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

ADS-B 1090ES MOPS Maintenance

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Proposal for Encoding of GPS Antenna Longitudinal and Lateral Position Offset In Surface Aircraft Operational Status Messages

Prepared by: Robert H. "Bob" Saffell, Rockwell Collins, Inc.
Presented by: Bob Saffell

Summary

Considerable discussion has been entertained in several ADS-B forums in regards to the need to compensate the ADS-B broadcast position for GPS Antenna Offsets from the reference point of the length/width box associated with the Surface Aircraft Operational Status Message. This paper proposes a method of encoding the GPS Antenna position offset into the Surface Aircraft Operational Status Message such that applications can properly perform position compensation as needed for the GPS Antenna offset.

It should be noted that this paper has been prepared on short notice, so there is not a lot of lead in material. Rather, the paper is expected to be discussed and the method approved or modified as needed during the next working group discussions.

ASSUMPTIONS:

- NEED HAS BEEN ESTABLISHED TO PROVIDE ANTENNA OFFSET ADJUSTMENT FOR PRECISION ADS-B GROUND APPLICATIONS
- IT IS NOT FEASIBLE TO DO SO IN THE ADS-B TRANSMITTER SINCE THE RAW OFFSET REALLY NEEDS TO BE KNOWN BY THE APPLICATION WHEN IT DOES ROTATION AND TRANSLATION BASED ON ITS DISPLAY HEADING
- SURFACE ENCODING ACCURACY OF THE CPR ALGORITHM IS APPROXIMATELY 5.1 METERS (SEE 1090 WP26-05): THEREFORE, OFFSET ENCODING TO A RESOLUTION OF 3 METERS SHOULD BE SUFFICIENT

  Note: There is no apparent advantage to encode the offset to a finer resolution than 3 meters since the CPR algorithm is not guaranteed to a resolution of less than 5.1 feet. In other words, encoding of the offset to a finer resolution will only be compromised by the CPR encoding.

- CURRENT NEED FOR OFFSET IS MOST NEEDED ALONG THE LONGITUDINAL AXIS. HOWEVER, FUTURE AIRCRAFT CONFIGURATIONS MAY NEED A LIMITED RANGE OF OFFSET ALONG THE LATERAL AXIS. THEREFORE, THE PROPOSED OFFSET ENCODING SHOULD PROVIDE FOR BOTH LONGITUDINAL AND LATERAL ENCODINGS.

CURRENT SURFACE AIRCRAFT OPERATIONAL STATUS MESSAGE: **(RTCA DO-260B, Figure 2-11)**

Aircraft Operational Status ADS-B Message "ME" Field Format														
MSG BIT #	33 - 37	38 - 40	41 - 52	53 - 56	57 - 72	73 - 75	76	77 - 80	81 - 82	83 - 84	85	86	87	88
"ME" BIT #	1 - 5	6 - 8	9 - 20	21 - 24	25 - 40	41 - 43	44	45 - 48	49 - 50	51 - 52	53	54	55	56
FIELD NAME	**TYPE=31 [5]**	**Subtype=0 [3]**	**Capability Class (CC) Codes [16]**		**Operational Mode (OM) Codes [16]**	**MOPS Version Number [3]**	**NIC Supp. [1]**	**NAC_P [4]**	**GVA [2]**	**Source Integrity Level (SIL) [2]**	**NIC_{BARO} [1]**	**HRD [1]**	**SIL Supp [1]**	**Reserved [1]**
		Subtype=1 [3]	**CC Codes [12]**	**L/W Codes [4]**					**Reserved [2]**		**TRK/HDG [1]**			
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		MSB LSB	MSB LSB	MSB LSB				

Note: *Subfields that are relevant only for Airborne Participants are allocated to Subtype ZERO (binary 000), while those that pertain only to Surface Participants are allocated to Subtype ONE (binary 001).*

Figure 2-11: "Aircraft Operational Status" ADS-B Message "ME" Field Format

CURRENT SURFACE AIRCRAFT OPERATIONAL STATUS MESSAGE CAPABILITY CLASS (CC) FORMAT:

(RTCA DO-260B, Table 2-61)

Table 2-61: Surface Capability Class (CC) Code Format in Version 2 Transmitting Subsystems.

Msg Bit #	41	42	43	44	45	46	47	48	49 – 51	52
"ME" Bit #	9	10	11	12	13	14	15	16	17 – 19	20
Content	**Service Level** MSBs = 0 0		**POA**	**1090ES IN**	**Service Level** LSBs = 0 0		**B2 Low**	**UAT IN**	**NAC_V [3]**	**Reserved [1]**

RECOMMENDATION:

USE SERVICE LEVEL BITS AND RESERVED BIT FOR ENCODING GPS ANTENNA OFFSET ALONG THE LONGITUDINAL AXIS

Table 2-61 would then appear as follows: (change areas are highlighted in "Blue")

Table 2-61_Modified: Surface Capability Class (CC) Code Format in Version 2 Transmitting Subsystems.

