RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #5

Draft 3 of Section 4 of the UAT MOPS

Presented by Greg Kuehl, UPS Airlines

SUMMARY
This is the 3rd Draft of the proposed Section 4 of the UAT MOPS with added text in blue font.

I am unable to attend the June meeting due to cost cutting initiatives. (I plan to attend the July meeting at the FAA Tech. Center.) But I have attached a revised Section 4 draft.

Changes are in blue and I have considered/incorporated inputs received from Chris Moody and Tom Teetor as follows:

I have removed references to a reduced transmission rate on the surface. Whether that is a separate operating mode or not, I think, is left up to the manufacturer. This might need some more discussion and rewording. Maybe a sensitivity or power reductions appropriate for the AT. The 1090 system cannot reduce power on the ground in order to compete with over flying squitters. UAT should not have this problem since it has a defined transmission slot, or does the same principle apply?

I have added the Uplink Message to the types of communications.

I don't know if the UAT "must" accept filter controls from the applications. The 1090 folks felt that it could be helpful in high density environments where message volume might begin to impact intra-system throughput. I think we allow it but don't require it!

I have not included a requirement for a 12 hour battery for the ELT function. I think this is outside the scope of the MOPS, as that would be an optional feature and needs considerable FAA policy work.

I have not specified a speed to indicate the surface mode. This will vary with the individual systems. I think the wording to allow use of state vector elements for determination is sufficient.

What does the Working Group think about separate transmit and receive controls? Are they required? In my opinion, they're nice to have. I would leave it up to the manufacturer to add as a feature. I have included the requirement to turn off transmissions for non-UAT license areas.

I believe the barometric altitude control is a requirement. Sources have been unreliable in the past. I think it is better to continue to transmit position only, than to go silent. We can't continue to transmit known erroneous data. I think the message formats allow for the transmission of geometric altitude if barometric fails, and actually require geometric for certain NUCS. (Am I mixing UAT and 1090 here?)

As always, comments and corrections are requested. See you all in Atlantic City.

1 PURPOSE AND SCOPE

2 EQUIPMENT PERFORMANCE REQUIREMENTS AND TEST PROCEDURES

3 INSTALLED EQUIPMENT PERFORMANCE

4 EQUIPMENT OPERATIONAL PERFORMANCE CHARACTERISTICS

4.1 Required Operational Performance Characteristics

The operation of the UAT ADS-B system should be highly automated, to minimize the need for crew intervention. To ensure operations can be conducted safely and reliably in the expected operational environment, specific operational performance characteristics are required. The following paragraphs identify these requirements.

4.1.1 Power Input and Control

The system should be powered whenever primary electrical power is available. Components may receive power from multiple sources or busses (e.g. 115 vac and 28 vdc). Typically, power is controlled by circuit breakers and is only interrupted due to an electrical fault. The equipment shall retain memory of variable data through power transfers, occurring during normal operations. Typical power transfer involves switching to engine driven generator(s) from external power, battery, or APU generator. The equipment shall not require re-initialization after a power transfer (i.e. power loss) lasting up to 0.3 second. Normal power transfer shall not latch a failure indication. Momentary failure indications during power transfer or a resulting system recovery are allowed.

4.1.1.1 Power On/Off (Optional)

Aircraft with limited electrical system capacity may employ system power controls for energy conservation. Power controls should be designed to prevent systems being turned off inadvertently.

4.1.2 Equipment Operating Modes

The equipment has two basic operating modes, broadcast transmission of own ship information and reception of data from other participants. Both transmission and reception modes are normally active at the same time. Both transmission and reception modes may employ sub-modes, tailored to specific phases of operation. Operating modes control variable ~~link~~ characteristics such as message types to be transmitted and message repetition ~~transmission rates~~.

4.1.2.1 Transmission Modes

The system shall have at least two (2) transmitting modes corresponding to surface operations and air operations. Switching between surface and air modes shall be accomplished automatically. Automatic mode selection may be determined by reference to State Vector (SV) data elements (e.g. speed, radio altitude) or discrete inputs (e.g. weight-on-wheels switch).

