

Greg Dunstone
ADS-B in Australia

ADS-B technology The Experience in Australia

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This presentation (in 2 parts)

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PART 1 : Australian experience

- What is ADS-B?
- The environment before ADS-B
- The environment with ADS-B
- Benefits
- How was it achieved ?
- The timeline
- Lessons learnt
- What was necessary ?
- Work in progress

PART 2 : Perspective on ADS-B issues

- Integration with ATC system
- GPS reliance/Spoofing/Privacy
- Bad ADS-B data
- Multilateration
- Other State plans
- DO260 , DO260A, DO260B & retrofit



What is ADS-B ?

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- Aircraft determines its position using GPS
- Broadcasts position, identity, altitude and velocity information (ADS-B out)
- Ground stations receive the broadcasts and relay the information to air traffic control
- Other aircraft receive broadcasts & display to pilot (ADS-B in)

Better performance than radar

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- Better accuracy
 - except very close to radar
- Higher update rate (2 * per second)
- Each report has an integrity measure
 - unlike radar
- Significantly lower cost (1/10th)
- More data
 - eg airborne derived velocity vector



Photo courtesy of Airservices Australia

What avionics are needed?

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3 major elements

- GPS
- Transponder
- Callsign entry

AIRCRAFT ID : CALLSIGN



- Airframe dependent
- Aircraft may have some elements already
- Transponder
 - ADS-B and Radar
- Multiple solutions
 - Multiple vendors

- **Australia uses 1090Mhz ONLY. No UAT is permitted.**

Position VARIANTS

- GPS SA ON
- GPS SA aware
- WAAS (OK, not required)
- INS (not allowed)



GPS/ MMR

POSITION & INTEGRITY



ATC TRANSPONDER

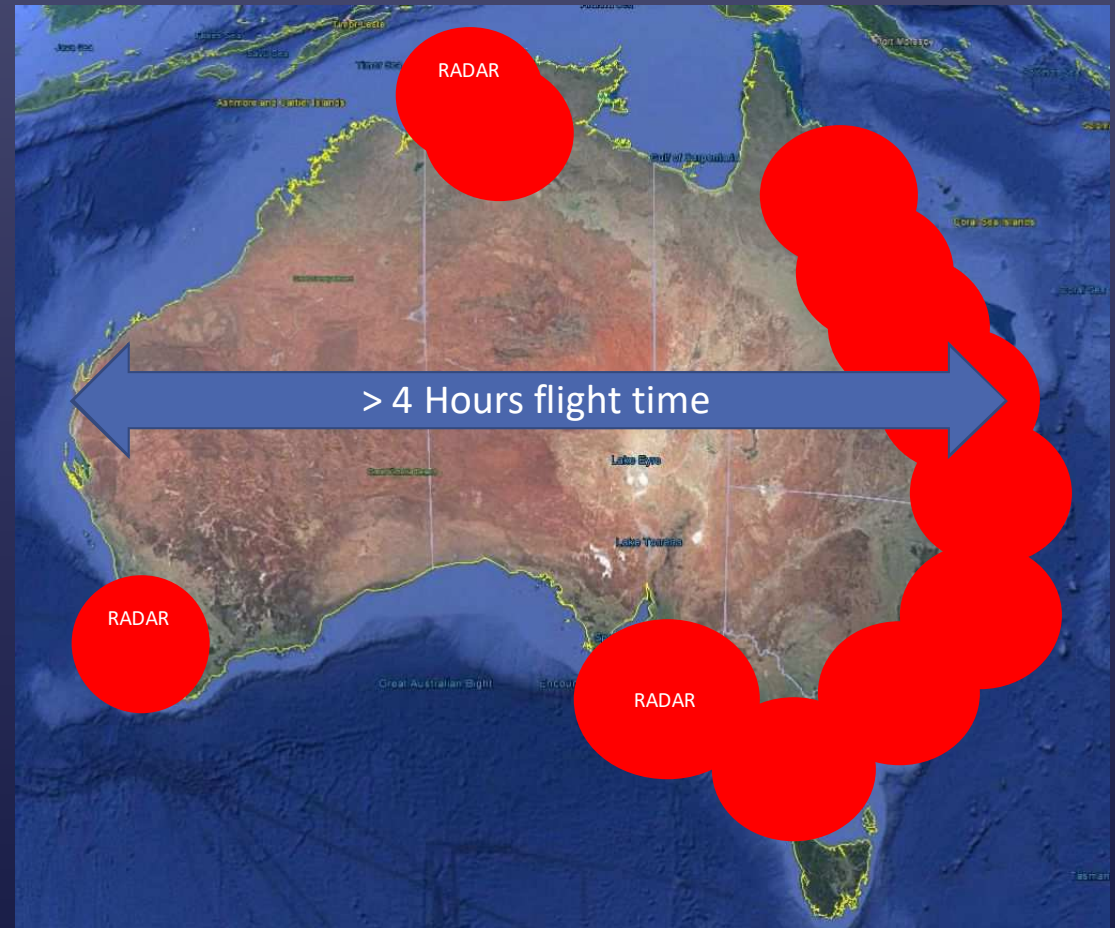
ALTITUDE

TRANSPONDER VARIANTS

- DO260 (Version 0)
 - Adopted by Asia Pac till at least 2020
 - Used for 5Nm & 3 Nm separation in Australia
- DO260A (Version 1)
- DO260B (Version 2)
 - Required by USA/ Europe

The environment before ADS-B (2003)

