RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #12

1090 MHz ADS-B MOPS Revisions for Intent Reporting

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Summary

Changes to the ADS-B MASPS (DO-242A) were agreed by SC-186 at its plenary 10-11 April 2002. DO-260A is expected to include the specific provisions to accommodate the changes introduced in DO-242A, except for TC Reports. This working paper and its attachments include updates to the proposed DO-260A changes/additions first proposed in 1090-WP-10-09 from the 10th WG3 meeting in March 2002 and further updated in WP11-01r1 and reviewed at the 11th WG3 meeting in May 2002. The attachments include specific proposals for 1090 MHz ADS-B MOPS revisions in section 2.1 and 2.2 for intent messages, message reporting rates and message scheduling.

References: 1. Proposed ADS-B MASPS DO-242A, final draft May 2002

2. WG3/ WP 11-01r1, May 2002

Attachment A: Proposed DO-260A, Section 2.1 updates

Attachment B: Proposed DO-260A, Section 2.2 revisions for Intent Messages, Reporting Rates and Message Scheduling.

1. Background

Changes to the ADS-B MASPS (DO-242A) were agreed by SC-186 at its plenary 10-11 April 2002. DO-260A is expected to include the specific provisions to accommodate the changes introduced in DO-242A, except for TC Reports. This working paper and its attachments include updates to the proposed DO-260A changes/additions first proposed in 1090-WP-10-09 from the 10th WG3 meeting in March 2002 and further updated in WP11-01r1 and reviewed at the 11th WG3 meeting in May 2002. The attachments include specific proposals for 1090 MHz ADS-B MOPS revisions in section 2.1 and 2.2 for intent messages, message reporting rates and message scheduling.

2. Proposal

It is proposed that WG3 accept the revisions/additions to DO-260A included in the attachments to this working paper as being mature and to authorize the MOPS editor to incorporate the material into the working draft of DO-260A.

ATTACHMENT A

Proposed DO-260A, Section 2.1 updates to replace TCP requirements with the current A/C Intent Reporting requirements as per DO-242A and DO-260A section 2.2

Table 2.1.11(a): ADS-B Aircraft System Classes (from RTCA DO-242, Table 3-1)

CLASS	SUBSYSTEM	CAPABILITIES	FEATURES	COMMENTS
Interactive Aircraft/Vehicle Participant Systems (Class A)				
A_0	Minimum Interactive Aircraft/Vehicle	Aid to Visual Acquisition.	Lower transmit power and less sensitive than Class A_1.	Minimum interactive capability with CDTI.
A_1	Basic Interactive Aircraft	A_0 Plus Conflict Avoidance.	Standard Tx and Rx.	Provides ADS-B based conflict avoidance and interface to current TCAS surveillance algorithms/displays.
A_2	Enhanced Interactive Aircraft	A_1 Plus Separation Assurance and Sequencing.	Standard transmit power and more sensitive receiver. Interface with avionics source required for ~~TCP~~ aircraft trajectory intent data.	Baseline for separation management employing intent information.
A_3	Extended Interactive Aircraft	A_2 Plus Flight Path Deconfliction Planning.	More sensitive receiver. Interface with avionics source required for ~~TCP and TCP+1~~aircraft trajectory intent data.	Extends planning horizon for strategic separation employing intent information.
Broadcast-Only Participant Systems (Class B)				
B_0	Aircraft Broadcast Only	Supports visual acquisition and conflict avoidance for other participants.	Transmit power may be matched to coverage needs. Nav data input required.	Enables aircraft to be seen by Class A and Class C users.
B_1	Aircraft Broadcast Only	Supports visual acquisition and conflict avoidance for other participants.	Transmit power may be matched to coverage needs. Nav data input required.	Enables aircraft to be seen by Class A and Class C users.
B_2	Ground Vehicle Broadcast Only	Supports visual acquisition and conflict avoidance on airport surface.	Transmit power matched to surface coverage needs. High accuracy Nav dat input required.	Enables vehicle to be seen by Class A and Class C users.
B_3	Fixed Obstruction	Supports visual acquisition and conflict avoidance.	Fixed coordinates. No Nav data input required. Collocation with obstruction not required with appropriate broadcast coverage.	Enables Nav hazard to be detected by Class A users.
Ground Receive Systems (Class C)				
C_1	ATS En route and Terminal Area Operations	Supports ATS cooperative surveillance.	Requires ATS certification and interface to ATS sensor fusion system.	En route coverage out to 200 nmi. Terminal coverage out to 60 nmi.
C_2	ATS Parallel Runway and Surface Operation	Supports ATS cooperative surveillance.	Requires ATS certification and interface to ATS sensor fusion system.	Approach coverage out to 10 nmi. Surface coverage out to 5 nmi.
C_3	Flight Following Surveillance	Supports private user operations planning and flight following.	Does not require ATS interface. Certification requirements determined by user application.	Coverage determined by application.

Table ~~2-2~~2.1.11(b) ADS-B MESSAGE TO REQUIREMENT CROSS-REFERENCE TABLE

MESSAGE	REFERENCE SECTION
AIRBORNE POSITION	2.2.3.2.3
SURFACE POSITION	2.2.3.2.4
AIRCRAFT IDENTIFICATION and TYPE	2.2.3.2.5
AIRBORNE VELOCITY (Subtype 1, 2, 3, & 4)	2.2.3.2.6.1- 2.2.3.2.6.4
AIRCRAFT TRAJECTORY INTENT AND SYSTEM STATUS ~~(TCP)~~	2.2.3.2.7.1
~~AIRCRAFT TRAJECTORY INTENT (TCP+1)~~	~~2.2.3.2.7.1~~
~~AIRCRAFT OPERATIONAL COORDINATION~~	~~2.2.3.2.7.2~~
AIRCRAFT OPERATIONAL STATUS	2.2.3.2.7.3
EVENT DRIVEN MESSAGE FOR TEST	2.2.3.2.7.4
EVENT DRIVEN	2.2.3.2.7.5 –2.2.3.2.7.8
EXTENDED SQUITTER AIRCRAFT STATUS	2.2.3.2.7.9

Table ~~2-3~~2.1.11.1(a): ADS-B CLASS A TRANSMITTER EQUIPMENT TO MESSAGE COVERAGE

TRANSMITTER CLASS	MINIMUM RANGE / MINIMUM TRANSMIT POWER (AT ANTENNA PORT)	OPERATION	MASPS REQUIREMENT (RTCA/DO-242A)	MINIMUM MESSAGE CAPABILITY REQUIRED (FROM Table ~~2-2~~2.1.11(b))
A_0 (Minimum)	10 nmi / 70 W	• Aid to Visual Acquisition • Conflict Avoidance	SV MS	Airborne Position A/C Identification & Type Airborne Velocity
A_0 (Minimum)	10 nmi / 70 W	• Airport Surface	SV MS	Surface Position A/C Identification & Type
A_1 (Basic)	20 nmi / 125 W	• Aid to Visual Acquisition • Conflict Avoidance • Simultaneous Approaches	SV MS	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status
A_1 (Basic)	20 nmi / 125W	• Airport Surface	SV MS	Surface Position A/C Identification & Type
A_2 (Enhanced)	40 nmi / 125 W	• Aid to Visual Acquisition • Conflict Avoidance • Separation Assurance and Sequencing • Flight Path Deconfliction Planning • Simultaneous Approaches	SV MS	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status A/C Trajectory Intent ~~(TCP)~~and System Status ~~A/C Operational Coordination~~
A_2 (Enhanced)	40 nmi / 125 W	• Airport Surface	SV MS	Surface Position A/C Identification & Type
A_3 (Extended)	90 nmi / 125 W	• Aid to Visual Acquisition • Conflict Avoidance • Separation Assurance and Sequencing • Flight Path Deconfliction Planning • Simultaneous Approaches	SV MS OC	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status A/C Trajectory Intent ~~(TCP)~~and System Status ~~A/C Operational Coordination~~ ~~A/C Trajectory Intent (TCP+1)~~ Event Driven
A_3 (Extended)	90 nmi 125 W	• Airport Surface	SV MS	Surface Position A/C Identification & Type

