International Civil Aviation Organization

THE TENTH MEETING OF AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/10)

Singapore, 26 -29 April 2011

Agenda Item 7: **Development of Asia/Pacific Regional ADS-B implementation plan and sub-regional ADS-B implementation plan**

ADS-B IN A RADAR ENVIRONMENT

(Presented by Australia)

SUMMARY

This paper discusses the standards that may be applicable for aircraft separation in airspace where there is both radar and ADS-B.

1. Background

1.1 At the ADS-B Task Force SE Asia Working Group meeting, Singapore highlighted that, so far, the ADS-B Task Force only considered NRA ADS-B applications; in the near future there will be a need to work out the requirements for using ADS-B in radar area (RAD) also.

1.2 Singapore also mentioned that the EASA AMC 20-24 explicitly mentions that the standard is for Non Radar Area. There is a need for the ADS-B SITF to decide whether it can be used for Radar Area. Australia volunteered to provide a paper for next ADS-B SITF Meeting explaining that standards other than DO-260B that may also be used for 3 NM separation. This paper is in response.

2. EASA

2.1 The EASA AMC 20-24 certification is based on the requirements expressed in the NRA document ED126 (and hence DO303)

2.2 It is expected that future European rulemaking will refer to an equivalent "AMC" document based on the requirements of the RAD documents (DO318/ED161). In fact it is expected that EASA will issue a Compliance Specification (CS-xx) for RAD to perform the same role as the AMC document used for NRA.

3. Eurocae/ RTCA

3.1 RTCA & Eurocontrol produced separate documents for the RAD and NRA environments with position quality requirements as follows :

	RTCA	EUROCAE	TMA 3Nm separation	ENROUTE 5 Nm separation
NRA (and AMC20-24)	DO303	ED126	HPL=1Nm 95% accuracy<0.3 Nm Airborne total latency<1.5 sec	HPL=2Nm 95% accuracy<0.5 Nm Airborne total latency<1.5 sec
RAD	DO318	ED161	HPL=0.5Nm 95% accuracy<0.05 Nm Airborne total latency<1.5 sec Uncompensated latency 95% < 0.6 sec	HPL=1Nm 95% accuracy<0.1 Nm Airborne total latency<1.5 sec Uncompensated latency 95% < 0.6 sec

3.2 The RAD standard defines more demanding requirements than NRA and is mainly based on the following issues which determine the RAD requirements :

a) Range of Applicability

RAD requires ADS-B performance to be as good as radar performance at the following range of applicability (RoA)s.

- 33 NM for delivery of 3 NM separation services in terminal areas
- 60 NM for delivery of 5 NM separation services

The RoA is chosen as the range at which range error equals azimuth error for the reference radar. This implies that ADS-B better than radar at all ranges. Inside the RoA ADS-B has to be as good as radar range accuracy and outside the RoA ADS-B must be as better than the azimuth error accuracy.

However, the ICAO Separation and Airspace Safety Panel has agreed that ADS-B only needs to be as good as the radar performance at the largest range permitted today. Eg: If 5 Nm separation is authorised to 200 Nm, then ADS-B need only be as good as radar at 200 Nm. SASP was comfortable with the fact that demonstrated ADSB performance meant that ADS-B was nearly always significantly better than radar at the extreme ranges

RAD does recognize the alternative approach and has included additional material at Annex B Appendix B-6 Alternative Reference Range Implications on Quality Indicators.

Tables B16 and B17 present relaxed accuracy and integrity values if Range of Applicability of

- 3 Nm separation : 40 Nm and 60 Nm (the 60 Nm giving the same NIC/NAC as NRA)

- 5 Nm separation : 120 Nm and 200 Nm (both giving the same NIC/NAC as NRA)

b) Density and/or Complexity of Airspace

RAD postulates that more dense airspace means that more demanding accuracy requirements are required. However, if this were the case, in a radar environment, higher density airspace would already have more demanding radar accuracy standards. This does not seem to be the case. High and low density airspace is served by the same monopulse SSR radar products around the world. It can be argued that the same surveillance performance is needed to separate two aircraft at the minimum allowed standard, even if there are only two aircraft in the coverage volume.

c) Alignment between radar and ADS-B

Some propose that in a RAD environment one has to consider additional bias errors when comparing radar reports to ADS-B. It is true, that if one is only using a single radar, bias errors apply to all targets and hence for aircraft-aircraft separation one is not concerned with these errors. It is also true that when using ADS-B and radar, one has to account for the radar bias errors just as one does when one uses multiradar

tracking and accounts for radar bias errors of all radars. ADS-B data is reported in WGS84 latitude/longitude and hence can be mapped to the display plane (display screen) very precisely and is not subject to the same type of azimuth bias alignment errors as radar. For those using multi-radar, the alignment errors involved for two separate radars (with 2 lots of alignment error) will be larger than for one radar and ADS-B.