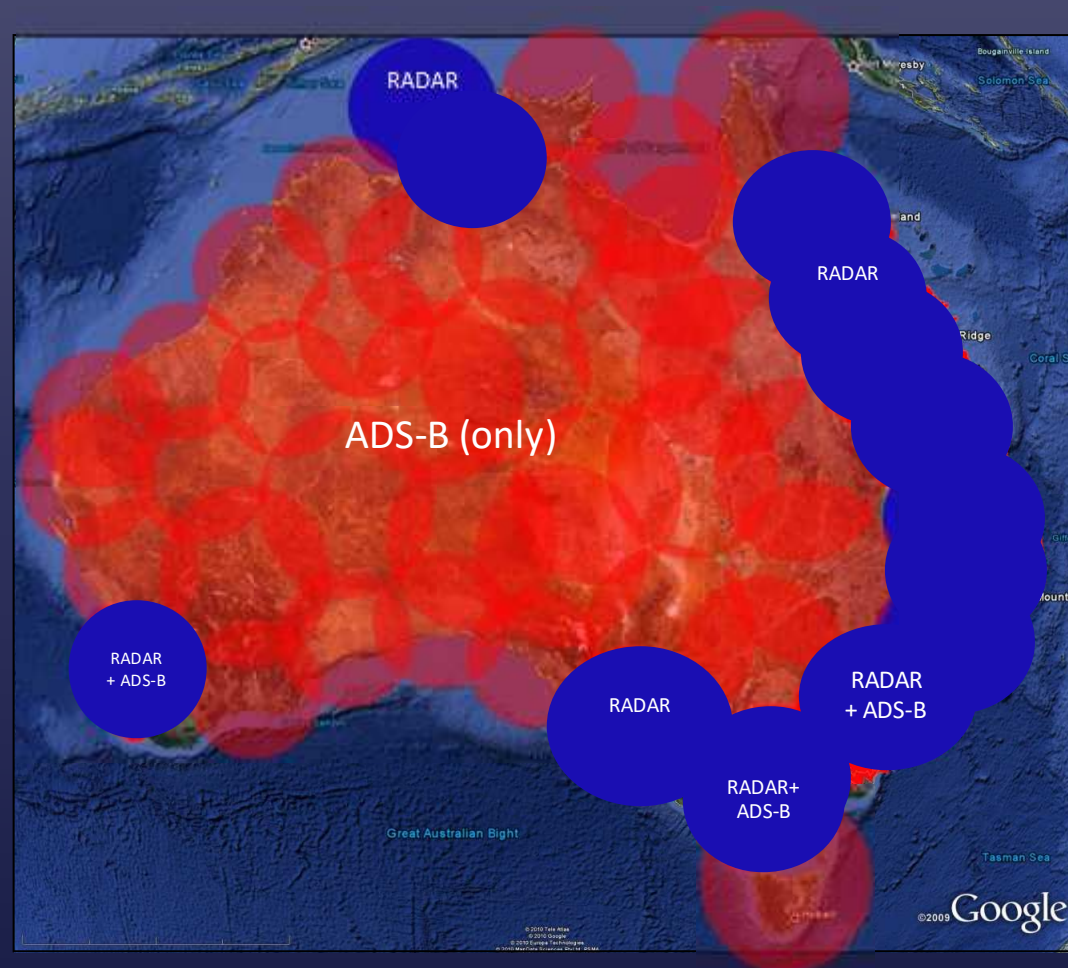
- A continent with only 20 radars
- 11% of worlds airspace, ~1200 controllers, ~12,000 GA aircraft, 480 airports, user pays fees
- Procedural control with VHF voice communication
- Procedural ATC at FIR boundaries
 - mismatch of systems, cultures, language etc
- Growing traffic
- A new airline fleet
- High cost of radar ownership



The environment with ADS-B

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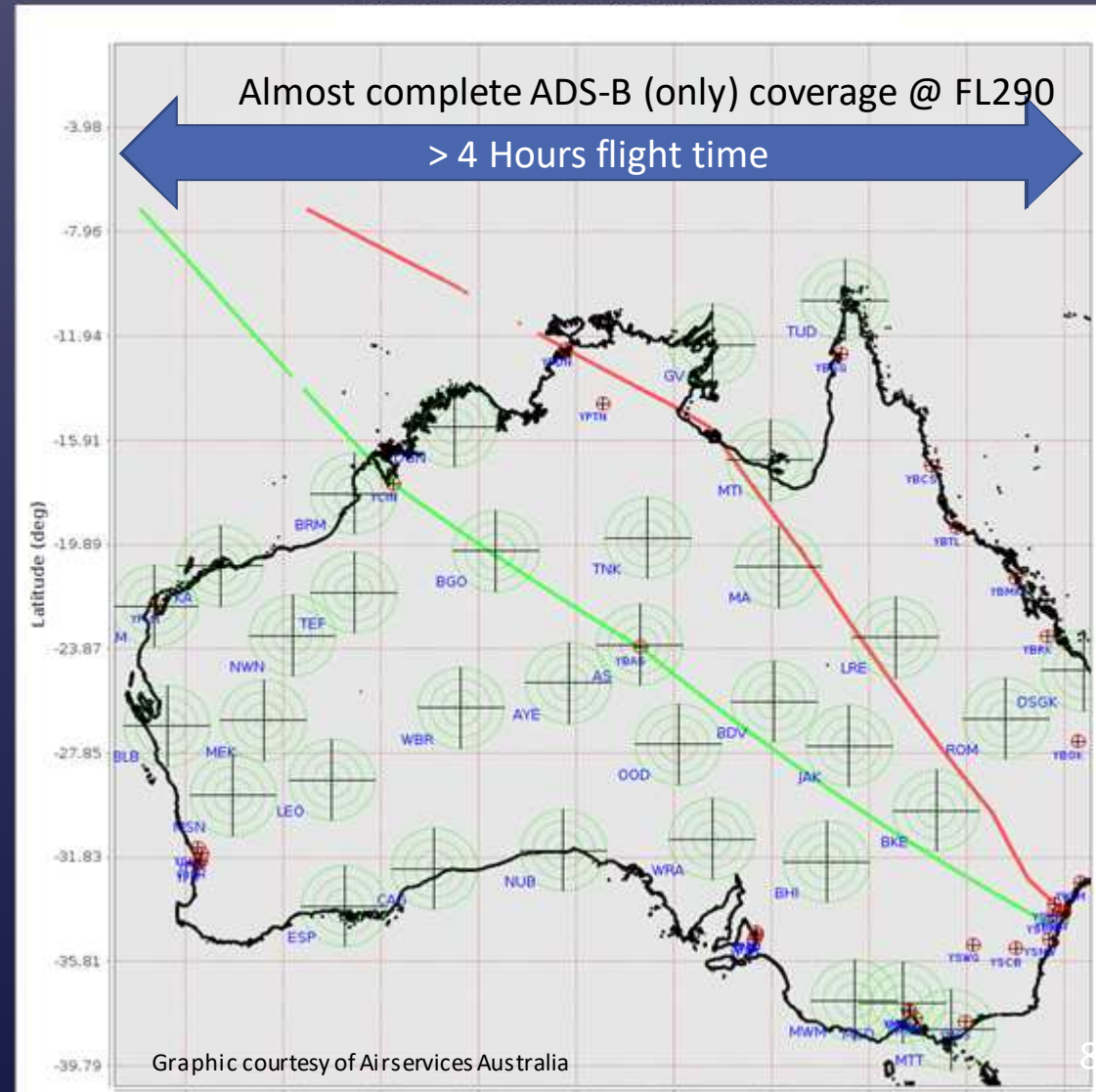
- Nature of ATC in Australia was transformed
 - > 70 Ground stations
- ADS-B has provided ATC separation services for more than a decade.
- Transition from “procedural” ATC to surveillance based ATC
- ADS-B separation
 - 5 miles enroute
 - 3 miles terminal area (Perth & Melbourne)
- ADS-B only at remote towers
- ADS-B supporting surface surveillance
- “Radar identified” is now just “Identified”



Operational Benefits

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- More clearances at optimal levels, fewer diversions, higher predictability
- No stepped climb/descents
- Reduced voice communications
- Reduced ATC & Pilot workload
- Increased Air Traffic Capacity
- Enables ADS-B IN use



