSB LSB | MSB LSB |

***Note:*** *"[#]" provided in the Field indicates the number of bits in the field.*

**Figure 2-3: ADS-B Airborne Position Message Format**

In RTCA DO-260A, replace §2.2.3.2.3.3 with the following:

**2.2.3.2.3.3 "NIC Supplement" Subfield in Airborne position Message**

The NIC Supplement subfield in the Airborne position Message is a one-bit subfield ("ME" bit 08, Message bit 40) that, together with the TYPE subfield in the same Airborne Position, **shall** be used to encode the Navigation Integrity Category (NIC) of the transmitting ADS-B participant.

This NIC supplement is also provided in the Operational Status message (register 6.5), in order to compute the integrity value, together with the Surface Position Type Code.

***Note:*** *The Navigation Integrity Category (NIC) is reported so that surveillance applications may determine whether the reported geometric position has an acceptable level of integrity for the intended use. See §2.1.2.12 of RTCA DO-242A, the ADS-B MASPS, for a fuller description of the Navigation Integrity Category.*

If an update has not been received from an on-board data source for the NIC Supplement within the past 5 seconds, then the NIC Supplement subfield **shall** be encoded as ZERO (0) to indicate the larger Radius of Containment ($R_C$).

Table 2-70 lists the possible NIC codes and the values of the TYPE subfield of the Airborne and Surface Position Messages, and of the NIC Supplement subfield that **shall** be used to encode those NIC codes in messages on the 1090 MHz ADS-B data link.

**Table 2-70: Navigation Integrity Category (NIC) Encoding.**

| NIC Value | Containment Radius ($R_C$) and Vertical Protection Limit (VPL) | Airborne | | Surface | |
|---|---|---|---|---|---|
| | | Airborne Position TYPE Code | NIC Supplement Code | Surface Position TYPE Code | NIC Supplement Code |
| 0 | $R_C$ unknown | 0, 18 or 22 | 0 | 0, 8 | 0 |
| 1 | $R_C$ < 20 NM (37.04 km) | 17 | 0 | N/A | N/A |
| 2 | $R_C$ < 8 NM (14.816 km) | 16 | 0 | N/A | N/A |
| 3 | $R_C$ < 4 NM (7.408 km) | 16 | 1 | N/A | N/A |
| 4 | $R_C$ < 2 NM (3.704 km) | 15 | 0 | N/A | N/A |
| 5 | $R_C$ < 1 NM (1852 m) | 14 | 0 | N/A | N/A |
| 6 | $R_C$ < 0.6 NM (1111.2 m) | 13 | 1 | N/A | N/A |
| | $R_C$ < 0.5 NM (926 m) | 13 | 0 | | |
| 7 | $R_C$ < 0.2 NM (370.4 m) | 12 | 0 | N/A | N/A |
| 8 | $R_C$ < 0.1 NM (185.2 m) | 11 | 0 | 7 | 0 |
| 9 | $R_C$ < 75m *and* VPL < 112 m | 11 | 1 | 7 | 1 |
| 10 | $R_C$ < 25m *and* VPL < 37.5 m | 10 or 21 | 0 | 6 | 0 |
| 11 | $R_C$ < 7.5m *and* VPL < 11 m | 9 or 20 | 0 | 5 | 0 |

**Note:** "N/A" means "This NIC value is not available in the ADS-B Surface Position Message formats."

In RTCA DO-260A, replace table 2-68 with the following:

**Table 2-68: Operational Mode (OM) Subfield Format**

| **Msg Bit #** | 57 | 58 | 59 | 60 | 61 | 62 | 63 – 72 |
|---|---|---|---|---|---|---|---|
| **"ME" Bit #** | 25 | 26 | 27 | 28 | 29 | 30 | 31-- 40 |
| **OM Format** | 0 0 | | RA Active | IDENT Switch Active | Receiving ATC Services | Single Antenna Flag | Reserved |
| | 0 1 | | Reserved | | | | |
| | 1 0 | | Reserved | | | | |
| | 1 1 | | Reserved | | | | |

In RTCA DO-260A, add a new §2.2.3.2.7.2.4.5 with the following:

**2.2.3.2.7.2.4.5 "Single Antenna Flag" OM Code Subfield in Aircraft Operational Status Message**

The "Single Antenna" subfield is a 1-bit ("ME" bit 30, Message bit 62) field that **shall** be used to indicate that the ADS-B Transmitting Subsystem is operating with a single antenna. The following conventions **shall** apply both to Transponder Based and Stand Alone ADS-B Transmitting Subsystems:

a. Non-Diversity, i.e., those transmitting functions that use only one antenna, **shall** set the Single Antenna subfield to "ONE" at all times.

b. Diversity, i.e., those transmitting functions designed to use two antennas, **shall** set the Single Antenna subfield to "ZERO" at all times that both antenna channels are functional.

At any time that the diversity configuration cannot guarantee that both antenna channels are functional, then the Single Antenna subfield **shall** be set to "ONE."

