Traffic Information Service Broadcast (TIS-B) via Extended Squitter

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Topics

- **TIS vs. TIS-B**

- **Need for Service Volume ID (SVID)**

- **Approach for Incorporating TIS-B in format Structure**

- **TIS-B Format Approach**

- **Transmission Rates**

- **Detailed TIS-B Formats**

Traffic Information Service (TIS)

- **Traffic Information Service (TIS) is an addressed ground-to-air service that provides automatic traffic advisories via addressed Comm A messages using the Mode S data link**

  - **Notification by exception**

  - **Alerts provided only for traffic that may be a factor**

- **Surveillance source for TIS is a Mode S interrogator**

  - **Surveillance data for aircraft in range**

  - **Data link delivery of messages to TIS clients**

- **TIS is defined as Mode S Specific Protocol (MSP) application in Vol. III, Chapter 5, Appendix 1**

  - **Formerly Doc 9688**

- **TIS is an alerting service**

Traffic Information Service Broadcast (TIS-B)

- **Traffic Information Service Broadcast (TIS-B) is a ground-to-aircraft broadcast service that provides "ADS-B like" surveillance for aircraft not equipped for ADS-B**

  - **Surveillance source can be a Mode S interrogator, a multilateration approach system or a surface surveillance system**

- **TIS-B is an aid to transition since it makes it possible to use ADS-B in regions of airspace where all users are not ADS-B equipped**

- **TIS-B is a surveillance service**

SVID Use for Track Stability

- Airborne aircraft may receive TIS-B messages from more than one TIS-B ground station

- Coarse formats are normally based on surveillance from a rotating beam sensor. Unless adjacent sensor data is merged:

  – Messages from different ground stations should not be mixed

  – Different biases will cause track to be unstable

- Airborne user should select data from only one ground station based on the Service Volume ID (SVID) in the coarse format

- SVID not necessary for fine format

  – Data quality will be similar to GPS (e.g., time difference multilateration surveillance system)

SVID Use for TIS-B Management

- **User needs to know limit of TIS-B coverage of a ground station**
  - To switch to new station (SVID) if available
  - Otherwise to alert pilot that TIS-B service is terminating

- **TIS-B station should broadcast management message**
  - Provides station SVID, and service area limits
  - Limits could include 2D area and minimum altitude at the limits of coverage

- **Overlap between adjacent stations would be the minimum needed to ensure continuity of service across a boundary**
  - Avoids unnecessary channel activity

- **User could select SVID based on own position and announced service volume**

- **TIS-B management necessary for coarse formats**
  - Broad area coverage by terminal or enroute radars

- **TIS-B management not necessary for fine formats**
  - Limited coverage area (surface or approach)
  - Can be defined by operating procedure

Format Approach

- **DF=18 extended squitter defined for non-transponder services**

10010	CF:3	AA:24	ME:56	PI:24

- **CF Field current definition**

  - **CF=0 indicates standard extended squitter formats from a non-transponder device**

  - **CF=1 to 7 undefined**

- **Propose definition of additional CF field codes as follows:**

  - **CF=2: Coarse TIS-B service based on ASR quality surveillance**

  - **CF=3: Fine TIS-B service based on high qualityu surveillance (e.g., a surface multilateration system)**

  - **CF=4: TIS-B management messsages**

Fine TIS-B Formats

- **Same formats as defined for transponder-based extended squitter for position, velocity and identity**

  - **except revision made to indicate Mode S or ATCRBS coding**

- **Identified as TIS-B by DF =18 and and CF = 3**

Coarse TIS-B Format

- **Coarse TIS-B format contains info on one aircraft per squitter and provides lat/lon, altitude, velocity and 24-bit address for Mode S aircraft, and Mode A code and track number for ATCRBS aircraft**

- **56-bit ME field contains:**

- **SVID : 4 bits (to identify source of surveillance data)**

- **Lat/lon 12 bits each**
  - **Same as CPR for regular position squitter but rounded to 12 bits**
  - **Resulting LSB =160 m adequate for accuracy from beacon radar**

- **Even/odd format (to resolve ambiguity for CPR): 1 bit**

- **Altitude: 12 bits**

- **Velocity: 13 bits**

- **Surveillance Status 2 bits**

- **Control: 1 bit - Indicates Mode S or ATCRBS**

- **AA field contains**
  - **Mode S: 24-bit address**
  - **ATCRBS : 12 bit Mode A code (plus 10 bit track number & 2 spare bits)**

Transmission Rates

- **Coarse TIS-B Transmission rates**
  - **3 times per radar scan after measurement**
    - **3 times per 4.8 sec for terminal sensor**
    - **3 times per 10 to 12 seconds for en route sensor**
  - **Less than one per 1.6 seconds per aircraft**

- **Fine Mode TIS-B Transmission rates**
  - **Twice per second for each format (s/a normal squitter)**

- **Ground will suppress TIS-B transmissions for extended squitter equipped aircraft**

- **Total squitter broadcasts no more than if aircraft were all extended squitter equipped**

Detailed Formats

- **Fine TIS-B Airborne Messages**

    - **Position**

    - **Velocity**

    - **Identification**

- **Fine TIS-B Surface Message**

- **Coarse TIS-B Airborne Message**

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

Bit	Field
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

Bit	Field
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

Bit	Field
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	All zeros = no velocity info
18	Value Velocity	Value Velocity
19	1 0 kts	1 0 kt
20	2 1 kt	2 4 kt
21	3 2 kt	3 8 kt
22	- -	- -
23	1022 1021 kt	1022 4084 kt
24	1023 >1021.5 kt	1023 > 4086kt
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	All zeros = no velocity info
29	Value Velocity	Value Velocity
30	1 0 kts	1 0 kt
31	2 1 kt	2 4 kt
32	3 2 kt	3 8 kt
33	- -	- -
34	1022 1021 kt	1022 4084 kt
35	1023 >1021.5 kt	1023 > 4086kt
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	Value Vertical rate	
41	1 0 ft/min	
42	2 64 ft/min	
43	- -	
44	510 32576 ft/min	
45	511 > 32608 ft/min	
46		
47	Reserved	
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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

Bit	Field
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** MSB (180º)
22	(90º)
23	(45º)
24	(22.5º)
25	LSB (11.25º)
26	**GROUND SPEED** MSB (1024 knots)
27	(512 knots)
28	(256 knots)
29	(128 knots)
30	(64 knots)
31	LSB (32 knots)
32	**CPR FORMAT (F)** (0 = even, 1 = odd)
33	
34	
35	
36	
37	
38	**CPR-ENCODED LATITUDE**
39	
40	(CPR Airborne Format
41	See A.1.7.1 to A.1.7.5)
42	
43	
44	LSB
45	MSB
46	
47	
48	
49	
50	**CPR-ENCODED LONGITUDE**
51	
52	(CPR Airborne Format
53	See A.1.7.1 to A.1.7.4)
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..

Figure A-19: TIS-B Management

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Purpose: To provide information about the location and the service volume boundaries of the TIS-B ground station