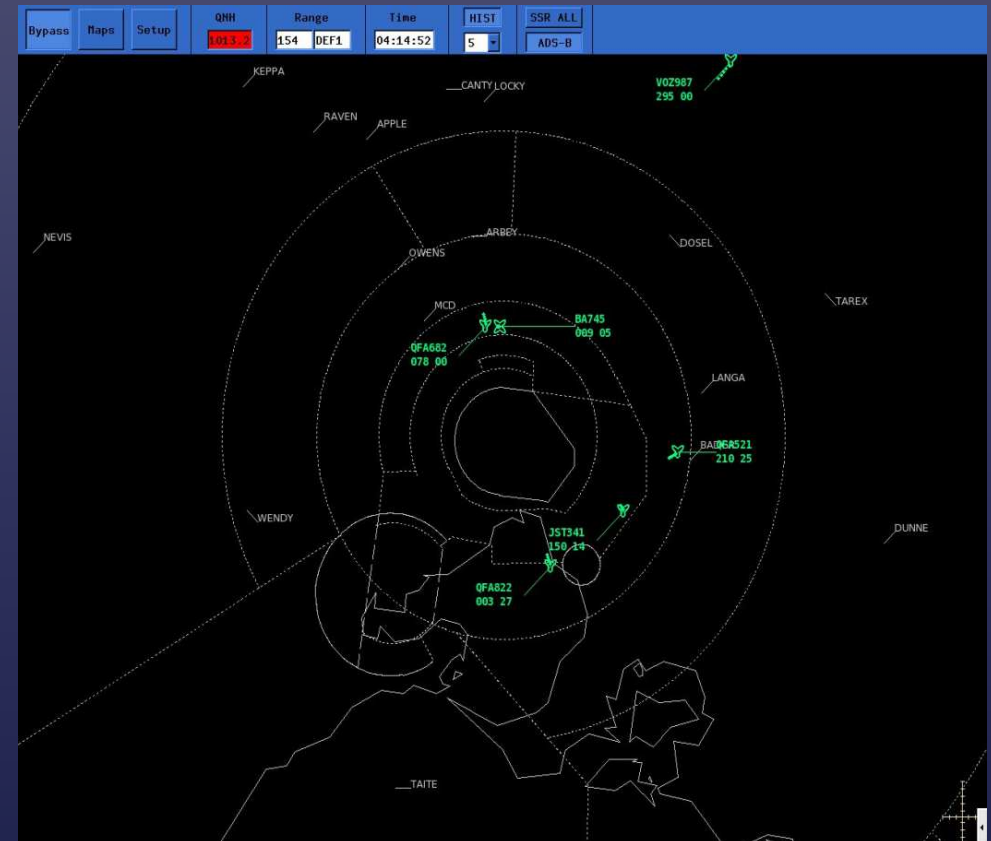
Safety Benefits

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- ATC situational awareness
- ATC Safety nets
- Reduced voice channel congestion



- FIR boundary safety
- Pilot situational improvement
- Search and rescue capability enhanced



ADS-B only display at remote control towers :
Operational at 5 locations

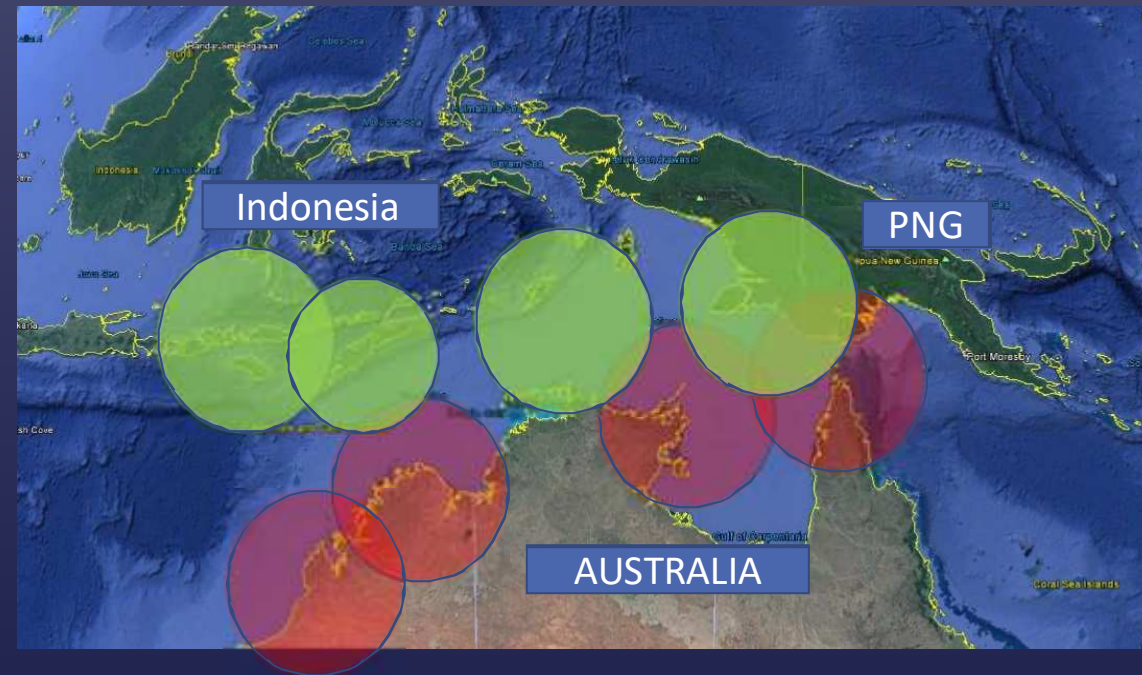
Photo courtesy of Airservices Australia

Airservices Australia video

Australia shares ADS-B data with Indonesia and soon with PNG

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- Improved safety at FIR boundaries (common view of traffic)
- Operational Feb 2010
- Situational awareness
- Automated Safety nets
- Supports procedural ATC



Economic Benefits

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- ATC provider
 - Less radars required
 - Increased capacity at lower cost
 - Less ATC staff per flight

- Airline
 - Operational efficiency
 - Fuel & Operating time

 - Lower airways charges
 - Compared to alternative
 - In Australia, Airspace users pay for all facilities (not the Government)

 - RVSM monitoring
 - Without special flights or height monitoring systems



Photo courtesy of Airservices Australia

Impact on radars

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- Three enroute radars were scheduled to be removed
 - Reduce costs & no significant loss of service
- First radar (Paraburdoo) was disconnected on 21 June 2017
 - See Australian AIC H12/17 “Paraburdoo radar decommissioning”
 - Airspace now ADS-B ONLY
- Second radar (Sydney basin) disconnected November 2017
 - Reduced radar coverage
- Third radar in progress (Perth TMA). Safety work complete.
- Australia uses ADS-B as truth data to test radars !



How was this achieved ?

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Learning, Demonstration, Co-operation, Hard work

- A step by step implementation over more than a decade.
 - A 24/7 operational trial & demonstration (Bundaberg QLD in 2004)
 - [Demonstrated success - Seeing is believing](#)
 - Deployment of 28 ground stations based on a one page business case
 - [Demonstrated success - Doing is better than talking](#)



- Significant stakeholder engagement
 - Aircraft New & Old, Big & small
 - International, Regional, Bizjets, General aviation
 - Based on : “What do we agree on?” and “How do we get there?”