It should be possible to force the system to either mode, while on the ground, for testing. Control of Surface and Air mode switching shall not be available to the flight crew during normal operation.

4.1.2.1.1 Surface Mode

The surface mode is used on the ground but might be extended to include low altitudes during take-off or approach phases. In the Surface mode, the system transmits State Vector messages and partial Mode Status (Flight Identification) ~~at reduced rates~~. ~~(Receiver sensitivity might be reduced in the surface mode.)~~

When operating on the ground, Ground Track Angle may be replaced with Magnetic Heading, if available.

NOTE: Switching to the Surface transmission mode, while in flight, shall not cause the Air/Ground data to indicate that the airplane is on the ground.

4.1.2.1.2 Air Mode

In the Air mode, the system transmits all message types, appropriate to the equipment class~~, at the designated rates and power output level~~.

4.1.2.1.3 Transmission Mode; Automatic Operation

The system transmits the required messages for the equipment class, without crew intervention. Own ship ADS-B position and velocity messages are formatted and transmitted without crewmember inputs or adjustments such as mode selection or channel tuning.

An exception is the Participant Address (ICAO 24-bit address). In most installations, the address does not change and is "hard-wired" at installation. The address may be entered by the crew, or internally generated by the system where anonymous operation is permitted by regulatory authorities.

Certain messages related to Mode Status (MS) information and On-Condition reports may be triggered by crew actions satisfying the conditions for the automatic generation of an associated message.

Crew member input of Mode Status (MS) information, where practical, (e.g. flight number) is acceptable. The capability to acquire all message elements automatically is desirable. Automatic acquisition of data reduces crew workload and avoids data entry errors. Supplemental information may be entered via associated equipment.

4.1.2.2 Receive Mode

The ADS-B system receive mode performs two (2) tasks. A radio frequency receiver detects incoming ADS-B messages (i.e. ADS-B surveillance messages and Information Uplink messages) and decodes the message data. A report generator collects and organizes the individual messages into reports and provides the reports to user applications via data bus(s). The most likely application is a Cockpit Display of Traffic Information (CDTI).

4.1.2.2.1 Receiver

Receiver operation does not vary between surface and air modes of operation. The UAT receiver continues to detect and decode any and all recognizable ADS-B messages and pass them to the report generator function. The report generator may apply filtering criteria to exclude data that is not required by an application.

~~When operating on the surface, receiver sensitivity may be reduced. A sensitivity reduction would limit receptions from distant participants, not of interest while operating on the surface.~~

4.1.2.2.2 Report Generator

The report generator may accept control inputs from applications. The report controls allow the report generator to filter out messages that are not important to the application(s). Filtering allows for more efficient use of available computing resources. Filtered messages are supplied to an application only if specific control conditions are met. Controls might specify certain message types, or require data values to be within a given range, for a message to be included in a report (e.g. Altitude ≤ 5,000 ft.). In the Surface Mode, the report generator might include ground traffic in the traffic file sent to the CDTI. Ground traffic would likely be omitted from the CDTI while airborne, to reduce clutter.

4.1.3 UAT Link Control (Optional)

A means may be provided for the flight crew to disable the UAT ADS-B link. Disabling results in the cessation of transmission and/or reception of ADS-B messages on the UAT link. Control of transmission and reception of any other installed ADS-B system(s) shall be independent of the UAT link status.

NOTE: Until a common, world-wide radio channel is assigned to UAT transmissions, it may be necessary to inhibit transmissions or select a different channel in certain geographical areas

4.1.4 Standby

A means shall be provided for the flight crew to select a standby mode in which UAT transmissions are inhibited. (Reception of messages and report generation may continue.)

4.1.5 Mode Status Message Control

The transmit function shall accept appropriate data for on-condition or event driven message transmissions, as appropriate to the equipment capability classification. At the manufacturer's option, a means may be provided for the flight crew to enter this data. (e.g. Minimum fuel, No Communications, Unlawful Interference, etc.)

4.1.6 Barometric Altitude

A means shall be provided for the flight crew to inhibit the broadcast of barometric altitude, if directed to do so by ATC, or if barometric altitude being reported is determined to be inaccurate

4.1.7 Broadcast Monitor

The system shall include an automatic monitor to verify that the UAT transmits messages at a nominal rate. The transmitter is considered to have failed if transmissions are not detected in five (5) consecutive frames.