Notes (Tables ~~2-3~~2.1.11.1(a) and ~~2-4~~2.1.11.1(b)):

4. *MS elements are as follows:*

   - *Address (the ICAO 24 Bit Address)*
   - *Call Sign (Up to 8 Alpha-numeric Characters)*
   - *Participant Category*
   - *Surveillance Support Code*
   - *Emergency/Priority Status*
   - *Class Codes*

   ~~*? TCP (Trajectory Change Point) Latitude*~~
   ~~*? TCP (Trajectory Change Point) Longitude*~~
   ~~*? TCP Altitude (Baro Alt or Flight Level)*~~
   ~~*? TTG (Time to Go)*~~

   - *Operational Mode Specific Data*

7. *OC reports is a category that includes multiple report types. Each specific OC report type includes the following elements~~ are as follows~~:*

   - *Air Referenced Velocity Report*
     - ~~?~~*Address (the ICAO 24 Bit Address)*
     - *Time of Applicability*
     - *Airspeed*
     - *Heading*

   - *Target State Reports*
     - *Time of Applicability*
     - *Horizontal Short Term Intent*
     - *Vertical Short Term Intent*

   - *Reserved for Trajectory Change Reports*

   ~~*? TCP+1 (Latitude)*~~
   ~~*? TCP+1 (Longitude)*~~
   ~~*? TCP+1 Altitude (Barometric or Flight Level)*~~
   ~~*? TCP+1 TTG*~~

Table ~~2-5~~2.1.11.2(a): ADS-B Class A Receiver Equipment To Report Coverage

RECEIVER CLASS	MINIMUM TRIGGER THRESHOLD LEVEL (MTL)	OPERATION	MASPS REQUIREMENT (RTCA/DO-242A)	MINIMUM REPORT REQUIRED
A_0 (Basic VFR)	72 dBm	• Aid to Visual Acquisition • Airport Surface	SV	ADS-B State Vector Report (per Section 2.2.8.1)
A_1 (Basic IFR)	-74 dBm	• Aid to Visual Acquisition • Conflict Avoidance • Simultaneous Approaches • Airport Surface	SV MS	ADS-B State Vector Report (per Section 2.2.8.1) AND ADS-B Mode Status Report (per Section 2.2.8.2)
A_2 (Enhanced IFR)	-79 dBm	• Aid to Visual Acquisition • Conflict Avoidance • Separation Assurance and Sequencing • Simultaneous Approaches • Airport Surface	SV MS OC	ADS-B State Vector Report (per Section 2.2.8.1) AND ADS-B Mode Status Report (per Section 2.2.8.2) AND ADS-B Target State Report (OC Report per Section 2.2.8.3) AND Reserved for ADS-B Target Change Reports
A_3 (Extended Capability)	-84 dBm	• Aid to Visual Acquisition • Conflict Avoidance • Separation Assurance and Sequencing • Flight Path Deconfliction Planning • Simultaneous Approaches • Airport Surface	SV MS OC	ADS-B State Vector Report (per Section 2.2.8.1) AND ADS-B Mode Status Report (per Section 2.2.8.2) AND ADS-B ~~TCP+1~~Target State Report (OC Report per Section 2.2.8.3) AND Reserved for ADS-B Target Change Reports

Table ~~2-6~~2.1.11.2(b): ADS-B Class C Receiver Equipment To Report Coverage

RECEIVER CLASS	MINIMUM TRIGGER THRESHOLD LEVEL (MTL)	OPERATION	MASPS REQUIREMENT (RTCA/DO-242A)	MINIMUM REPORT REQUIRED
C_1 (ATS En Route and Terminal)	Not Specified in this MOPS	• Aid to Visual Acquisition • Conflict Avoidance • Separation Assurance and Sequencing • Flight Path Deconfliction Planning	SV MS OC	ADS-B State Vector Report (per Section 2.2.8.1) AND ADS-B Mode Status Report (per Section 2.2.8.2) AND ADS-B ~~TCP+1~~Target State Report (per Section 2.2.8.3) AND Reserved for ADS-B Trajectory Change Report(s)
C_2 (Approach and Surface)	Not Specified in this MOPS	• Aid to Visual Acquisition • Conflict Avoidance • Separation Assurance and Sequencing • Simultaneous Approaches • Airport Surface	SV MS OC	ADS-B State Vector Report (per Section 2.2.8.1) AND ADS-B Mode Status Report (per Section 2.2.8.2) AND ADS-B ~~TCP+1~~Target State Report (per Section 2.2.8.3) AND Reserved for ADS-B Trajectory Change Report(s)
C_3 (Flight Following)	Not Specified in this MOPS	• Aid to Visual Acquisition • Separation Assurance and Sequencing • Airport Surface	SV MS OC	ADS-B State Vector Report (per Section 2.2.8.1) AND ADS-B Mode Status Report (per Section 2.2.8.2) AND ADS-B ~~TCP+1~~Target State Report (per Section 2.2.8.3) AND Reserved for ADS-B Trajectory Change Report(s)

Notes (Tables 2.1.11.2(a)~~2-5~~ and 2.1.11.2(b)~~2-6~~):

1. *SV = State Vector;*
2. *MS = Mode Status;*
3. *MS-P_{IFR} = Partial Mode Status for IFR Applications;*
4. *OC = On-Condition.*

ATTACHMENT B

Proposed DO-260A, Section 2.2 revisions for Intent Messages, Reporting Rates and Message Scheduling

Summary of changes from what was presented in WG3/WP11-01r1

- Text revised to include “Shall” statements in each paragraph.
- Table and Figures re-numbered to correspond to paragraph numbers.
- Limited valid target altitude range from –1000 to + 100,000 ft.
- Other Editorial changes

The text of the following paragraphs have been revised for this revision to this working paper (changes from 1090-WP-12-01 to 1090-WP-12-01R1):

2.2.3.2.7.1.4	**corrected para. title and text**
2.2.3.3.1.4.6	**allow simplified message scheduling function for systems that don’t support broadcast of intent messages**
2.2.3.3.1.4.6.1	**added note on future addition of trajectory change messages**
2.2.3.3.2.9.2	**change requirement to align with change to para. 2.2.3.3.1.4.6**

2.2.3.2.7 ADS-B Intent, Operational Coordination, and Operational Status Messages

Type codes 29 and 31 shall be used for Aircraft Intent and Aircraft Operational Status messages respectively. The structure of these messages is provided in detail in the subsequent paragraphs.