Australian ADS-B avionics Regulations & Mandate were necessary to :

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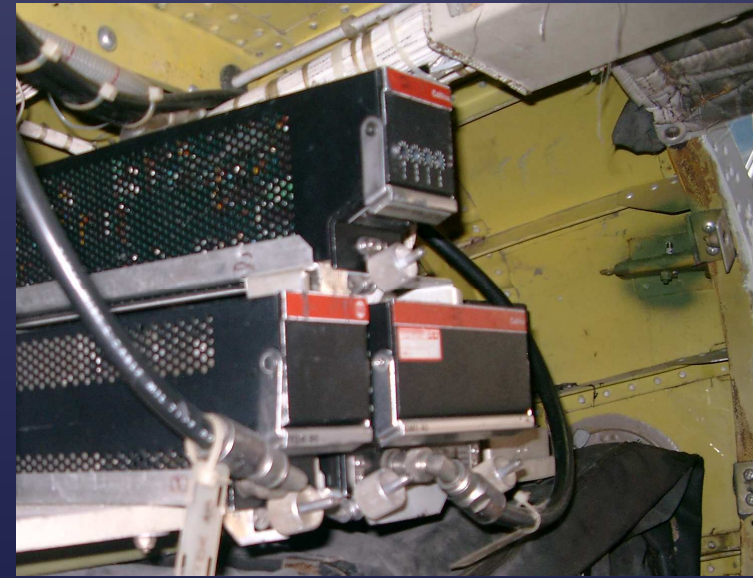
- Define the acceptable standards.
- Prohibit misleading or non compliant ADS-B
 - Note ICAO Regional Doc 7030 requirements
- Require all IFR to have ADS-B from Feb 2017
 - A few limited exemptions
 - VFR exempt, but new transponders must be ADS-B capable
 - Forward fit requirement for SA aware GPS for aircraft manufactured after Dec 2016



ADS-B avionics fitment debate

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- Like the SSR transponder fitment debate
 - 40 years ago
- How will it be viewed 20 years from now?



Industry requested the Mandate

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- Industry vision for “Surveillance in Australia” developed by stakeholders (ASTRA see www.astra.aero)
 - Synchronised investment (ANSP & Operators)
- In 2010 the Industry stakeholders (ASTRA) reached a compromise position and **asked regulator for Mandates**
- ASTRA includes :
 - Major airlines
 - RAAA (Regional airlines)
 - AOPA (GA)
 - ABAA (Bizjets)
 - ASAC (Sport aviation)
 - Airservices Australia
 - AAA (Airports)



Photo courtesy of Airservices Australia

Presentations & Demonstrations and papers to trade shows, organisations and even to politicians at Parliament house

Australia had numerous mandates as it learnt & phased in the technology

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(Historical perspective – this would not be necessary for others)

Effective date	Mandate	Status
6 June 2007	<ul style="list-style-type: none"> Non compliant ADS-B must be disabled before flight [no bad data] 	Regulation in place (see CAO 20:18)
12 Dec 2013	<ul style="list-style-type: none"> Operation at/above FL290 requires ADS-B 	(All airspace categories)
6 Feb 2014	<ul style="list-style-type: none"> All IFR aircraft first registered after 6 Feb 2014 must have ADS-B out VFR aircraft first registrations must have ADS-B capable transponder (in class A,B,C,E or above 10,000 feet) 	
4 Feb 2016	<ul style="list-style-type: none"> All IFR must have ADS-B out within 500 Nm Perth to north & east 	
8 Dec 2016	<ul style="list-style-type: none"> ADS-B position source must be SA aware for aircraft manufactured after date 	Regulation in place (see CAO 20:18)
2 Feb 2017	<ul style="list-style-type: none"> All IFR must have ADS-B out in Australia 	(All airspace categories)

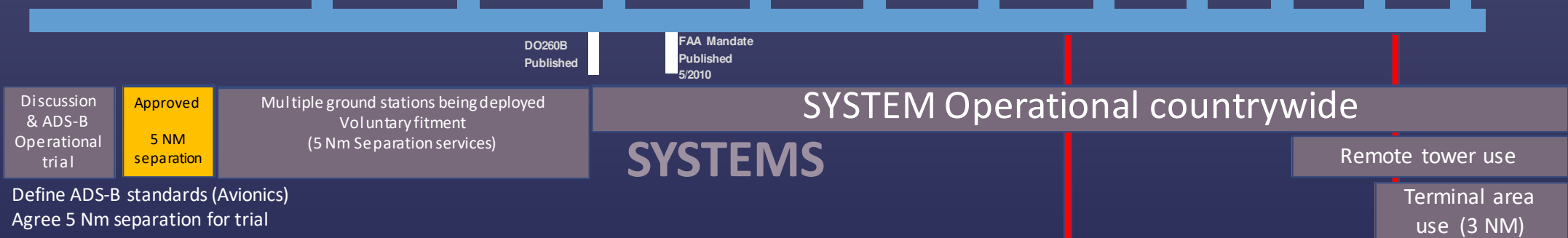
Australia's ADS-B timeline

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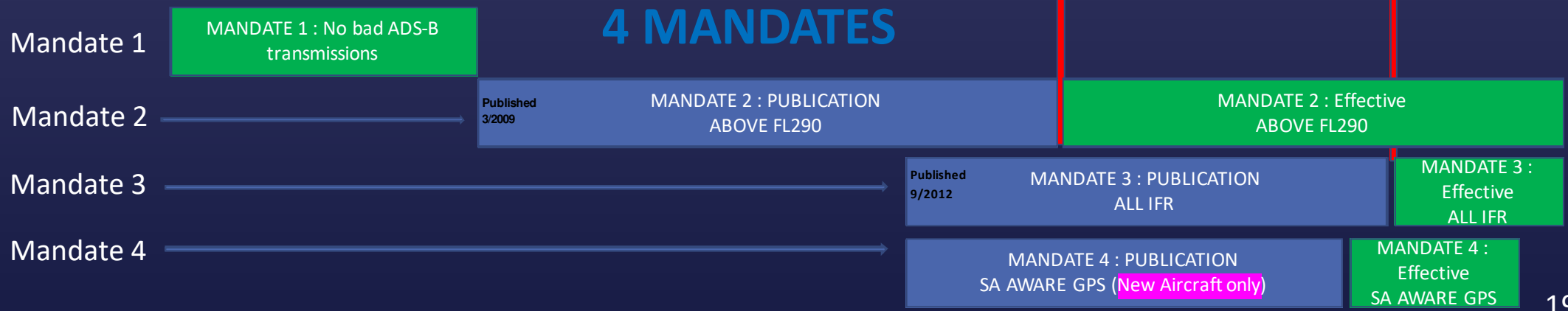
> Decade of operational use – Aircraft separation



