

RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #9

Action Item 8-9

Appendix Material for 1090 TIS Broadcast

Draft 5

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SUMMARY

This working paper proposes the fifth draft of TIS-B material for Appendix A. It includes comments received at meeting #8 of WG-3. The text that is changed is identified in red and with a change bar in the right hand margin.

Specific changes relative to the last version are: (1) the addition of NIC Supplement, NAC and SIL fields to the Operational Status message, (2) changing the material on management messages to include only a definition of a format to be reserved for future use, and (3) the addition of details for Ground Track Status, Ground Track Angle and Ground Speed in the Coarse Position format based on comments received from industry.

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A.2 Traffic Information Service – Broadcast (TIS-B) Formats and Coding

A.2.1 Introduction

Notes:

1. *This section of Appendix A defines the formats and coding for a Traffic Information Service Broadcast (TIS-B) based on the same 112-bit 1090 MHz signal transmission that is used for ADS-B on 1090 MHz.*
2. *TIS-B complements the operation of ADS-B by providing ground-to-air broadcast of surveillance data on aircraft that are not equipped for 1090 MHz ADS-B. The basis for this ground surveillance data may be an ATC Mode S radar, a surface or approach multilateration system or a multisensor data processing system. The TIS-B ground-to-air transmissions use the same signal formats as 1090 MHz ADS-B and can therefore be accepted by a 1090 MHz ADS-B receiver.*
3. *TIS-B service is the means for providing a complete surveillance picture to 1090 MHz ADS-B users during a transition period. After transition, it also provides a means to cope with a user that has lost its 1090 MHz ADS-B capability.*

A.2.2 TIS-B Format Definition

TIS-B information is broadcast using the 112-bit Mode S DF=18 format as shown below in Figure A-13:



Figure A-13: TIS-B Format Definition

A.2.3 Control Field Allocation

The content of the DF=18 transmission is defined by the value of the control field, as specified in Table A-21.

Table A-21: “CF” Field Code Definitions in DF=18 ADS-B and TIS-B Messages.

| CF Value | ICAO/Mode A Flag (IMF) | Meaning |
|----------|------------------------|--|
| 0 | N/A | ADS-B message from a non-transponder device, AA field holds 24-bit ICAO aircraft address |
| 1 | N/A | Reserved for ADS-B message in which the AA field holds anonymous address or ground vehicle address or fixed obstruction address |
| 2 | 0 | Fine TIS-B message, AA field contains the 24-bit ICAO aircraft address |
| | 1 | Fine TIS-B message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number |
| 3 | 0 | Coarse TIS-B airborne position and velocity message, AA field contains the 24-bit ICAO aircraft address |
| | 1 | Coarse TIS-B airborne position and velocity message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number. |
| 4 | N/A | Reserved for TIS-B management message AA field holds TIS-B service volume ID + other information (e.g., MSB of reference position for the service volume) |
| 5 – 7 | N/A | Reserved for other uses (e.g., for FIS-B messages) |

A.2.4 TIS-B Surveillance Message Definition

A.2.4.1 TIS-B Fine Airborne Position Message

The TIS-B fine airborne position ME field shall be formatted as specified in Figure A-14.

***Note:** Additional details are specified in the following paragraphs.*

A.2.4.1.1 ICAO/Mode A Flag (IMF)

This one-bit field (bit 8) shall indicate the type of identity associated with the aircraft data reported in the TIS-B message. IMF equal to ZERO (0) shall indicate that the TIS-B data is identified by an ICAO 24-bit address. IMF equal to ONE (1) shall indicate that the TIS-B data is identified by a “Mode A” code. A “Mode A” code of all zeroes shall indicate a primary radar target.

***Note:** The AA field is coded differently for 24-bit addresses and Mode A codes as specified in Table A-21.*

A.2.4.1.2 Pressure Altitude

This 12-bit field shall provide the aircraft pressure altitude. This field shall contain barometric altitude encoded in 25 or 100-foot increments (as indicated by the Q Bit). All zeroes in this field shall indicate that there is no altitude data.

A.2.4.1.3 Compact Position Reporting (CPR) Format (F)

This field shall be set as specified in subparagraph A.1.4.2.1

A.2.4.1.4 Latitude/Longitude

The latitude/longitude fields in the TIS-B fine airborne position message shall be set as specified in subparagraph A.1.4.2.3.

A.2.4.2 TIS-B Surface Position Message

The TIS-B surface position ME field shall be formatted as specified in Figure A-15.