2.2.3.2.7.1 "Aircraft Trajectory Intent and System Status" Messages

The "Aircraft Trajectory Intent and System Status" Message is used to provide the current state of an airborne aircraft in navigating to its intended trajectory and the status of the aircraft's navigation data source, CDTI and TCAS/ACAS systems. For this version of these MOPS the Aircraft Trajectory Intent and System Status message is defined to convey information on the aircraft's target heading and altitude (i.e. Target State information) as well as information on the status of the navigation data being used by ADS-B and the status of the aircraft CDTI and TCAS systems. The format of the Aircraft Trajectory Intent and System Status message **shall** be as defined in Figure 2.2.3.2.7.1, while further definition of each of the subfields **shall** be as defined in the subsequent paragraphs.

Notes:

1. *Future editions of these MOPS may include provisions for additional sub-types of aircraft trajectory intent and status messages supporting broadcast of trajectory change information. An overview of such messages is provided in Appendix **tbd**.*

2. *At the time of the adoption of RTCA DO-260, it was decided by RTCA SC-186 Plenary that insufficient information was known about Trajectory Change Points and their usage to broadcast a TCP Valid Flag ("ME" bit 11) set equal to one (1), indicating that the following TCP Data was "Valid," without a clear understanding of what that data represented. It was agreed that the TCP Valid Flag be set to zero (0), until the issue of TCP was resolved by changes to the ADS-B MASPS, RTCA DO-242. This would result in the TCP/TCP+1 messages not being broadcast from a RTCA DO-260 compliant airborne implementation.*

   It was further agreed by the RTCA SC-186 Plenary, which approved DO-260 that all remaining text in DO-260 regarding TCP and TCP+1 was to remain as written, without modification, except for the test procedure in subparagraph 2.4.3.2.7.1.4, which deals specifically with the TCP Valid Flag in subparagraph 2.2.3.2.7.1.4.

   In these revised MOPS (RTCA DO-260A) the provisions of RTCA DO-260 related to TCP/TCP+1 have been removed and provisions for a Aircraft Trajectory Intent and System Status message has been defined using the same message Type value (i.e, Type = 29) as previously defined by RTCA DO-260 for the Aircraft Trajectory Intent messages that conveyed TCP/TCP+1 information. It is not expected that any implementation based on RTCA DO-260 would have implemented the messages for TCP and TCP+1. However, for purposes of backward compatibility these MOPS require for a Type=29 message that "ME" bit 11 always be set to zero (0) which would result in a RTCA DO-260 conformant ADS-B receiver not attempting to make use of the remaining contents of the message. Likewise any Type = 29 message transmitted by an implementation based on DO-260 that has incorrectly set "ME" bit 11 set to one(1) (i.e., indicating a valid TCP/TCP+1 message is being transmitted) should be discarded.

MSG BIT #	33--37	38---39	40---88
ME BIT #	1----5	6---7	8---56
FIELD NAME	TYPE=29 [5]	SUBTYPE [2]	Intent/Status Information (see 2.2.3.2.7.1.2) [49]
	MSB---LSB	MSB---LSB	MSB---LSB

Figure 2.2.3.2.7.1: "Aircraft Trajectory Intent and System Status" Message Overall Format

2.2.3.2.7.1.1 "TYPE" Subfield in Aircraft Trajectory Intent and System Status Message

The "TYPE" subfield was previously defined for the Airborne Position Message in subparagraph 2.2.3.2.3.1 and shall use the same subfield format for the Aircraft Trajectory Intent and System Status Message which uses Type Code = 29.

2.2.3.2.7.1.2 "SUBTYPE" Subfield in Aircraft Trajectory Intent and System Status Message

The "SUBTYPE" subfield is a 2 bit ("ME" bits 6 and 7, Message bits 38 and 39) field used to identify the format of the remainder of the Aircraft Trajectory Intent and System Status message. The "SUBTYPE" subfield shall encoded in accordance with Table 2.2.3.2.7.1.2.

Table 2.2.3.2.7.1.2: "SUBTYPE" Subfield Encoding

Encoding	Meaning
00	Target State and Status Information provided in the subsequent subfields of the message (see 2.2.3.2.7.1.3)
01	Reserved for Trajectory Change information to be conveyed in the subsequent subfields of the message
10	Reserved for Trajectory Change information to be conveyed in the subsequent subfields of the message
11	Reserved for Trajectory Change information to be conveyed in the subsequent subfields of the message

2.2.3.2.7.1.3 Target State and Status Information SUBTYPE=0 Format

TARGET STATE AND STATUS INFORMATION is conveyed by the Aircraft Trajectory Intent and System Status Message (TYPE = 29) when SUBTYPE = zero (0). The format of the Target State and Status Information shall as be in accordance with Figure 2.2.3.2.7.1.3.

MSG BIT #	33--37	38---39	40---41	42	43	44---45
ME BIT #	1----5	6---7	8---9	10	11	12---13
FIELD NAME	TYPE=29 [5]	SUBTYPE=0 [2]	VERTICAL DATA AVAILABLE /SOURCE INDICATOR [2]	TARGET ALTITUDE TYPE [1]	BACKWARD COMPATIBILITY FLAG = 0 [1]	TARGET ALTITUDE CAPABILITY [2]
	MSB--LSB	MSB---LSB	MSB---LSB			MSB---LSB

MSG BIT #	46---47	48---57	58---59	60---68	69	70---71
ME BIT #	14---15	16----25	26---27	28---36	37	38---39
FIELD NAME	VERTICAL MODE INDICATOR [2]	TARGET ALTITUDE [10]	HORIZONTAL DATA AVAILABLE/ SOURCE INDICATOR [2]	TARGET HEADING /TRACK ANGLE [9]	TARGET HEADING /TRACK INDICATOR [1]	HORIZ. MODE INDICATOR [2]
	MSB---LSB	MSB---LSB	MSB--LSB	MSB--LSB		MSB--LSB

MSG BIT #	72---75	76	77---78	79---83	84---85	86---88
ME BIT #	40-43	44	45---46	47---51	52---53	54---56
FIELD NAME	NAC_P [4]	$NIC_{bar\ o}$ [1]	SIL [2]	Reserved [5]	CAPABILTY /MODE CODES [2]	EMERGENCY /PRIORITY [3]
	MSB--LSB		MSB--LSB	MSB--LSB	MSB--LSB	MSB--LSB

Figure 2.2.3.2.7.1.3: "Target State and Status Information" SUBTYPE = Zero (0) Format

2.2.3.2.7.1.3.1 "VERTICAL DATA AVAILABLE/SOURCE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "Vertical Data Available/Source Indicator" subfield is a 2 bit ("ME" bits 8 and 9, Message bits 40 and 41) field used to identify if aircraft vertical state information is available and present as well as the data source for the vertical data when present in the subsequent subfields ("ME" bits 10 through 25, Message bits 42 through 57) of the ATISS Message. The "Vertical Data Available/Source Indicator" subfield shall be encoded in accordance with Table 2.2.3.2.7.1.3.1. If the "Vertical Data Available/Source Indicator" subfield is encoded with a value of ZERO (0), the target altitude related data in the subsequent subfields shall be ignored.