2004 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018



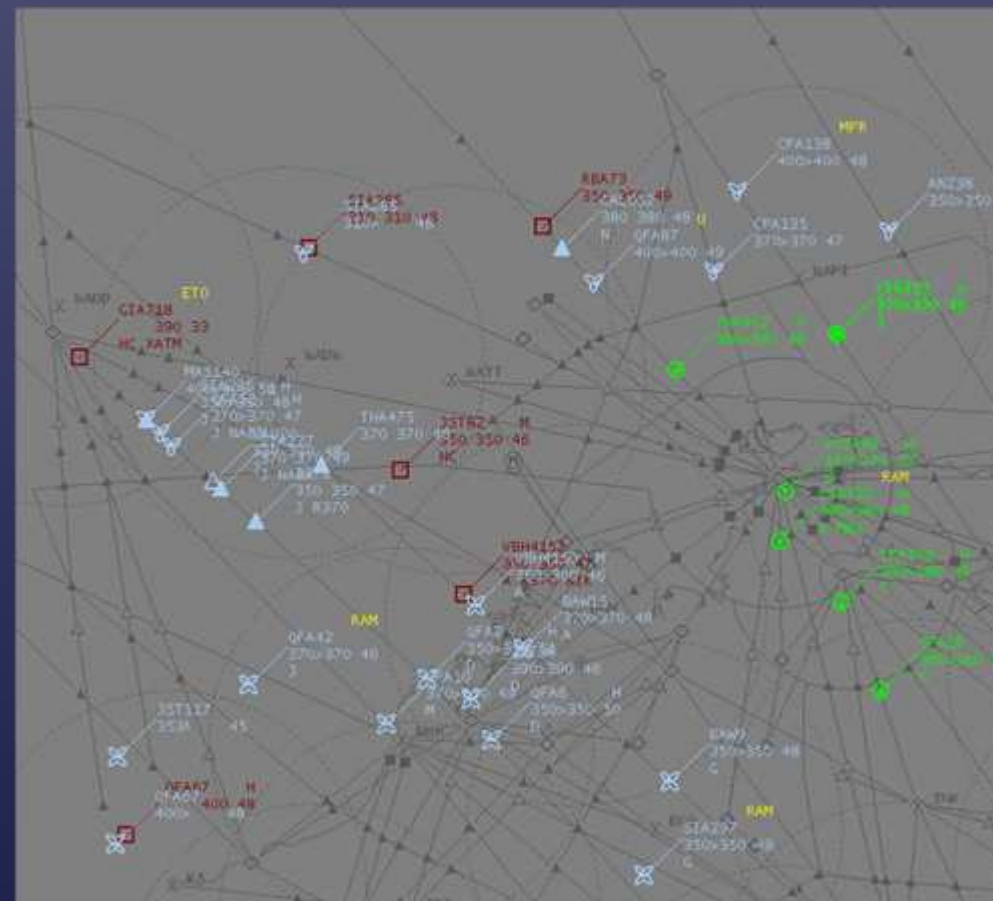
Define ADS-B standards (Avionics)
Agree 5 Nm separation for trial



ADS-B Transition

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- Services were provided before the mandate
- Airservices gradually increased service
 - Initially for situational awareness & safety nets
 - Then 5Nm separation in a mixed equipage environment
 - Equipped aircraft separated by 5 nautical miles
 - Non equipped aircraft separated procedurally
- Even in the mandated environment, sometimes exempt aircraft are separated procedurally



Radar, ADS-B and ADS-C symbols on live ATC display during transition

Photo courtesy of Airservices Australia

Lessons were learnt

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- Keep focussed on the outcome
- Remain flexible and able to compromise
 - 80% now is better than 95% in 10 years
- Do the right amount of planning
 - Not too little, not too much
 - Have a “Vision”
 - Demonstrated performance is powerful
- Considerable ongoing effort is required no matter what the plan
 - Fault finding, bugs in equipment/procedures
 - Education, media, politics
 - Keeping everyone “on track”



Surveillance and Navigation were changed together

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Navigation

- GPS based navigation instead of conventional nav aids
- With a terrestrial sparse backup network

Surveillance – using navigation source

- ADS-B instead of radar
- With a radar based backup

Navigation program

- The industry equipped aircraft with suitable GPS.
 - Air transport jets used GPS already
 - GPS became mandatory for IFR in 2016
- Paves the way for PBN efficiency benefits
- Airservices decommissioned 179 navaids in April 2016 (See Australian AIC H11/16)
 - The alternative would have been to replace them at enormous cost to their customers.

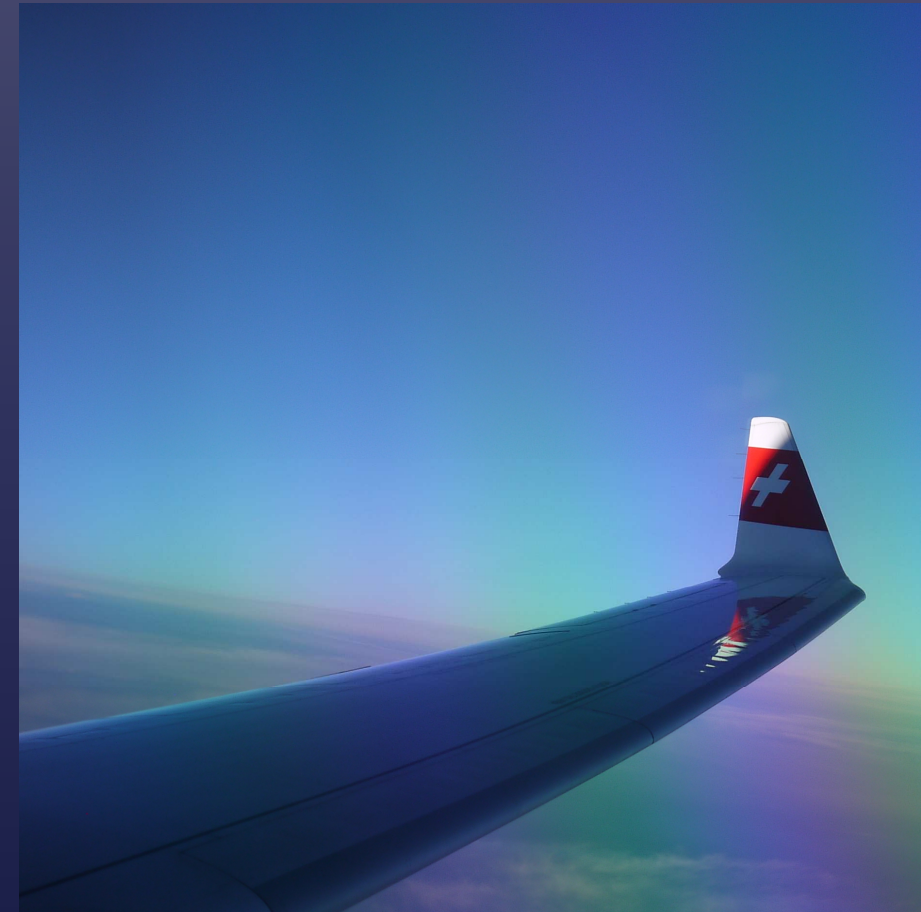


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	AERONAUTICAL INFORMATION SERVICE AIRSERVICES AUSTRALIA GPO BOX 367 CANBERRA ACT 2601	
E-mail: AIM.Editorial@airservicesaustralia.com		H11/16
Effective: 201604260500UTC		
AIRSERVICES NAVIGATION RATIONALISATION PROJECT (NRP)		
179 ground-based navigation aids will be withdrawn from operational service effective 201605251600UTC		