Msg Bit #	41	42	43	44	45	46	47	48	49 – 51	52
"ME" Bit #	9	10	11	12	13	14	15	16	17 – 19	20
Content	**Longitudinal GPS Antenna Offset** MSBs		**POA**	**1090ES IN**	**Longitudinal GPS Antenna Offset** LSBs		**B2 Low**	**UAT IN**	**NAC_V [3]**	**Longitudinal GPS Antenna Encoding Direction**

When POA = "1", then the longitudinal offset encoding would be as shown in the following table::

Note that the POA = "1" can be used to indicate that valid Longitudinal and/or Lateral GPS Offset encoding is available.

Forward means forward of the reference point, e.g., moving towards the nose from the reference point.
Aft means aft of the reference point, e.g., moving towards the tail from the reference point.
Reference point is the center of the length/width box as per RTCA DO-242A.

Longitudinal Axis GPS Antenna Offset Encoding						
"ME" Bit (Message bit)					**Longitudinal Axis GPS Antenna Offset**	
20 (52)	**9** (41)	**10** (42)	**13** (45)	**14** (46)		
0 = forward 1 = aft	**Encoding**					
	Bit 3	**Bit 2**	**Bit 1**	**Bit 0**	**Direction**	**(meters)**
0	0	0	0	0	**FORWARD**	0
	0	0	0	1		3
	0	0	1	0		6
	0	0	1	1		9
	0	1	0	0		12
	0	1	0	1		15
	0	1	1	0		18
	0	1	1	1		21
	1	0	0	0		24
	1	0	0	1		27
	1	0	1	0		30
	1	0	1	1		33
	1	1	0	0		36
	1	1	0	1		39
	1	1	1	0		42
	1	1	1	1		45
1	0	0	0	0	**AFT**	0
	0	0	0	1		3
	0	0	1	0		6
	0	0	1	1		9
	0	1	0	0		12
	0	1	0	1		15
	0	1	1	0		18
	0	1	1	1		21
	1	0	0	0		24
	1	0	0	1		27
	1	0	1	0		30
	1	0	1	1		33
	1	1	0	0		36
	1	1	0	1		39
	1	1	1	0		42
	1	1	1	1		45

NEXT, NEED TO ESTABLISH LATERAL OFFSET ENCODING:

RECCOMENDATION:

USE RESERVED BITS 49, 50, AND 56.

Figure 2-11 would then appear as follows: (change areas are highlighted in "Blue")

Aircraft Operational Status ADS-B Message "ME" Field Format														
MSG BIT #	33 - 37	38 - 40	41 - 52	53 - 56	57 - 72	73 - 75	76	77 - 80	81 - 82	83 - 84	85	86	87	88
"ME" BIT #	1 - 5	6 - 8	9 - 20	21 - 24	25 - 40	41 - 43	44	45 - 48	49 - 50	51 - 52	53	54	55	56
FIELD NAME	**TYPE=31 [5]**	**Subtype=0 [3]**	**Capability Class (CC) Codes [16]**		**Operational Mode (OM) Codes [16]**	**MOPS Version Number [3]**	**NIC Supp. [1]**	**NAC_P [4]**	**GVA [2]**	**Source Integrity Level (SIL) [2]**	**NIC_{BARO} [1]**	**HRD [1]**	**SIL Supp [1]**	**Lateral GPS Antenna Encoding Direction**
		Subtype=1 [3]	**CC Codes [12]**	**L/W Codes [4]**					**Lateral GPS Antenna Offset**		**TRK/HDG [1]**			
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		MSB LSB	MSB LSB	MSB LSB				

When POA = "1", then the lateral offset encoding would be as shown in the following table::

Note that the POA = "1" can be used to indicate that valid Longitudinal and/or Lateral GPS Offset encoding is available.

Left means left of the reference point, e.g., moving towards the left wing tip from the reference point.
Right means right of the reference point, e.g., moving towards the right wing tip from the reference point.
Reference point is the center of the length/width box as per RTCA DO-242A.

Lateral Axis GPS Antenna Offset Encoding				
"ME" Bit (Message bit)			**Lateral Axis GPS Antenna Offset**	
56 (88)	**49** (81)	**50** (82)		
0 = left 1 = right	**Encoding**			
	Bit 1	**Bit 0**	**Direction**	**(meters)**
0	0	0	**LEFT**	0
	0	1		3
	1	0		6
	1	1		9
1	0	0	**RIGHT**	0
	0	1		3
	1	0		6
	1	1		9

ARINC 718A-2 MODIFICATION CONSIDERATIONS:

Longitudinal Encoding requires:	32	states
Lateral Encoding requires:	8	states
Total Offset Encoding requires	40	states

SHOULD BE ABLE TO MAKE CHANGES FOR OFFSET ENCODING VIA AD-HOC WORK.
WILL ALSO HAVE TO ADD SOME INPUT DEFINITION MODS TO ARINC 718A-2 FOR OTHER CHANGES THAT ARE BEING MADE IN RTCA DO-260B, e.g., SIL, SDA, SIL SUPP, etc.