***Note:** Additional details are specified in the following paragraphs.*

A.2.4.2.1 Movement

This field shall be set as specified in subparagraph A.1.4.3.1

A.2.4.2.1.1 Ground Track (true)

A.2.4.2.1.1.1 Ground Track Status

This field shall be set as specified in subparagraph A.1.4.3.2.1.

A.2.4.2.1.1.2 Ground Track Angle

This field shall be set as specified in subparagraph A.1.4.3.2.2.

A.2.4.2.12 ICAO/Mode A Flag (IMF)

This one-bit field (bit 21) shall indicate the type of identity associated with the aircraft data reported in the TIS-B message. IMF equal to ZERO (0) shall indicate that the TIS-B data is identified by an ICAO 24-bit address. IMF equal to ONE (1) shall indicate that the TIS-B data is identified by a "Mode A" code. A "Mode A" code of all zeroes shall indicate a primary radar target.

***Note:** The AA field is coded differently for 24-bit addresses and Mode A codes as specified in Table A-21.*

A.2.4.2.1.3 Compact Position Reporting (CPR) Format (F)

This field shall be set as specified in subparagraph A.1.4.3.3.

A.2.4.2.1.4 Latitude/Longitude

The latitude/longitude fields in the TIS-B fine surface position message shall be set as specified in subparagraph A.1.4.3.5.

A.2.4.3 Identification and Category Message

The TIS-B identification and category ME field shall be formatted as specified in Figure A-16. This message shall only be used for aircraft identified with an ICAO 24-bit address.

Note: Additional details are specified in the following paragraphs.

A.2.4.3.1 Aircraft Identification Coding

This field shall be set as specified in subparagraph A.1.4.4.1.

A.2.4.4 Airborne Velocity Message

The TIS-B airborne velocity ME field shall be formatted as specified in the Figure A-17.

Note: Additional details are specified in the following paragraphs.

A.2.4.4.1 Subtype Field

Only subtypes 1 and 2 shall be used for the TIS-B airborne velocity message. Subtype 1 shall be used for velocities under 1000 knots and subtype 2 shall be used for aircraft capable of supersonic flight when the velocity might exceed 1022 knots.

The supersonic version of the velocity coding shall be used if either the east-west OR north-south velocities exceed 1022 kt. A switch to the normal velocity coding shall be made if both the east-west AND north-south velocities drop below 1000 kt.

A.2.4.4.2 ICAO/Mode A Flag (IMF)

This one-bit field (bit 9) shall indicate the type of identity associated with the aircraft data reported in the TIS-B message. IMF equal to ZERO (0) shall indicate that the TIS-B data is identified by an ICAO 24-bit address. IMF equal to ONE (1) shall indicate that the TIS-B data is identified by a "Mode A" code. A "Mode A" code of all zeroes shall indicate a primary radar target.

Note: The AA field is coded differently for 24-bit addresses and Mode A codes as specified in Table A-21.

A.2.4.4.3 Navigation Integrity Category (NIC) Supplement

This one-bit field (bit 46) shall be used together with the message type code to define the NIC value for the airborne and surface position messages.

Coding of the NIC Supplement field shall be as specified for the Operational Status Message in Table 2.2.3.2.3.1-B

A.2.4.4.4 Navigation Accuracy Coding (NAC)

This four-bit field (47-50) shall define the NAC value for the airborne and surface position messages.

Coding of the NAC field shall be as specified for the Operational Status Message in Table 2.2.3.2.7.3.7

A.2.4.4.5 Surveillance Integrity Level (SIL)

This two-bit field (51-52) shall define the SIL value for the airborne and surface position messages.

Coding of the SIL field shall be as specified for the Operational Status Message in Table 2.2.3.2.7.3.8

A.2.4.5 Coarse Airborne Position Message

The TIS-B coarse airborne position ME field shall be formatted as specified in Figure A-18.

Notes:

- 1. This message is used if the surveillance source for TIS-B is not of high enough quality to justify the use of the fine formats. An example of such a source is a scanning beam Mode S interrogator.*
- 2. Additional details are specified in the following paragraphs.*

A.2.4.5.1 ICAO/Mode A Flag (IMF)

This one-bit field (bit 1) shall indicate the type of identity associated with the aircraft data reported in the TIS-B message. IMF equal to ZERO (0) shall indicate that the TIS-B data is identified by an ICAO 24-bit address. IMF equal to ONE (1) shall indicate that the TIS-B data is identified by a “Mode A” code. A “Mode A” code of all zeroes shall indicate a primary radar target.

