PRELIMINARY DRAFT

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ADS-B UAT MOPS

Meeting #2

Proposed Contents and Transmission Rates for ADS-B Messages

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SUMMARY
This paper proposes that the UAT MOPS address two types of ADS-B message payloads. One is the *MOPS-defined* payload. These payloads alone support all documented information requirements defined in RTCA DO-242 as well as those requested by Eurocontrol. The other type of payload is generated and defined external to the UAT MOPS—at least initially. These *externally generated* payloads are transmitted once by the UAT system "on condition" each time they are provided by the external source. These externally generated payloads could support future applications as they become better defined or they could support special user needs.

1. Approach for ADS-B Message Definition in UAT MOPS

This paper proposes that the UAT MOPS address two types of ADS-B message payloads. One is the *MOPS-defined* payload. These payloads alone support all documented information requirements defined in RTCA DO-242 as well as those requested by Eurocontrol. The other type of payload is generated and defined external to the UAT MOPS—at least initially. These *externally generated* payloads are transmitted once by the UAT system "on condition" each time they are provided by the external source. These externally generated payloads could support future applications as they become better defined or they could support special user needs.

ADS-B messages for transmission over the UAT RF interface may take on one of two forms:

a) A "Basic" length message containing only the State Vector (SV) payload of 17 bytes
b) An "Extended" length message containing the SV plus a Supplemental payload of 16 bytes.

There are three MOPS-defined payloads. They are the SV payload, the Supplemental Type 0 payload and the Supplemental Type 1 payload. All other payloads are generated and defined external to the MOPS and supplied to the UAT transmitter interface. Up to 13 separate externally supplied payload types can be supported. It is assumed that definition of these external payloads would be accomplished by later appendix to this MOPS or through a separate document. The objective of this approach is to allow MOPS development to proceed with message elements that are most mature while providing a framework for supporting future and/or special purpose applications.

2. SV Payload Contents

Table 1 shows the contents of the SV payload. Changes of content relative to that currently used in Capstone are noted.

Message Field		Length (bits)	Comments	Departure From Capstone
Payload Type Code		4	Gives flexibility for future payload definitions.	Moved from front of supplemental payload to front of message.
Address Qualifier	Service Type	2	00 = ADS-B Direct 01 = ADS-B rebroadcast 10 = TIS-B 11 = Spare	New[1]
	Target Type	1	0 = Aircraft 1 = Non aircraft (further breakdown possible via address blocks—no need for global uniqueness)	New[2]
	Address Type	1	0 = Permanent Airframe assigned 1 = Temporary self assigned (ADS-B) or track number (TIS-B)	Basically replaces the Extension bit
Address		24		No change
Pos Valid		1	These fields become a 4 bit Sensor/Tracker ID when "Service Type" = TIS-B[3]	No change
Time Valid		1		No change
Turn Indicator		2		New per DO-242
A/G State		2	00 = 0.5 kt velocity resolution, airborne/on-ground UNKNOWN 01 = 0.25 kt vel res, KNOWN to be on ground 10 = 1.0 kt vel res, KNOWN to be airborne with spd <1023 kts 11 = 4.0 kt vel res, KNOWN to be airborne with spd > 1023 kts	No change
Lat		23	Encoded in units of 2^{-23} "circles" in a signed fractional binary form (LSB = ~2.5 m)	Reduced by 1 bit to 23 bits
Lon		24	Encoded in units of 2^{-24} "circles" in a signed fractional binary form (LSB = ~2.5 m at equator)	No change
N/S Velocity		11	These fields take on a different polar encoding for targets "known to be on ground"[4]	No change
E/W Velocity		11		
Alt (Baro)		12	25 ft resolution	No change
Alt Rate		10	64 fpm LSB, 32000 fpm max	No change
NIC/NAC/NUC		7	Encoding TBD	Same bit allocation
		136	**SV payload expands by one byte**	

Table 1. Contents for the State Vector (SV) Payload

[1] Addition of this field allows a more general applicability of the message format to the various modes in which target info could be conveyed. This format is also used for TIS-B uplinks. No special TIS-B format is needed

[2] Same as above. This field allows surface vehicle targets to be distinguished on receipt of the SV alone

[3] This is a change from current Capstone in that the Sensor/Tracker ID is included in the 24 bit address field. The problem with this is that it does not allow TIS-B to convey a permanent Mode S address on a Mode S surveilled radar target. This is now supported

[4] This polar format allows for a heading input if available (Track/Heading -10 bits; Track/Heading Type – 1 bit; Speed 10 bits; Spare – 1 bit)

3. Supplemental Type 0 Payload Contents

Table 2 shows the contents of the Type 0 Supplemental payload. Changes of content relative to that currently used in Capstone are noted.