Table 2.2.3.2.7.1.3.1: "Vertical Data Available/Source Indicator" Subfield Encoding

Encoding	Meaning
00	No valid vertical Target State data is available
01	Autopilot control panel selected value, such as Mode Control Panel (MCP) or Flight Control Unit (FCU)
10	Holding Altitude
11	FMS/RNAV System

2.2.3.2.7.1.3.2 "TARGET ALTITUDE TYPE" Subfield in Aircraft Trajectory Intent and System Status Message

The "Target Altitude Type" subfield is a 1 bit ("ME" bit 10, Message bit 42) field used to identify whether the altitude reported in the "Target Altitude" subfield is referenced to mean sea level (MSL) or to a flight level (FL). The "Target Altitude Type" subfield shall be encoded in accordance with Table 2.2.3.2.7.1.3.2.

Table 2.2.3.2.7.1.3.2: "Trajectory Type" Subfield Encoding

Encoding	Meaning
0	Target Altitude referenced to Pressure Altitude (Flight Level)
1	Target Altitude referenced to Baro-Corrected Altitude (Mean Sea Level)

2.2.3.2.7.1.3.3 "BACKWARD COMPATIBILITY FLAG" Subfield in Aircraft Trajectory Intent and System Status Message

The "Backward Compatibility Flag" subfield is a 1-bit ("ME" bit 11, Message bit 43) field used to provide backward compatibility for version 0 (zero) 1090 MHz ADS-B systems based on the initial version of these MOPS (i.e., in RTCA DO-260). RTCA DO-260 designated message TYPE = 29 for TCP and TCP+1 messages. RTCA DO-260 required the "TCP/TCP+1 DATA VALID" subfield ("ME" bit 11) to be encoded with a value of ZERO (0), indicating the TCP/TCP+1 information in the message is not valid. For the current version of these MOPS where message TYPE = 29 is no longer being used for TCP/TCP+1 Messages, backward capability is provided by always setting "ME" bit 11 to a value of ZERO (0) in order to ensure that any receiving system based on the first version of these MOPS (i.e., based on RTCA DO-260) will ignore the contents of this message. Any TYPE = 29 message received with the "Backward Compatibility

Flag" set to ONE (1) **shall** be discarded. The "Backward Compatibility Flag" subfield **shall** be encoded in accordance Table 2.2.3.2.7.1.3.3.

Table 2.2.3.2.7.1.3.3: "Backward Compatibility Flag" Subfield Encoding

Encoding	Meaning
0	Required Value
1	Invalid Message (discard entire Aircraft Trajectory Intent and System Status Message)

2.2.3.2.7.1.3.4 "TARGET ALTITUDE CAPABILITY" Subfield in Aircraft Trajectory Intent and System Status Message

The "Target Altitude Capability" subfield is a 2-bit ("ME" bits 12 and 13, Message bits 44 and 45) field used to describe the aircraft's capabilities for providing the data reported in the "Target Altitude" subfield. The "Target Altitude Capability" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.4.

Table 2.2.3.2.7.1.3.4: "Target Altitude Capability" Subfield Encoding

Encoding	Meaning
00	Capability for reporting holding altitude only
01	Capability for reporting either holding altitude or autopilot control panel selected altitude
10	Capability for reporting either holding altitude, autopilot control panel selected altitude, or any FMS/RNAV level-off altitude
11	Reserved

2.2.3.2.7.1.3.5 "VERTICAL MODE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "Vertical Mode Indicator" subfield is a 2-bit ("ME" bits 14 and 15, Message bits 46 and 47) field used to indicate whether the target altitude is in the process of being acquired (i.e., aircraft is climbing or descending toward the target altitude) or whether the target altitude has been acquired/being held. The "Vertical Mode Indicator" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.5.

Table 2.2.3.2.7.1.3.5: "Vertical Mode Indicator" Subfield Encoding

Encoding	Meaning
00	Unknown Mode or Information Unavailable
01	"Acquiring" Mode
10	"Capturing" or "Maintaining" Mode
11	Reserved

2.2.3.2.7.1.3.6 "TARGET ALTITUDE" Subfield in Aircraft Trajectory Intent and System Status Message

The "Target Altitude" subfield is a 10 bit ("ME" bits 16 through 25, Message bits 48 through 57) field used to provide aircraft's next intended level-off altitude if in a climb or descent, or the aircraft current intended altitude if it is intending to hold its current altitude. It is intended that the reported "Target Altitude" be the operational altitude recognized by the aircraft's guidance system. The reported "Target Altitude" **shall** be consistent with the reported "Target Altitude Capability" as defined in 2.2.3.2.7.1.3.4.

The "Target Altitude" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.6.

Table 2.2.3.2.7.1.3.6: "Target Altitude" Subfield Encoding

Coding (binary)	**Coding** (decimal)	**Meaning**
00 0000 0000	0	Target Altitude = -1000 feet
00 0000 0001	1	Target Altitude = -900 feet
00 0000 0010	2	Target Altitude = -800 feet
***	***	***
00 0000 1011	11	Target Altitude = zero (0) feet
00 0000 1100	12	Target Altitude = 100 feet
***	***	***
11 1111 0010	1010	Target Altitude = 100,000 feet
11 1111 0011 - 11 1111 1111	1011 - 1023	Invalid (out of range)

2.2.3.2.7.1.3.7 "HORIZONTAL DATA AVAILABLE/SOURCE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "Horizontal Data Available/Source Indicator" subfield is a 2 bit ("ME" bits 26 and 27, Message bits 58 and 59) field used to identify if aircraft horizontal state information is available and present as well as the data source for the horizontal target data when present in the subsequent subfields ("ME" bit 28 through 39, Message bit 60 through 71) of the ATISS Message. The "Horizontal Data Available/Source Indicator" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.7. If the "Horizontal Data Available/Source Indicator" subfield is encoded with a value of ZERO (0), the target heading related data in the subsequent subfields **shall** be ignored.

Table 2.2.3.2.7.1.3.7: "Horizontal Data Available/Source Indicator" Subfield Encoding

Encoding	**Meaning**
00	No valid horizontal Target State data is available
01	Autopilot control panel selected value, such as Mode Control Panel (MCP) or Flight Control Unit (FCU)
10	Maintaining current heading or track angle (e.g., autopilot mode select)
11	FMS/RNAV System (indicates track angle specified by leg type)

2.2.3.2.7.1.3.8 "TARGET HEADING/TRACK ANGLE" Subfield in Aircraft Trajectory Intent and System Status Message

The "Target Heading/Track Angle" subfield is a 9-bit ("ME" bits 28 through 36, Message bits 60 through 68) field used to provide aircraft's intended (i.e., target or selected) heading or track. The "Target Heading/Track Angle" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.8.

Table 2.2.3.2.7.1.3.8: "Target Heading/Track Angle" Subfield Encoding

Coding (binary)	Coding (decimal)	Meaning
0 0000 0000	0	Target Heading/Track = Zero degrees
0 0000 0001	1	Target Heading/Track = 1 degrees
0 0000 0010	2	Target Heading/Track = 2 degrees
***	***	***
1 0110 0111	359	Target Heading/Track = 359 degrees
1 0110 1000 through 1 1111 1111	360 through 511	Invalid

2.2.3.2.7.1.3.9 "TARGET HEADING/TRACK INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "Target Heading/Track Indicator" subfield is a 1-bit ("ME" bit 37, Message bit 69) field used to indicate whether a heading angle or a track angle is being reported in the "Target Heading/Track Angle" subfield. The "Target Heading/Track Indicator" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.9.