Contributions to achieve this :

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- **Air Navigation Service Provider (ANSP) provided :**
 - ATC technical capability (ADS-B receivers, ATC system)
 - ATC procedures
 - Monitoring capability, statistics, information flow to operators, installers, airlines
 - Problem identification, negotiation of solutions, engagement in avionics issues
 - Training & knowledge transfer about ADS-B, about GPS, about avionics, about ATC systems
See <http://www.airservicesaustralia.com/projects/ads-b/>
- **ANSP & Regulator provided**
 - Monitoring capability (are installations good enough, equipage rate statistics)
 - Managing exemptions & failures etc
- **Airlines provided**
 - Airline compliance, installation (takes time)
 - Procedures & processes for failure conditions
- **Aircraft OEMs & Avionics companies**
 - Products & customer support
- **All stakeholders provided**
 - Training & knowledge transfer
 - A will to succeed



Regulator Activity

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- Regulation to

- Define approved type of avionics
- Prohibit misleading data
- Require ADS-B equipage for operations in certain airspace and for certain aircraft
- Forward fit requirement for SA Aware GPS
- Define when mandatory and allow time for fitment
- Follow-up and enforcement

- Training & education

Eg: See CASA brochure :

https://www.casa.gov.au/sites/g/files/net351/f/_assets/main/pilots/download/ads-b.pdf

- Procedures to manage exemptions



Engagement internationally

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- Significant engagement to ensure compatibility & that Operators could equip with available products
 - Standard setting (ICAO, RTCA/Eurocae)
 - Airframe companies
 - Avionics companies
 - FAA, Eurocontrol, Navcanada, (Airservices)
 - Our Neighbours : Indonesia, PNG
 - IATA

- Least demanding requirement allowed (DO260 and SA ON)
 - Supporting current fleet
 - Supporting 3Nm & 5Nm standards
 - Recognising forward fit transition to better standards
 - Recognising FAA & Eurocontrol rules will push DO260B
 - FAA requirement for SA aware



ICAO in Asia Pacific

- APANPIRG ICAO ADS-B Study & Implementation WG (March 2003 → April 2016)
- Guidance Documents available
 - <https://www.icao.int/APAC/Pages/edocs.aspx>
 - **ADS-B Implementation Guidance Document (Version 10)**
 - **Safety case guidance**
- ADS-B is used in Region (Singapore, China, Vietnam, India, Indonesia, PNG, New Zealand, Mongolia, Hong Kong....)
- ADS-B data sharing and VHF outlet sharing is fully operational
- Asia Pac agreed that no “operational approval” process is required

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SUR & ADS-B	
Guidance Material on Generation, Processing & Sharing of ASTERIX Category 21 ADS-B Messages	Adopted by APANPIRG/23 - September 2012
Guidance Material on Advice to Military Authorities regarding ADS-B Sharing	Adopted by APANPIRG/23 - September 2012
Guidance Material on Building a Safety Case for Delivery of an ADS-B Separation Service	Version 1.0 - Adopted by APANPIRG/22 - September 2011
ADS-B Implementation and Operations Guidance Document (AIGD)	Edition 10.0, June 2017
Baseline ADS-B Service Performance Parameters	Second Edition, September 2003
Multilateral (MLAT) Concept of Use	Edition 1.0 – September 2007
Regional Supplement to the ASTERIX Interface Control Document (ICD) for the ASIA/PAC Region	Second Edition, September 2003
Revised Guidelines for Development of ADS-B Implementation Plan	
Guidelines for Airworthiness and Operational Approval for ADS-B Avionics Equipage	adopted by APANPIRG/21 – September 2010
Guidance Material on Comparison of Surveillance Technologies (GMST)	Edition 1.0 – September 2007
Guidance Material on Reporting Probability of ADS-B Update	Adopted by APANPIRG/19 September 2008
Guidance Material on Reporting ADS-B Avionics Fitment	Adopted by APANPIRG/19 – September 2008
Guidance Material on Issues to be considered in ATC Multi-sensor Fusion Processing including the Integration of ADS-B Data	Adopted by APANPIRG/19 – September 2008
Revised Sample Agreement for Data Sharing (MS Word format)	Edition 2.0 - Adopted by



ICAO Supports ADS-B

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- Technical standards (Annex 10)
 - Version 0 = DO260
 - Version 1 = DO260A
 - Version 2 = DO260B

- Separation standards (SASP)
 - Circular 326

- PANS ATM Doc 4444
 - Wording now “Surveillance” instead of “Radar”

- ASBUs

APPENDIX C

KEY ADS-B PERFORMANCE REQUIREMENTS TO SUPPORT THE CLAIM THAT ADS-B SURVEILLANCE IS “AS GOOD AS THE REFERENCE SSR”

Table C-1 identifies the key minimum performance requirements for an ADS-B system to enable the use of a 3 NM or 5 NM separation minimum in the provision of air traffic control.

States should refer to Attachment A of the SASP comparative assessment document for the description of the reference SSR used in that assessment.

The list is not intended as an exhaustive list of performance requirements; but namely a list of characteristics requiring consideration when deploying ADS-B and assumes a sound background of “radar” knowledge, techniques and practice.

Table C-1: SASP comparative assessment

	Characteristic	Minimum Requirement 3 NM	Minimum Requirement 5 NM
1.	Position: Accuracy	A 95 percentile accuracy of 0.3 nautical miles This can be represented by either: a) Navigation Accuracy Category (position) = 6 or better; or b) Navigation Uncertainty Category = 5 (for GNSS derived positional data only)	A 95 percentile accuracy of 0.5 nautical miles This can be represented by either: a) Navigation Accuracy Category (position) = 5 or better; or b) Navigation Uncertainty Category = 4 (for GNSS derived positional data only)
2.	Position: Integrity	A containment radius of <1 NM and the likelihood of the position error exceeding containment radius of $1e - 5$ This can be represented by either: a) Navigation Uncertainty Category = 5 or better; or b) Navigation Integrity Category = 5 (or better) and Surveillance Integrity Limit = 2 (or better)	A containment radius of <2 NM and the likelihood of the position error exceeding containment radius of $1e - 5$ This can be represented by either: a) Navigation Uncertainty Category = 4 or better; or b) Navigation Integrity Category = 4 (or better) and Surveillance Integrity Limit = 2 (or better)
3.	Position: Latency	4 seconds	4 seconds
4.	Position: Update Rate	5 seconds	12 seconds

Note – For the provision of separation services to aircraft equipped with DO260 avionics, a State may select lower encoded values for NUC in relation to accuracy and integrity when it is demonstrated by safety assessment that the 95 percentile accuracy, and containment radius values, identified in Table C-1 will continue to be met.