Message Field	Length (bits)	Comments	Departure From Capstone
Call Sign Category	48	Both fields "radix 40" encoded into one 48 bit field	No change
Emrg/Priority Status	3		No change
MSO	6	Six LSBs of the 12 bit MSO representation. Allows receiver to make independent integrity check on ADS-B message	Reduced from 12 to 6 bits.
Alt (Geo)	12	Supports independent integrity check on baro	Now absolute vs relative from baro. Simplifies and makes independent of baro
Alt Rate (Geo)	10	Supports independent integrity check on baro	Now absolute vs relative from baro. Simplifies and makes independent of baro.
App Class Code	12	Encoding TBD	Not used in Capstone
Airspeed	11	Scaled per A/G State setting	New per Eurocontrol
Airspeed Type	1	IAS/TAS	New per Eurocontrol
Mag Hdg	10		New per Eurocontrol
Mag Hdg Valid	1		New per Eurocontrol
Selected Alt	10	LSB=100 feet	New per Eurocontrol
Spare[5]	4		
Total	**128**		

Table 2. Contents for the Supplemental Type 0 Payload

[5] Capstone ATC experience may result in the need to support a function equivalent to the transponder IDENT

4. Supplemental Type 1 Payload Contents

Table 3 shows the contents of the Type 1 Supplemental payload. Changes of content relative to that currently used in Capstone are noted.

Message Field	Length (bits)	Comments	Departure From Capstone
TCP#	4	Supports TCP expandability	Not used in Capstone
TCP or TCP+n Latitude	18	Binary encoded per SV. LSB = ~80 meters	Not used in Capstone
TCP or TCP+n Longitude	19	Binary encoded per SV. LSB = ~80 meters	Not used in Capstone
TCP or TCP+n Altitude	10	Encoded per SV. LSB = 100 feet	Not used in Capstone
TCP or TCP+n Time to Go	8	LSB = 5 seconds; Max = ~20 mins	Not used in Capstone
TCP#	4	Supports TCP expandability	Not used in Capstone
TCP or TCP+n Latitude	18	Binary encoded per SV. LSB = ~80 meters	Not used in Capstone
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TCP or TCP+n Altitude	10	Encoded per SV. LSB = 100 feet	Not used in Capstone
TCP or TCP+n Time to Go	8	LSB = 5 seconds; Max = ~20 mins	Not used in Capstone
Spare	10		
Total	**128**		

Table 3. Contents for the Supplemental Type 1 Payload

5. Message Generation and Transmission

Table 3 shows the complete set of ADS-B message types and how the externally supplied payloads influence the ultimate message transmission schedule. The bolded items are the payloads generated and defined within the functional boundary of the UAT MOPS. Message scheduling for transmission is based on a 4 second epoch. This is a change from Capstone which used a 5 second epoch. The 4 second epoch improves the long range performance of the system in simulations for high density future environments.

Message Type	Payload Type Code	Message Length	Contents	Transmission Rate per Epoch: All Class B (non-aircraft transmitters)	Transmission Rate per Epoch: Standard Info Bdcst for All Class A0, A1	Transmission Rate per Epoch: Standard info Bdcst for Class A2, A3	Future Applications
Basic	**1111**	**Short**	**SV *only***	**4**	**3**	**1**	Rules for future applications: 1. Exactly four messages per epoch shall be transmitted (one per second) 2. External system is responsible for updating all externally supplied payloads to UAT system as needed each epoch. Duplicate payloads required if transmission needed more than once per epoch 3. Lack of externally supplied payloads will cause UAT transmissions to default to Standard for the equipage Class (at left)
Extended Type 0	**0000**	**Long**	**SV *plus* Supplemental Type 0 payload**		**1**	**1**	
Extended Type 1	**0001**	**Long**	**SV *plus* Supplemental Type 1 payload**			**2**	
Extended Type 2	0010	Long	SV plus Supplemental externally supplied payload (128 bits) provided "on condition" each epoch				
Extended Type 3	0011	Long					
Extended Type 4	0100	Long					
Extended Type 5	0101	Long					
Extended Type 6	0110	Long					
Extended Type 7	0111	Long					
Extended Type 8	1000	Long					
Extended Type 9	1001	Long					
Extended Type 10	1010	Long					
Extended Type 11	1011	Long					
Extended Type 12	1100	Long					
Extended Type 13	1101	Long					
Extended Type 14	1110	Long					

Table 4. UAT Message Types, Component Payloads and Transmission Rates for ADS-B

6. Recommendation

It is recommended that the development of Section 2.2 of the draft MOPS proceed on the basis of the ADS-B message types, component payloads, and transmission rates described in this paper.