Table 2.2.3.2.7.1.3.9: "Target Heading/Track Indicator" Subfield Encoding

Encoding	Meaning
0	Target Heading Angle being reported
1	Target Track Angle being reported

2.2.3.2.7.1.3.10 "HORIZONTAL MODE INDICATOR" Subfield in Aircraft Trajectory Intent and System Status Message

The "Horizontal Mode Indicator" subfield is a 2-bit ("ME" bits 38 and 39, Message bits 70 and 71) field used to indicate whether the target heading/track is being acquired (i.e., lateral transition toward the target direction is in progress) or whether the target heading/track has been acquired and is currently being maintained. The "Horizontal Mode Indicator" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.10.

Table 2.2.3.2.7.1.3.10: "Horizontal Mode Indicator" Subfield Encoding

Encoding	Meaning
00	Unknown Mode or Information Unavailable
01	"Acquiring" Mode
10	"Capturing" or "Maintaining" Mode
11	Reserved

2.2.3.2.7.1.3.11 "NAC_P" Subfield in Aircraft Trajectory Intent and System Status Message

The "NAC_P" subfield is a 4-bit ("ME" bits 40 through 43, Message bits 72 through 75) field used to indicate the Navigational Accuracy Category of the navigation information used as the basis for the aircraft reported position. The "NAC_P " subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.11.

Table 2.2.3.2.7.1.3.11: "NAC_P" Subfield Encoding

Encoding	Meaning = 95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU)
0000	EPU ≥ 18.52 km (10 NM) - Unknown accuracy
0001	EPU < 18.52 km (10 NM) - RNP-10 accuracy
0010	EPU < 7.408 km (4 NM) - RNP-4 accuracy
0011	EPU < 3.704 km (2 NM) - RNP-2 accuracy
0100	EPU < 1852 m (1NM) - RNP-1 accuracy
0101	EPU < 926 m (0.5 NM) - RNP-0.5 accuracy
0110	EPU < 555.6 m (0.3 NM) - RNP-0.3 accuracy
0111	EPU < 185.2 m (0.1 NM) - RNP-0.1 accuracy
1000	EPU < 92.6 m (0.05 NM) - e.g., GPS (with SA)
1001	EPU < 30 m and VEPU < 45 m - e.g., GPS (SA off)
1010	EPU < 10 m and VEPU < 15 m - e.g., WAAS
1011	EPU < 3 m and VEPU < 4 m - e.g., LAAS
1100-- 1111	Not Assigned

2.2.3.2.7.1.3.12 "NIC_{BARO}" Subfield in Aircraft Trajectory Intent and System Status Message

The "NIC_{BARO}" subfield is a 1-bit ("ME" bit 44, Message bit 76) field used to indicate whether or not the barometric pressure altitude being reported in the Airborne Position Message (2.2.3.2.3) has been cross-checked against another source of pressure altitude. The "NIC_{BARO} " subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.12.

Table 2.2.3.2.7.1.3.12: "NIC_{BARO}" Subfield Encoding

Encoding	Meaning
0	The barometric altitude that is being reported in the Airborne Position Message is based on a Gilham coded input (ARINC 572???TBD) that has not been cross-checked against another source of pressure altitude
1	The barometric altitude that is being reported in the Airborne Position Message is either based on a Gilham code input that has been cross-checked against another source of pressure altitude and verified as being consistent, or is based on a non-Gilham coded source

Notes:

1. *The NIC value itself is conveyed within the ADS-B Position message.*

2. *The NIC_{BARO} subfield provides a method of indicating a level of data integrity for aircraft installed with Gilham encoding barometric altitude sources (ARINC 572???TBD). Because of the potential of an undetected error when using a Gilham encoded altitude source, a comparison will be performed with a second source and only if the two sources agree will the NIC_{BARO} subfield be set to a value of "1". For other barometric altitude sources (Synchro or DADC) the integrity of the data is indicated with a validity flag or SSM. No additional checks or comparisons are necessary. For these sources the NIC_{BARO} subfield will be set to a value of "1" whenever the barometric altitude is valid.*

3. *The use of Gilham type altimeters is strongly discouraged because of the potential for undetected altitude errors.*

2.2.3.2.7.1.3.13 "SIL" Subfield in Aircraft Trajectory Intent and System Status Message

The "SIL" subfield is a 2-bit ("ME" bits 45 and 46, Message bits 77 and 78) field used to define the probability of the integrity containment radius used in the NIC subfield being exceeded, without alerting, including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used by the navigation source. The "SIL " subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.13.

Table 2.2.3.2.7.1.3.13: "SIL" Subfield Encoding

Encoding	Meaning Probability of Exceeding the Integrity Containment Radius Reported in the NIC Subfield Without Detection
00	Unknown
01	1×10^{-3} per flight hour or per operation
10	1×10^{-5} per flight hour or per operation
11	1×10^{-7} per flight hour or per operation

2.2.3.2.7.1.3.14 "CAPABILITY/MODE CODES" Subfield in Aircraft Trajectory Intent and System Status Message

The "Capability/Mode Codes" subfield is a 2-bit ("ME" bits 52 and 53, Message bits 84 and 85) field used to indicate the current operational status of TCAS/ACAS systems/functions. The "Capability/Mode Codes" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.14 as two individual 1-bit length data elements that each indicate the status of a specific system or function on the transmitting aircraft

Table 2.2.3.2.7.1.3.14: "CAPABILITY/MODE CODES" Subfield Encoding

Encoding	Meaning
ME bit 52 = 0	TCAS/ACAS operational or unknown
ME bit 52 = 1	TCAS/ACAS not operational
ME bit 53 = 0	No TCAS/ACAS Resolution Advisory active
ME bit 53 = 1	TCAS/ACAS Resolution Advisory active

2.2.3.2.7.1.3.15 "EMERGENCY/PRIORITY STATUS" Subfield in Aircraft Trajectory Intent and System Status Message

The "Emergency/Priority Status" subfield is a 3-bit ("ME" bits 54 through 56, Message bits 86 through 88) field used to provide additional information regarding aircraft status. The "Emergency/Priority Status" subfield **shall** be encoded in accordance with Table 2.2.3.2.7.1.3.15.

Table 2.2.3.2.7.1.3.15: "Emergency/Priority Status" Subfield Encoding

Encoding	Meaning
000	No emergency
001	General emergency
010	Lifeguard/medical emergency
011	Minimum fuel
100	No communications
101	Unlawful interference
110	Downed Aircraft
111	Reserved

2.2.3.2.7.1.4 Trajectory Change Information (TYPE = 29 and SUBTYPE > 0) Format

<<<Revised for this version of this working paper by correcting title and text>>>

This section is reserved for future editions of these MOPS to define Trajectory Change Information to be conveyed by the Aircraft Trajectory Intent and System Status Message (TYPE = 29) when SUBTYPE > zero (0).

PART 2

The following draft DO-260A material proposes provisions for the version number subfield in the Aircraft Operational Status Message (tentative para. 2.2.3.2.7.3.5). The intent of the proposed changes from the previous reviewed draft text on version numbers is to provide more explicit statements on the backward and forward interoperability of equipment built to different versions of the MOPS.