Note: *The AA field is coded differently for 24-bit addresses and Mode A codes as specified in Table A-21.*

A.2.4.5.2 Service Volume ID (SVID)

The 4-bit SVID field shall identify the TIS-B site that delivered the surveillance data.

Note: *In the case where TIS-B messages are being received from more than one TIS-B ground stations, the SVID can be used to select coarse messages from a single source. This will prevent the TIS-B track from wandering due to the different error biases associated with different sources.*

A.2.4.5.3 Pressure Altitude

This 12-bit field shall provide the aircraft pressure altitude. This field shall contain barometric altitude encoded in 25 or 100-foot increments (as indicated by the Q Bit).

A.2.4.5.4 Ground Track Status

This one bit field shall define the validity of the ground track value. Coding for this field shall be as follows: 0=not valid and 1= valid.

A.2.4.5.5 Ground Track Angle

This 6-bit (21-25) field shall define the direction (in degrees clockwise from true north) of aircraft motion. The ground track shall be encoded as an unsigned angular weighted binary numeral, with an MSB of 180 degrees and an LSB of 360/32 degrees, with ZERO (0) indicating true north. The data in the field shall be rounded to the nearest multiple of 360/32 degrees.

A.2.4.5.6 Ground Speed

This 6-bit (26-31) field shall define the aircraft speed over the ground. Coding of this field shall be as specified in 2.2.17.3.5.6.

A.2.4.5.7 Latitude/Longitude

The latitude/longitude fields in the TIS-B coarse airborne position message shall be set as specified in subparagraph A.1.4.2.3, except that the 12-bit form of CPR coding shall be used.

A.2.5 Reserved for TIS-B Management Messages

Note: TIS-B management messages could announce information such as location and the service volume of the TIS-B ground station. There is no requirement in the TIS-B MASPS (DO-TBD) for management messages. Format DF=18 with CF=4 has been reserved for management messages should they be required in the future.

Figure A-14: TIS-B Fine Airborne Position Message

| | |
|----|--------------------------------------|
| 1 | |
| 2 | |
| 3 | FORMAT TYPE CODE |
| 4 | (See A.1.4.1 and Note 1) |
| 5 | |
| 6 | SURVEILLANCE STATUS |
| 7 | LSB |
| 8 | IMF (See A.2.4.1.1) |
| 9 | |
| 10 | |
| 11 | PRESSURE ALTITUDE |
| 12 | |
| 13 | |
| 14 | The altitude code (AC) as specified |
| 15 | in section 2.2.13.1.2 of DO-181B but |
| 16 | with the M-bit removed |
| 17 | |
| 18 | |
| 19 | |
| 20 | |
| 21 | Reserved |
| 22 | CPR FORMAT (F) (See A.1.4.2.1) |
| 23 | MSB |
| 24 | |
| 25 | |
| 26 | |
| 27 | |
| 28 | |
| 29 | |
| 30 | CPR ENCODED LATITUDE |
| 31 | |
| 32 | (CPR Airborne Format |
| 33 | See A.1.7.1 to A.1.7.5) |
| 34 | |
| 35 | |
| 36 | |
| 37 | |
| 38 | |
| 39 | LSB |
| 40 | MSB |
| 41 | |
| 42 | |
| 43 | |
| 44 | |
| 45 | |
| 46 | |
| 47 | CPR ENCODED LONGITUDE |
| 48 | |
| 49 | (CPR Airborne Format |
| 50 | See A.1.7.1 to A.1.7.4) |
| 51 | |
| 52 | |
| 53 | |
| 54 | |
| 55 | |
| 56 | LSB |

Purpose: To provide airborne position information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on high quality surveillance data.

Surveillance Status coding

- 0 = no condition information
- 1 = permanent alert (emergency condition)
- 2 = temporary alert (change in Mode A identity code other than emergency condition)
- 3 = SPI condition

Codes 1 and 2 take precedence over code 3.