Work continues in Australia :

- Trial : ADS-B only for small airport surface surveillance
- Examine : ADS-B only for Parallel runway Monitoring operations
- Examine : Space based ADS-B
- Lower cost avionics (& standards) to enable VFR voluntary equipage



ADS-B only surface trial at Canberra airport

Photo courtesy of Airservices Australia



See <http://www.airservicesaustralia.com/projects/ads-b/>

What does ATC think?

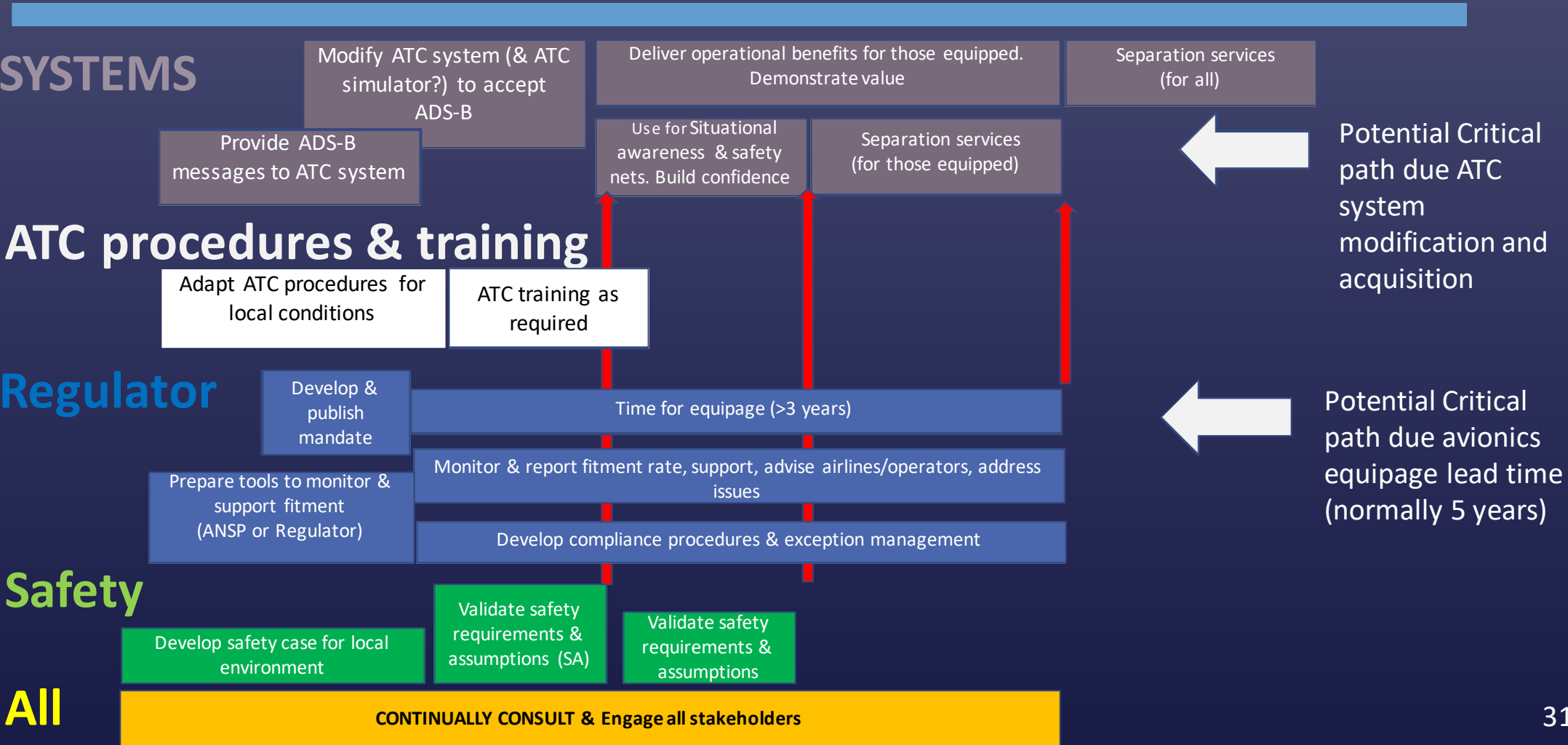
- In more than 40 years experience providing technology to ATC, it was the one that was very enthusiastically accepted – and more coverage volume was demanded.



General Manager ATC (at the time) said “ADS-B is better than sliced bread”

A potential timeline to transition:

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One minute break – before Part 2



The Blue mountains west of Sydney : ADS-B receiver at Kings Tableland to left.

PART TWO : A Perspective on ADS-B issues



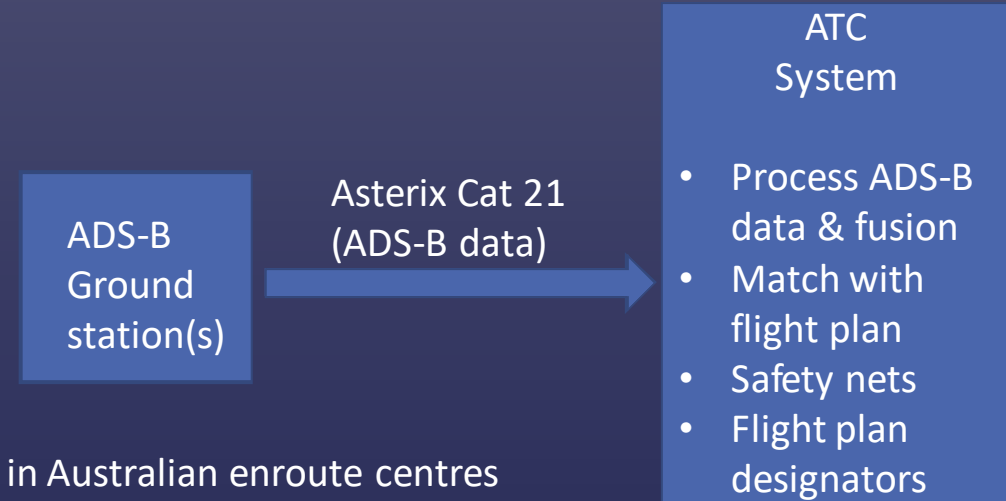
ADS-B testing on B717
Qantaslink regional fleet

How can I connect ADS-B to ATC?