<<< NOTE: The proposed change is the same as proposed in WG3/WP 10-09 >>>

x.x.x Version Number Subfield in Aircraft Operational Status Message

The "Version Number" subfield is a 3-bit ("ME" bits 41 through 43, Message bits 73 through 75) field used to indicate the Version Number of the formats and protocols in use on the aircraft installation. Encoding of the Version Number subfield **shall** be as shown in Table 2-xx. Airborne ADS-B systems conformance to the initial version of the 1090 MHz ADS-B MOPS (DO-260) do not broadcast an explicit version number. Therefore, ADS-B Receiving Subsystems conformant with this version of the 1090 MHz MOPS will initially assume a Version Number of ZERO (binary 000), until received Version Number data indicates otherwise.

Future versions of these RTCA MOPS are expected to maintain backward compatibility with DO-260A. Messages originating from 1090 MHz ADS-B aircraft reporting a MOPS Version Number value that is indicated in Table A-21 as "reserved" are to be considered valid. However, all message types and all subfields within messages that are currently "unassigned" or are indicated as being "reserved" by these MOPS shall be ignored and not used for ADS-B Report Generation.

Table 2-xx: "VERSION NUMBER" Subfield Encoding

Encoding	Meaning
000	Reserved for implementation conformance to DO-260
001	Version Number to be reported for implementations conformant to RTCA DO-260A
010 though 111	Reserved (for implementations conformant to future version of the 1090 MHz ADS-B MOPS).

PART 3

Update to Appendix A, Figure A-9

Proposed Change: Add Emergency/Priority Status Coding for value 6 = Downed Aircraft

Reason: To align with change in DO-242A

<<< NOTE: The proposal has not changed from WG3/WP 10-09 >>>

2.2.3.3.1.4 ADS-B Event-Driven Message Broadcast Rates

2.2.3.3.1.4.1 ADS-B Aircraft Trajectory Intent and System Status Message Broadcast Rates

a. The Aircraft Trajectory Intent and System Status Message(s) (message TYPE = 29, Section 2.2.3.2.7.1) shall be initiated only when the aircraft is airborne and when vertical and/or horizontal trajectory intent information is available and valid as a minimum.

a. The Aircraft Trajectory Intent and System Status Message with a SUBTYPE value of zero (0) shall, for the nominal case, be broadcast at random intervals that are uniformly distributed over the range of 1.2 to 1.3 seconds relative to the previous Aircraft Trajectory Intent Message and System for as long as data is available to satisfy the requirements of subparagraph "a." above.

b. The broadcast rates for Aircraft Trajectory Intent and System Status Messages with a SUBTYPE subfield value of other than zero (0) are not defined by this version of these MOPS.

Note 1: Future versions of these MOPS may require unique broadcast update intervals for each Aircraft Trajectory Intent and System Status Message SUBTYPE (i.e., unique for each value of the SUBTYPE subfield).

Note 2: Future versions of these MOPS may require that the broadcast rate for Aircraft Trajectory Intent and System Status Messages be temporarily increased (e.g., for 24 seconds) following any change in intent or status information.

2.2.3.3.1.4.2 ADS-B Aircraft Operational Status Message Broadcast Rates

The rate at which the Aircraft Operational Status Messages (message TYPE = 31 and SUBTYPE = zero (0), Section 2.2.3.2.7.3) shall be broadcast varies depending on the following conditions:

Condition 1: Aircraft Trajectory Intent and System Status message (2.2.3.2.7.1) for Target State and System Information (i.e., TYPE = 29 and SUBTYPE = 0) is not being broadcast versus being broadcast.

Condition 2: There has been a change within the past 24 seconds in the value of one or more of the following parameters included in the Operational Status Message

a. TCAS/ACAS Operational

b. ACAS/TCAS resolution advisory active

c. NAC_p

d. SIL

a. For the two cases where:

i. the Aircraft Trajectory Intent and System Status message (2.2.3.2.7.1) with SUBTYPE = zero (0) is not being broadcast and Condition 2 above is not applicable (nominal condition); or

ii. the Aircraft Trajectory Intent and System Status message with SUBTYPE = zero (0) is being broadcast regardless of the applicability of Condition 2 above;

The Aircraft Operational Status message shall be broadcast at random intervals uniformly distributed over the range of 2.4 to 2.6 seconds.

b. For the case where the Aircraft Trajectory Intent and System Status message (2.2.3.2.7.1) with SUBTYPE = zero (0) is not being broadcast and Condition 2 above is applicable, the Aircraft Operational Status message broadcast rate shall be increased for a period of 24 seconds (+/- 1 second) such that the broadcasts occur at random intervals that are uniformly distributed over the range of 0.75 to 0.85 seconds.

2.2.3.3.1.4.3 "Extended Squitter Aircraft Status" ADS-B Event - Driven Message Broadcast Rate

The rate at which the "Extended Squitter Aircraft Status" (TYPE = 28), "Emergency/Priority Status" ADS-B Event - Driven Message (SUBTYPE = 1) shall be broadcast varies depending on whether the "Aircraft Trajectory Intent and System Status Message" (2.2.3.2.7.1) with SUBTYPE = zero (0) is not being broadcast versus being broadcast.

a. In the case where the "Aircraft Trajectory Intent and System Status Message" with SUBTYPE = zero (0) is not being broadcast the "Emergency/Priority Status" shall be broadcast at random intervals that are uniformly distributed over the range of 0.75 to 0.85 seconds relative to the previous Emergency/Priority Status Message for the duration of the emergency condition established in accordance with Appendix A, Figure A-9, Note 2.

b. In the case where the "Aircraft Trajectory Intent and System Status Message" with SUBTYPE = zero (0) is being broadcast the "Emergency/Priority Status" shall be broadcast at random intervals that are uniformly distributed over the range of 2.4 to 2.6 seconds relative to the previous Emergency/Priority Status Message for the duration of the emergency condition established in accordance with Appendix A, Figure A-9, Note 2.

2.2.3.3.1.4.4 "TYPE 23 (TEST)" ADS-B Event - Driven Message Broadcast Rate

The "TEST" ADS-B Event - Driven Messages shall be broadcast NOT MORE THAN ONCE each time the Event Driven Test Information is updated to the transponder

2.2.3.3.1.4.5 "TYPE 24 - 27" ADS-B Event - Driven Message Broadcast Rate

In general, TYPE 24 - 27 ADS-B Event - Driven Messages shall be broadcast ONCE each time the Event-Driven TYPE 24 - 27 information is updated to the transponder.

2.2.3.3.1.4.6 ADS-B Message Transmission Scheduling <<<Revised for this version of this working paper to allow simplified message scheduling for systems that don't support broadcast of intent information >>>

An ADS-B Message scheduling function shall be used to determine the sequence of ADS-B Messages to be broadcast and to control the overall transmission rate of event-driven messages. ADS-B systems that are not capable of supporting the broadcast of Aircraft Trajectory Intent and System Status Messages (§2.2.3.2.7.1) shall be permitted to use a simplified scheduling function for Event-Driven messages (i.e., the subset of the defined Event-Driven Message Scheduling function that is applicable to the specific messages types that are supported) in lieu of the full scheduling function described in §2.2.3.3.1.4.6.1.