Figure A-15: TIS-B Fine Surface Position Message

| | |
|----|---|
| 1 | |
| 2 | |
| 3 | FORMAT TYPE CODE |
| 4 | (See A.1.4.1) |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | MOVEMENT |
| 10 | (See A.1.4.3.1) |
| 11 | |
| 12 | |
| 13 | STATUS for Gnd Tk (1 =valid, 0 = not valid) |
| 14 | MSB |
| 15 | |
| 16 | GROUND TRACK (7 bits) |
| 17 | (See A.1.4.3.2) |
| 18 | |
| 19 | Resolution = 360/128 deg |
| 20 | LSB |
| 21 | IMF (See A.2.4.2.12) |
| 22 | CPR FORMAT (F) (See A.1.4.2.1) |
| 23 | MSB |
| 24 | |
| 25 | |
| 26 | |
| 27 | |
| 28 | |
| 29 | |
| 30 | CPR ENCODED LATITUDE |
| 31 | |
| 32 | (CPR Surface Format |
| 33 | See A.1.7.1 to A.1.7.4 and A.1.7.6) |
| 34 | |
| 35 | |
| 36 | |
| 37 | |
| 38 | |
| 39 | LSB |
| 40 | MSB |
| 41 | |
| 42 | |
| 43 | |
| 44 | |
| 45 | |
| 46 | |
| 47 | CPR ENCODED LONGITUDE |
| 48 | |
| 49 | (CPR Surface Format |
| 50 | See A.1.7.1 to A.1.7.4) |
| 51 | |
| 52 | |
| 53 | |
| 54 | |
| 55 | |
| 56 | LSB |

Purpose: To provide surface position information for aircraft that are not equipped with 1090 MHz ADS-B.

Figure A-16: TIS-B Identification and Category Message

| | |
|----|------------------|
| 1 | |
| 2 | |
| 3 | FORMAT TYPE CODE |
| 4 | (See A.1.4.1) |
| 5 | |
| 6 | |
| 7 | EMITTER CATEGORY |
| 8 | |
| 9 | MSB |
| 10 | |
| 11 | CHARACTER 1 |
| 12 | |
| 13 | |
| 14 | LSB |
| 15 | MSB |
| 16 | |
| 17 | CHARACTER 2 |
| 18 | |
| 19 | |
| 20 | LSB |
| 21 | MSB |
| 22 | |
| 23 | CHARACTER 3 |
| 24 | |
| 25 | |
| 26 | LSB |
| 27 | MSB |
| 28 | |
| 29 | CHARACTER 4 |
| 30 | |
| 31 | |
| 32 | LSB |
| 33 | MSB |
| 34 | |
| 35 | CHARACTER 5 |
| 36 | |
| 37 | |
| 38 | LSB |
| 39 | MSB |
| 40 | |
| 41 | CHARACTER 6 |
| 42 | |
| 43 | |
| 44 | LSB |
| 45 | MSB |
| 46 | |
| 47 | CHARACTER 7 |
| 48 | |
| 49 | |
| 50 | LSB |
| 51 | MSB |
| 52 | |
| 53 | CHARACTER 8 |
| 54 | |
| 55 | |
| 56 | LSB |

Purpose: To provide aircraft identification and category for aircraft that are not equipped with 1090 MHz ADS-B.

Type coding:

- 1 = Aircraft identification, category set D
- 2 = Aircraft identification, category set C
- 3 = Aircraft identification, category set B
- 4 = Aircraft identification, category set A

ADS-B Emitter Category coding:

Set A

- 0 = No ADS-B Emitter Category Information
- 1 = Light (< 15 500 lbs.)
- 2 = Small (15 500 to 75 000 lbs.)
- 3 = Large (75 000 to 300 000 lbs.)
- 4 = High Vortex Large (aircraft such as B-757)
- 5 = Heavy (> 300 000 lbs.)
- 6 = High Performance (> 5 g acceleration and > 400kts)
- 7 = Rotorcraft

Set B

- 0 = No ADS-B Emitter Category Information
- 1 = Glider/sailplane
- 2 = Lighter-than-Air
- 3 = Parachutist/Skydiver
- 4 = Ultralight/hang-glider/paraglider
- 5 = Reserved
- 6 = Unmanned Aerial Vehicle
- 7 = Space/Trans-atmospheric Vehicle

Set C

- 0 = No ADS-B Emitter Category Information
- 1 = Surface Vehicle – Emergency Vehicle
- 2 = Surface Vehicle – Service Vehicle
- 3 = Fixed Ground or Tethered Obstruction
- 4-7 = Reserved

Set D : Reserved

Aircraft identification coding:

Coding as specified for A.1.4.4

**Figure A-17: TIS-B Airborne Velocity Messages
(Subtypes 1 and 2: Velocity Over Ground)**

BDS 0,9

| | | |
|----|---|---------------------------|
| 1 | MSB | 1 |
| 2 | | 0 |
| 3 | FORMAT TYPE CODE = 19 | 0 |
| 4 | | 1 |
| 5 | LSB | 1 |
| 6 | SUBTYPE 1 0 | SUBTYPE 2 0 |
| 7 | 0 | 1 |
| 8 | 1 | 0 |
| 9 | IMF (See A.2.4.4.2) | |
| 10 | Reserved | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | DIRECTION BIT for E-W velocity (0=East, 1=West) | |
| 15 | EAST-WEST VELOCITY (10 bits) | |
| 16 | NORMAL : LSB = 1 knot | SUPERSONIC : LSB =4 knots |
| 17 | All zeros = no velocity info | |
| 18 | <u>Value</u> | <u>Velocity</u> |
| 19 | 1 | 0 kts |
| 20 | 2 | 1 kt |
| 21 | 3 | 2 kt |
| 22 | - | - |
| 23 | 1022 | 1021 kt |
| 24 | 1023 | >1021.5 kt |
| 25 | DIRECTION BIT for N-S velocity (0=North, 1=South) | |
| 26 | NORTH-SOUTH VELOCITY (10 bits) | |
| 27 | NORMAL : LSB = 1 knot | SUPERSONIC : LSB =4 knots |
| 28 | All zeros = no velocity info | |
| 29 | <u>Value</u> | <u>Velocity</u> |
| 30 | 1 | 0 kts |
| 31 | 2 | 1 kt |
| 32 | 3 | 2 kt |
| 33 | - | - |
| 34 | 1022 | 1021 kt |
| 35 | 1023 | >1021.5 kt |
| 36 | Reserved | |
| 37 | SIGN BIT FOR VERTICAL RATE: 0 = up, 1 = down | |
| 38 | VERTICAL RATE (9 bits) | |
| 39 | All zeros – no vertical rate information, LSB = 64 ft/min | |
| 40 | <u>Value</u> | <u>Vertical rate</u> |
| 41 | 1 | 0 ft/min |
| 42 | 2 | 64 ft/min |
| 43 | - | - |
| 44 | 510 | 32576 ft/min |
| 45 | 511 | > 32608 ft/min |
| 46 | NIC Supplement (See A.2.4.4.3) | |
| 47 | | |
| 48 | Navigation Accuracy Coding (NAC) | |
| 49 | (See A.2.4.4.4) | |
| 50 | | |
| 51 | Surveillance Integrity Level (SIL) | |
| 52 | (See A.2.4.4.5) | |
| 53 | | |
| 54 | | |
| 55 | | |
| 56 | | |

Purpose: To provide velocity information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on high quality surveillance data.

Subtype Coding

| Code | Velocity | Type |
|------|--------------|------------|
| 1 | Ground speed | normal |
| 2 | | supersonic |

Figure A-18: TIS-B Coarse Airborne Position Message

| | |
|----|--|
| 1 | IMF (See A.2.4.5.1) |
| 2 | SURVEILLANCE STATUS |
| 3 | |
| 4 | MSB |
| 5 | SERVICE VOLUME ID (SVID) |
| 6 | |
| 7 | LSB |
| 8 | MSB |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | PRESSURE ALTITUDE |
| 14 | |
| 15 | |
| 16 | |
| 17 | |
| 18 | |
| 19 | LSB |
| 20 | GRND TRACK STATUS (1=valid, 0=invalid) |
| 21 | GROUND TRACK ANGLE |
| 22 | |
| 23 | (See A.2.4.5.5) |
| 24 | |
| 25 | |
| 26 | GROUND SPEED |
| 27 | |
| 28 | (See A.2.4.5.6) |
| 29 | |
| 30 | |
| 31 | |
| 32 | CPR FORMAT (F) (0 = even, 1 = odd) |
| 33 | |
| 34 | |
| 35 | |
| 36 | |
| 37 | |
| 38 | CPR-ENCODED LATITUDE |
| 39 | |
| 40 | (See A.2.4.5.7) |
| 41 | |
| 42 | |
| 43 | |
| 44 | LSB |
| 45 | MSB |
| 46 | |
| 47 | |
| 48 | |
| 49 | |
| 50 | CPR-ENCODED LONGITUDE |
| 51 | |
| 52 | (See A.2.4.5.7) |
| 53 | |
| 54 | |
| 55 | |
| 56 | LSB |

Purpose: To provide airborne position information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on moderate quality surveillance data..