3.3 It does not seem reasonable that in a case where you have radar as well as ADS-B (eg in RAD), that the ADS-B accuracy requirements are more demanding than ADS-B alone (eg in NRA), when the same service is to be delivered with the same separation standard in the same airspace environment. One could argue that a lower continuity & availability is required in a RAD environment because Radar is available as a backup if ADS-B fails.

3.4 These requirements drive the need for ATC ground systems to insist on accuracy & integrity requirements to deliver different separation standards, but in fact have little impact on the airborne systems. The main additional requirements of DO-318 (RAD) for the airborne segment – over that already guaranteed by NRA includes the following[1] :

- Prefers separate accuracy and integrity reports (but still allows for a single value NUC[2])
- Whilst maintaining a 1.5 second total latency in the aircraft, requires an uncompensated latency 95% < 0.6 sec
- Requires SPI capability during an emergency
- Requires Mode A code in ADS-B messages. This may be required by some states if the data is to be presented to the ATC automation system as a radar message. The RAD document Annex F describes operation in an environment where Mode A code is not broadcast
- Requires that aircraft report the type of emergency
- Requires some additional data including
  - Velocity vector
  - TCAS availability and RA active flags (not available from radar)
  - A number of very specific flags not available from radar
  - Aircraft length

[1] For more detail see RAD DO318 page 491 Table E-1

[2] For more detail see RAD DO318 Annex E : Considerations for the use of legacy DO260ADS-B avionics

3.5 DO260B compliant avionics will include all the above capabilities. DO260A compliant avionics will include most of the above capabilities. Some DO260 compliant avionics include some of the above capabilities.

3.6 Whilst DO260B is desirable, there are few, if any, compliant avionics available at this time. States need to consider whether the desirable additional characteristics of DO260B are necessary before RAD services can be delivered.

4. ICAO Circular Cir 326 AN/188 (Replaces Circular 311)

4.1 The ICAO Separation and Airspace Safety Panel (SASP) considered whether it was necessary to develop separate standards for radar and non radar environments – and decided that this was not the case as the current PANS-ATM does not make these distinctions for 3 and 5 nm radar minima. However, SASP acknowledged that some states may wish to develop more demanding ADS-B requirements for particular National or Regional operating environments. Ie: SASP was careful to define the minimum standards rather than the most demanding standards that might be applied.

4.2 Circular 326 "Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation" was developed and reflects this position. In both para 4.16 and para 4.20 the Guidance material effectively says that

a) If the national/ regional radar performance requirements are equivalent or less demanding than the radars used as the SASP Reference MSSR then the ADS-B Performance requirements in Attachment C can be used.

The radars used by SASP as the reference are based on SSR monopulse performance characteristics as follows:

- Nominal Range 250 NM
- Pulse Repetition Frequency 120 to 300 Hz

- Position Accuracy:
  - Azimuth (RMS) +- 0.08 degrees
  - Range (RMS) +- 0.05 NM

- Target Resolution:
  - Azimuth 1.0 degree
  - Range 0.15 NM

- Target Detection Efficiency 90%

- Velocity Vector Accuracy (non manoeuvring aircraft)
  - Magnitude (RMS) 20 Knots
  - Heading (RMS) 5 degrees

b) If the State requires more demanding radar performance, then states may need to derive more demanding ADS-B requirements. Europe and USA have set more demanding requirements that may require GPS augmentation to achieve acceptable system availability and continuity as indicated in the RTCA DO318.

5. Consequence of requiring better accuracy, integrity

5.1 If a state requires more demanding accuracy/integrity performance requirements and if the position source is GNSS (almost always), then the system will have more ADS-B loss of service events when GPS is unable to meet these performance levels.

5.2 Adequate continuity and availability may be difficult to achieve if the requirements are set too high, especially in the absence of GPS augmentation systems.

6. Australian status

6.1 Australia has been successfully using ADS-B in an enroute radar environment at Bundaberg for many years. Most of the Bundaberg ADS-B coverage overlaps that of adjacent radars.

6.2 Australia expects to use ADS-B in a RAD environment in its busiest airspace at Sydney using ADS-B data (from Sydney WAM system) provided to enroute ATC centres for integration with comprehensive radar coverage.

6.3 In the future, Australia expects to use ADS-B in Terminal areas for 3 Nm separation, using both DO260, DO260A and DO260B avionics, however a safety case has not yet been prepared.

7. Recommendation

7.1 It is recommended that

- the meeting note the various standards;
- the meeting note that ICAO SASP and ICAO Circular 326 do not differentiate between radar and non radar environments; and
- States rely on the ICAO minimum requirements for ADS-B applications and use more demanding standards if there is a particular need for the more demanding performance.

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