2.2.3.3.1.4.6.1 Event-Driven Message Scheduling Function **<<<Revised by adding the following note for this version of this working paper>>>**

Note: This version of these MOPS do not define the message format for the broadcast of trajectory change information (paragraph 2.2.3.2.7.1.4). However it is anticipated that future versions of these MOPS will require the broadcast of trajectory change information for all Class A2 and Class A3 airborne systems and will be optional for Class A1 airborne systems. The following requirements for the Event-driven Message Scheduling Function include provisions to accommodate the future addition of messages conveying trajectory change information (i.e., message TYPE = 29 and SUBTYPE = 0).

The Event-driven Message Scheduling Function shall ensure that the total Event-Driven message rate does not exceed 2 transmitted messages per second. This is consistent with the required overall maximum allowed transmission rate specified in section 2.2.3.3.1.3.

The Event-Driven Message Scheduling Function shall apply the following rules as a means of prioritizing the Event-Driven message transmissions and limited the transmission rates:

a. The Event-Driven message scheduling function shall reorder, as necessary, pending Event-Driven messages according to the following message priorities, listed below in descending order from highest to lowest priority:

   i. When an Extended Squitter Status Message (2.2.3.2.7.9) is active for the broadcast of an Emergency/Priority Condition (message TYPE = 28 and SUBTYPE = 1), it shall continue to be transmitted at the rate specified in Section 2.2.3.3.1.4.3 for the duration of the emergency/priority condition.

   ii. Reserved for future use.

      Note: This priority level may be used in a future version of these MOPS for the case when an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of trajectory change information (message TYPE = 29 and SUBTYPE = 0) and there has been a change in one or more of the message parameters that results in a higher update rate reporting requirement.

   iii. Reserved for future use.

      Note: This priority may be used in a future version of these MOPS for the case when an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of trajectory change information (message TYPE = 29 and SUBTYPE > 0) and there has been a change in one or more of the message parameters that results in a higher update rate reporting requirement.

   iv. When an Aircraft Operational Status Message (2.2.3.2.7.3) is active (message TYPE = 31 and SUBTYPE = 0) and there has been a change in one or more of the message parameters within the past 24 seconds that results in a higher update rate reporting requirement, the Aircraft Operational Status Message shall be transmitted at the nominal rate specified in section 2.2.3.3.1.4.2.

   v. When an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of trajectory state information (message TYPE = 29 and SUBTYPE = 0) the Aircraft Trajectory Intent and System Status message shall be transmitted at the nominal rate specified in section 2.2.3.3.1.4.1.

vi. Reserved for future use.

Note: This priority level may be used in a future version of these MOPS for the case when an Aircraft Trajectory Intent and System Status Message (2.2.3.2.7.1) is active for the broadcast of trajectory change information (message TYPE = 29 and SUBTYPE > 0) at a nominal rate.

vii. When an Aircraft Operational Status Message (2.2.3.2.7.3) is active (message TYPE = 31 and SUBTYPE = 0) and is being broadcast at a nominal rate, the Aircraft Operational Status Message shall be transmitted at the rate specified in section 2.2.3.3.1.4.2.

viii. This priority level applies as a default to any event-driven message TYPE and SUBTYPE combination not specifically identified at a higher priority level above. Event-Driven messages of this default priority level shall be delivered to the transponder on a first-in-first-out basis at equal priority.

b. The Event-Driven message scheduling function shall limit the number of Event-Driven messages provided to the transponder to two (2) messages per second.

Note: It is possible that future versions of these MOPS, and requiring a complementary change to the Mode S transponder MOPS, will allow for Event-Driver messages to be transmitted at a rate of greater than the current limit of two (2) messages per second. Therefore, a means should be provided to allow for a future adjustment to the value used for the message rate limit in the Event-Driven Message scheduling function.

c. If (b) results in a queue of messages awaiting delivery to the transponder, the higher priority pending messages, according the (a) above shall be delivered to the transponder for transmission before lower priority messages.

d. If (b) results in a queue of messages awaiting delivery to the transponder, new Event-Driven messages shall directly replace older messages of the same exact Type and Subtype (where a Subtype is defined) that are already in the pending message queue. The updated message shall maintain the same position in the message queue as the pending message that is being replaced.

e. If (b) above results in a queue of messages awaiting delivery to the transponder, then pending message(s), shall be deleted from the message transmission queue if not delivered to the transponder for transmission, or not replaced with a newer message of the same message Type and Subtype, within the Message Lifetime value specified in the Table 2.2.3.3.1.4.6.1 below:

Table 2.2.3.3.1.4.6.1: Event-Drive Message Lifetime

Message TYPE	Message SUBTYPE	Message Lifetime (seconds)
23		reserved (see note)
24		reserved (see note)
25		reserved (see note)
26		reserved (see note)
27		reserved (see note)
28	=1 0, >1	5.0 seconds (+/- 0.2 sec.) reserved (see note)
29		reserved (see note)
30	=0 >0	2.5 seconds (+/- 0.2 sec.) reserved (see note)
31	=0 >0	5.0 seconds (+/- 0.2 sec.) reserved (see note)

Note: A default message lifetime of 20 seconds shall be used for queue management unless otherwise specified

2.2.3.3.2 Transmission Rates for Stand - Alone Transmitters

a. Transmitters for Class A0 and Class B equipment may be implemented independent of a Mode S transponder. Such transmitters shall meet the transmission rate requirements of section 2.2.3.3.1.3 and the message update rate requirements specified in the following subparagraphs.

b. Extended squitter messages shall be transmitted at random intervals that are uniformly distributed over the specified time interval using a time quantization no greater than 15 milliseconds.

Note: *The possible transmission time epochs should not be correlated with UTC to preclude inadvertent synchronization of transmissions from different aircraft.*

2.2.3.3.2.1 Power-On Initialization and Start Up

2.2.3.3.2.1.1 Power-On Initialization

a. At power-up initialization, the ADS-B transmission device shall start operations in a mode in which it transmits **NO** messages.

b. Given that appropriate message data is provided to the ADS-B transmission device, the transmission device shall be capable of transmitting ADS-B messages no later than 2.0 seconds after Power-On.

c. After a power-up initialization exceeding the momentary power interruption capability of the equipment, the total set of BITE tests that check all necessary functions of the ADS-B device shall be completed within 20 seconds. As a

minimum, the BITE tests shall include RAM, ROM, I/O, Timing, CPU instruction integrity, and any associated RF hardware tests necessary to ensure proper functioning of the ADS-B device.

2.2.3.3.2.1.2 Start Up

a. The ADS-B transmission device shall initiate broadcast transmissions of the Airborne Position, Surface Position, Aircraft Identification and Type, Velocity, and/or Event-Driven messages only once it has received appropriate data to structure at least one variable data field of the respective message. As such, each message shall be initiated individually and independently of the other messages.

   The single exception is presented by Altitude data in the Airborne Position message which shall be processed as follows:

   The ADS-B transmission device shall not initiate broadcast of the Airborne Position message until horizontal position data has been received. That is, that altitude data alone shall not be sufficient to initiate broadcast of the Airborne Position Message.

b. Once ADS-B message transmission has been initiated the transmission rate of each type of ADS-B message shall be as provided in the following paragraphs.