***Note:*** *Certain applications may require confirmation that each participant has functioning antenna diversity for providing adequate surveillance coverage.*

## 2.2 Changes to DO-260A Volume 2

In RTCA DO-260A, replace §A.1.4.2.5 with the following:
A.1.4.2.5 NIC Supplement
[content of § A.1.4.10.6]

In RTCA DO-260A, replace §1.4.10.6 with the following:
A.1.4.10.6 Single Antenna Flag
[content of §A.1.4.2.5]

In RTCA DO-260A, replace figure A-10 with the following
[replace the NIC Supplement field with the Single Antenna Flag field, with the appropriate reference]

In RTCA DO-260A, replace figure A-1 with the following
[replace the Single Antenna flag field with the NIC Supplement, with the appropriate reference]

### *2.3 Impact on backward compatibility with previous DO-260x versions*

The Single Antenna Flag field was initially defined in DO-260 (version 0). It was kept for consistency and to maintain backward compatibility in DO-260A (version 1). Change 1 and Change 2 to DO-260A have kept backward interchangeability, version number remained 1.

However, if this change is introduced, it will have the following effects:

- Version 0 and version 1 of DO-260 will still be backward compatible, but this change will implicitely require a change of the version of the MOPS, to B (version 2)
- A user of the bit "Single Antenna Flag", if any, will have to consider the MOPS version field from BDS 6.5 in order to know the meaning of this bit ➔ more complexity at reception level.
- Currently, no airborne application is using this bit, so it should impact only the ground systems (if they use it… TBC)

This change can be supported in the revision of the MOPS only is the Version indicator is changed from version 1 to version 2 of DO-260.

## 3 TIS-B Airborne position squitters

Currently, in the equivalent of Airborne position message, the bit 8 of ME field (DF18, CF=2 to 3, ME field bit 8) indicates the information IMF (ICAO / Mode A Flag).

There is no indication that the applications requiring TIS-B would also require indications of the NIC supplement in the same message as the Type Code for the determination of the integrity value. As the ADS-B-RAD SPR/INTEROP document focuses only on the ADS-B OUT implementation, it naturally does not imply TIS-B information requirements; As the two message content (DF17 Airborne position and DF18 Airborne position) was already not consistent between TIS-B and ADS-B, it is thought that implementing a different bit meaning in the ADS-B Airborne position message would not be inconsistent with the current implementation of TIS-B.

NIC Supplement was anyway not available in any other message, so it is not considered as an issue to not have the NIC Supplement in the Airborne position message.

## 4 ADS-R Airborne and Surface position squitters

There is no application, which currently plans to use the ADS-R with the same integrity requirements as identified in RFG RAD document. It is proposed to keep the current definition of the Airborne position message, i.e. NIC Supplement available in the Operational Status message, and bit 8 of the Airborne position message used for the IMF bit, as defined in §3.

Moreover, he ADS-R is retransmitted from a ground station after reception of an ADS-B message, whose performance is expected to comply with RAD requirements, i.e. transmit integrity with each airborne position message.

From a ground perspective:

- Ground receiver has the knowledge of the ADS-B integrity NIC and NIC Supplement in a single position message (thanks to the bit swapping)
- When retransmitting the ADS-R, the ground will change the content of the bit 8 of the ME field from register Airborne Position from NIC Supplement to IMF.
- This change of bit definition is already in the definition of the ADS-R, as this bit 8 indicates Single Antenna Flag in ADS-B airborne position message, and indicates IMF in ADS-R Airborne position message

From the Airborne point of view:

- If NIC supplement for airborne position message determines the difference between Rc=0.1NM or 75m
    - ATSA-ITP requires a Rc < 1 NM ➔ NIC supplement is useless, Type code 11 is acceptable whatever the NIC Supplement value is
    - ATSA-VSA requires a Rc < 0.75 NM ➔ NIC supplement is useless, Type code 11 is acceptable whatever the NIC Supplement value is
- If NIC supplement for airborne position message determines the difference between Rc=0.6 or 0.5NM
    - ATSA-ITP requires a Rc < 1 NM ➔ NIC supplement useless, Type Code 13 is acceptable whatever the NIC Supplement value is
    - ATSA-VSA requires a Rc < 0.75 NM ➔ NIC supplement is useless, Type code 13 is acceptable whatever the NIC Supplement value is
- If NIC Supplement for Airborne position message determines the difference between Rc=4 or 8NM
    - Neither ATSA-ITP nor VSA (currently defined applications), nor any of the foreseen airborne applications, will accept a Rc>=4NM.
    - NIC supplement useless for these type codes for airborne applications
- Current airborne applications do not require the NIC Supplement to be transmitted together with the Type Code, as it will not impact the filtering on the intruders for these applications
- Even if NIC Supplement was required, there is no indication in any application existing today will need the NIC Supplement to be transmitted in every Airborne position message, together with horizontal position.
- Next coming applications are not expected to require a Rc threshold of any of the values indicated through the Type Code, requiring the NIC Supplement for Rc determination.

As a consequence, it is considered acceptable that the ADS-R, from ground station to airborne user, does not contain the NIC Supplement in the same message than the Type Code (as it is today).