4.1.8 Address Monitor

A Participant Address monitor shall be provided. In the event that the transmitted Participant Address (ICAO 24 bits) is all zeros or all ones, the system shall declare a failure.

4.1.9 Failure Indication

The detection of a failure shall be annunciated to the flight crew. System output(s) shall be provided to indicate the validity/non-validity of the ADS-B system. Momentary power interruptions should not cause the output(s) to latch in the invalid state. If normal operation is subsequently resumed, the failure indication may assume the valid state. At a minimum, failure to transmit state vector (SV) messages at a nominal rate, a failure detected by self-test, or a failure of the ICAO Participant Address verification, shall cause the Failure Indication output(s) to assume the invalid state.

NOTE: It is desirable to continue operating the system in the presence of partial system failures (e.g. Continue to receive messages and display traffic even though the transmitter has failed.) System architects are encouraged to provide partitioning, monitoring, and annunciation, such that unaffected system functions can be identified and used, in the presence of a failure.

4.2 Certification Test Procedures for Operational Performance Requirements

Equipment operational tests may be conducted as part of normal pre-flight tests. For those tests that can only be run in flight, procedures should be developed to perform these tests as early during the flight as possible to verify that the equipment is performing its intended function(s).

4.2.1 Power Input

Energize the equipment and verify that the equipment operates when powered from all normal electrical power sources.

4.2.1.1 Ground Power Unit (GPU)

If the aircraft and the ADS-B system are designed to accept electrical power from an external source, verify that the equipment is operational when the aircraft electrical system is powered by an appropriate ground power source. At a minimum, system self-tests and crew pre-flight activities (e.g. flight number entry) should be operational.

4.2.1.2 Auxiliary Power Unit (APU)

If the aircraft is equipped with an auxiliary power unit capable of supplying electrical power, verify that the equipment is operational when the APU generator is powering the aircraft and the UAT equipment. At a minimum, system self-tests and crew pre-flight activities should be operational.

4.2.1.3 Engine Generator(s)

Verify that the equipment is operational when the engine generator(s) are supplying electrical power to the aircraft. If system operation is limited when powered by APU or GPU, verify that the system is fully operational when powered by the engine generator(s).

4.2.1.4 Power On/Off (Optional)

If the system uses a power on/off control, verify that the control performs the intended function. The design/installation of the power control should preclude inadvertent system shut off.

4.2.2 Transmitter Operating Modes

Verify that the equipment transmits the messages appropriate to the equipment class designation and mode of operation.

4.2.2.1 Surface Mode

Verify that the system transmits the State Vector messages and Partial Mode Status (Flight Identification) when the Surface mode of operation is appropriate.

NOTE: If the system can switch to the surface transmission mode while airborne, verify that the Air/Ground data in the transmitted messages indicates "airborne" until actually on the surface (or appropriate conditions are met).

4.2.2.2 Air Mode

Verify that the system transmits all the messages required of its equipment class, when the Air mode of operation is appropriate.

4.2.2.3 Automatic Operation

Verify that the system switches between the surface and air modes without crew intervention. If the system installation design includes On-Condition reports, verify that the appropriate report is transmitted when the condition(s) are satisfied. Verify that interfaces to Mode Status (MS) information operate as designed, providing the correct information. (e.g. tail number, flight number , etc.)

4.2.3 Controls and Indicators

Verify that all required controls and indicators are installed. Verify all controls and indicators perform their intended function(s).

4.2.3.1 Standby Mode

Verify that a means is provided for the crew to inhibit UAT transmissions.

4.2.3.2 UAT Link Control (Optional)

If a UAT link control is installed, verify that deselecting the UAT link has no affect on operation of any other installed ADS-B system.

4.2.3.3 Barometric Altitude

Verify that a means is provided for the crew to inhibit the broadcast of barometric altitude.

4.2.3.4 Failure Indication

Verify that an indication of UAT system failure is provided to the crew.

Continue with other test procedures to verify the requirements of paragraph 4.1.