2.2.3.3.2.2 ADS-B Airborne Position Message Broadcast Rate

Once started, ADS-B Airborne Position Messages shall be broadcast by the transmission device when in the Airborne state at random intervals that are uniformly distributed over the range of 0.4 to 0.6 seconds relative to the previous Airborne Position Message, with the exceptions as specified in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.3 ADS-B Surface Position Message Broadcast Rate

a. Once started, ADS-B Surface Position Messages shall be broadcast by the transmission device when in the On-Ground state using either the "High" or "Low" rate which has been selected as follows:

   (1). Switching from "High" rate to "Low" Rate:

      (a). The broadcast rate shall be changed from "High" to "Low" when the navigation source position data has not changed more than 10 meters in a 30 second sampling interval.

         Note: *It is acceptable to compute the 10 meter distance using either rectangular or polar coordinates.*

      (b). Upon selecting the "Low" rate, the transmission device shall save the Position data at the time that the "Low" rate was selected.

   (2). Switching from "Low" rate to "High" Rate:

      The broadcast rate shall be changed from "Low" to "High" when the position of the transmission device has changed by 10 meters or more since the "Low" rate was selected.

      Note: *It is acceptable to compute the 10 meter distance using either rectangular or polar coordinates.*

b. If the "High" rate is selected, then the Surface Position Message shall be transmitted at random intervals that are uniformly distributed over the range of 0.4 to 0.6 seconds relative to the previous Surface Position Message.

c. If the "Low" rate is selected, then the Surface Position Messages shall be transmitted at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds relative to the previous Surface Position Message.

Note: *Pending further study and analysis of surface broadcast rates and their triggering mechanisms by regulatory authorities, it is widely assumed that the "Low" rate will be raised to a nominal rate approaching once per second.*

d. In the event that the transmission device cannot determine the required transmission rate, then the "High" rate shall be used as the default transmission rate.

e. Exceptions to these transmission rate requirements are defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.4 ADS-B Aircraft Identification and Type Message Broadcast Rate

a. Once started, ADS-B Aircraft Identification and Type Messages shall be broadcast by the transmission device at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds relative to the previous Identification and Type Message, when the ADS-B transmitting device is reporting the Airborne Position Message, or when reporting the Surface Position Message at the high rate.

b. When the Surface Position Message is being reported at the low surface rate, then the Aircraft Identification and Type Message shall be broadcast at random intervals that are uniformly distributed over the range of 9.8 to 10.2 seconds relative to the previous Identification and Type Message.

c. When neither the Airborne Position Message nor the Surface Position Message is being transmitted, then the Aircraft Identification and Type Message shall be broadcast at the rate specified in subparagraph a.

d. Exceptions to these transmission rate requirements shall be as defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.5 ADS-B Velocity Information Message Broadcast Rate

a. Once started, ADS-B Velocity Information Messages shall be broadcast by the transmission device at random intervals that are uniformly distributed over the range of 0.4 to 0.6 seconds relative to the previous Velocity Information Message.

b. Exceptions to these transmission rate requirements shall be as defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.6 ADS-B Trajectory Intent and Status Message Broadcast Rates

2.2.3.3.2.6.1 ADS-B Aircraft Trajectory Intent and System Status Message Broadcast Rates

a. The requirements of Section 2.2.3.3.1.4.1 are applicable.

c. The Aircraft Trajectory Intent and System Message (TYPE = 29, SUBTYPE = 0, Section 2.2.3.2.7.1) shall be broadcast at random intervals that are uniformly distributed over the range of 1.2 to 1.3 seconds relative to the previous Aircraft

Trajectory Intent and System Status Message for as long as data is available to satisfy the requirements of subparagraph "a." above.

b. Exceptions to these transmission rate requirements shall be as defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.6.2 ADS-B Aircraft Operational Status Message Broadcast Rates

a. The rate at which the Aircraft Operational Status Messages (message TYPE = 31 and SUBTYPE = 0, Section 2.2.3.2.7.3) shall be broadcast varies as defined in Section 2.2.3.3.1.4.2.

b. Exceptions to these transmission rate requirements shall be as defined in subparagraph 2.2.3.3.2.9.

2.2.3.3.2.6.3 "Extended Squitter Aircraft Status" ADS-B Event - Driven Message Broadcast Rate

a. The rate at which the "Extended Squitter Aircraft Status" (Type = 28), "Emergency/Priority Status" ADS-B Event-Driven Message (SUBTYPE = 1) shall be broadcast varies as defined in Section 2.2.3.3.1.4.3.

b. The exceptional conditions specified in 2.2.3.3.2.9 shall be observed.

2.2.3.3.2.7 "TYPE 23 (TEST)" ADS-B Event - Driven Message Broadcast Rate

The "TEST" ADS-B Event - Driven Messages shall be broadcast ***NOT MORE THAN*** ONCE each time the Event Driven Test Information is updated to the ADS-B transmission device. The delay conditions specified in 2.2.3.3.2.9 shall be observed.

2.2.3.3.2.8 "TYPE 24 - 27" ADS-B Event - Driven Message Broadcast Rate

In general, TYPE 24 - 27 ADS-B Event - Driven Messages shall be broadcast ONCE each time the Event Driven TYPE 24 - 27 Information is updated to the ADS-B transmission device. The delay conditions specified in 2.2.3.3.2.9 shall be observed.

2.2.3.3.2.9 ADS-B Message Transmission Scheduling

An ADS-B message scheduling function shall be used to determine the sequence of ADS-B messages to be broadcast and to control the overall transmission rate of event-driven messages.

As an exception to the general requirement for the transmission of ADS-B messages, the scheduled message transmission shall be delayed if a Mutual Suppression interface is active.

2.2.3.3.2.9.1 Position, Velocity and Identification Message Scheduling

The priority for transmission (from highest to lowest) for the message types that are not event-driven shall be:

a. Position Message (either Airborne Position Message, as defined in Section 2.2.3.2.3, or Surface Position Message, as defined in 2.2.3.2.4)

b. Airborne Velocity Message (2.2.3.2.6.3)

c. Aircraft Identification and Type Message (2.2.3.2.5)

2.2.3.3.2.9.2 Event-Driven Message Scheduling **<<Revised for this version of this working paper by correcting typo in note and expanding para. b text>>**

An Event-Driven Message Scheduling function shall:

a. Ensure that the total Event-Driven message rate does not exceed 2 transmitted messages per second. This is consistent with the required overall maximum allowed transmission rate specified in section 2.2.3.3.2.10.

Note: It is possible that future versions of these MOPS may allow for Event-Driven messages to be transmitted at a rate of greater than the current limit of two (2) messages per second. Therefore a means should be provided to allow for a future adjustment to the value used for the message rate limit in the Event-Driven Message scheduling function.

b. The Event-Driven message scheduling requirements of paragraph 2.2.3.3.1.4.6 shall be used as the means of ensuring the Event-Driven message broadcast limit of 2 messages per second is not exceeded.

2.2.3.3.2.10 Maximum ADS-B Message Transmission Rates

The maximum ADS-B message transmission rate of non-transponder ADS-B transmitter implementations shall not exceed 6.2 transmitted messages per second.

Note: It is possible that future versions of these MOPS may allow for ADS-B messages to be transmitted at a rate of greater than the current limit of 6.2 messages per second. Therefore a means should be provided to allow for a future adjustment to the value used for the message rate limit in the message scheduling function.