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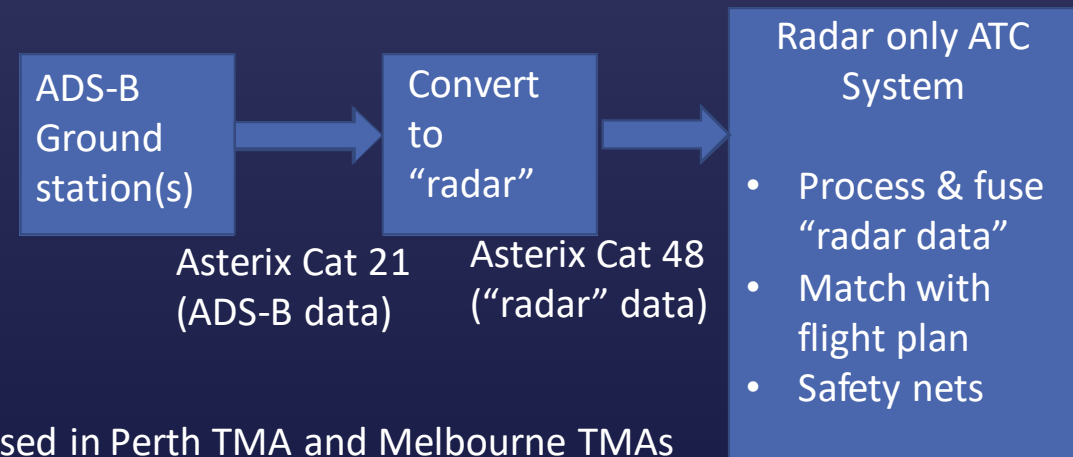
■ Optimum / Preferred : Upgrade ATC system to accept ADS-B

- Simple tracking & matching with flight plan
 - Flight ID, Mode A (if available), ICAO 24 bit (least desirable)
- Include safety nets
- Flight plan designators
- Possible different ATC symbology



■ Sub-optimal : Convert ADS-B messages to radar like messages

- Pseudo radar rotation
- Performance still better than radar
- Potential issues if no Mode A code (some old ATC systems require it)
 - Can fuse based on ICAO 24 bit if Mode S radars are used



Claim : We don't have a Conops

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- The Conops could be as simple as to “use ADS-B as if it is radar”
- Do you have a radar CONOPS?
 - Cut and paste!
 - Change the word “radar” to “surveillance”
- Don't make it complicated



Claim : Aircraft aren't equipped !

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- That's up to the ANSP, the regulator, the customers the Industry & the Government.
 - They won't all equip until you have a mandate
- There is work to do, to "herd the cats"
 - To get agreement
 - To make it clear that it is good strategy & the benefits exceed costs
- Each State can require equipage
 - Choose whether DO260 is adequate (most airliners are already equipped)
 - DO260B is preferred for new fitments
 - DO260 is used for radar like applications including 3Nm and 5Nm separation in Australia
 - GPS SA aware preferred – forward fit requirement
- If you wait till everyone is equipped you will never progress



Australian Government
Civil Aviation Safety Authority

Civil Aviation Order 20.18 (Aircraft equipment — basic operational requirements) Instrument 2014 (as amended)

made under regulations 207 and 232A of the *Civil Aviation Regulations 1988* and subsection 33 (3) of the *Acts Interpretation Act 1901*.

This compilation was prepared on 16 December 2016 taking into account amendments up to *Civil Aviation Order 20.18 Amendment Instrument 2016 (No. 2)*. It is a compilation of the *Civil Aviation Order 20.18 (Aircraft equipment — basic operational requirements) Instrument 2014* as amended and in force on 16 December 2016.



Claim : Some aircraft give bad data

- Initially true - It will remain the case unless you act.
 - What is the impact on ATC operations when experienced?
 - Is radar data always perfect? No
- There are some known software or installation errors
 - Like faulty SSR transponders. They need to be fixed.
 - Investigation and root cause work is ongoing, as for transponders
 - Compliance activity by regulator required
- Regulation required to prohibit bad transmissions
 - Non compliant transmissions must have NIC/NUC=0
 - See Asia-Pac ICAO 7030
- Most bad data is ADS-B transmissions with “INS position source”
 - In early days were seen with NUC* or NIC*=0 and discarded by ATC system
 - But remained a favourite advertising gimmick by multilateral vendors
 - **No longer seen in Australia – because**
 - ADS-B is mandatory for IFR. All INS aircraft have ADS-B with GPS position source

All Airframe OEMs
All major avionics vendors
New and Old equipment



Nullabor ADS-B Ground station : Photo courtesy of Airservices Australia

* ADS-B reported integrity

ADS-B depends on GPS

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- As does much of society
 - Banks, Public Land transport, Pizza delivery
 - Enormous incentive to maintain it
- In Australia – a robust radar backup network in critical areas
 - A level of insurance against failure
- The alternative could be NO surveillance



Sydney airport - Approx. 1,000 movements / day

Claim : ADS-B - spoofing

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- ADS-B data between aircraft and receiver can be spoofed & is not protected by encryption
 - As a one-way transmission, encryption key distribution is problematic
 - Change would take 15+ years & require all avionics worldwide to change.

- No other technical system in civilian ATC is encrypted today including
 - Voice communication
 - Nav aids
 - FANS1A Data link
 - Mode A, Mode C and Mode S radar

- One needs to look at total risk, consequences & mitigations
 - Spoofing can be considered equivalent to denial of service (surveillance failure), or equivalent to false radar targets
 - One must balance between security/safety improvement and risk
 - Air Traffic control is not determined by surveillance alone

Claim : ADS-B – privacy concern

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- Mode S and TCAS transmissions uniquely identify each airframe
 - Privacy was lost when TCAS & Mode S was implemented in 1970s
 - It is easy to listen to 1090 MHz replies to mode S radars
- Availability of low cost digital receivers makes it a easier to receive
- ADS-B itself is a minor player in the loss of privacy – it adds position (multilat can get position without ADS-B)
- Somewhat like character recognition of car licence plates for tollways

Mode S
transponder
Without ADS-B

All TCAS aircraft have
Mode S transponders

Autonomously
TRANSMITS worldwide
unique 24 bit code
every 1 second

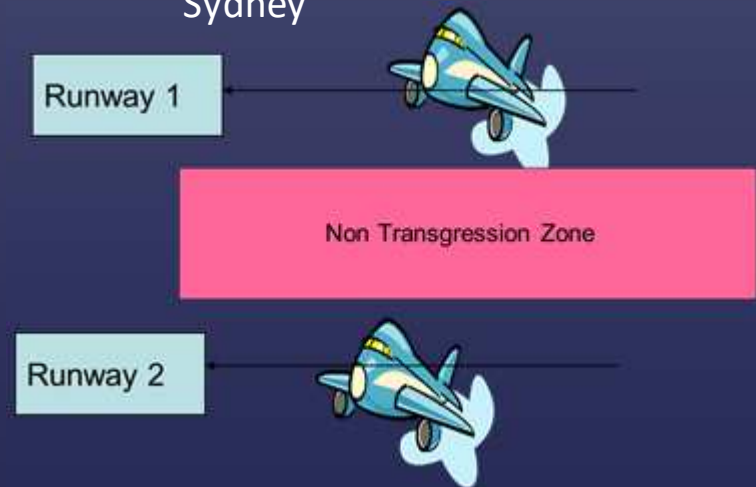
Most TRANSMIT
IDENTITY when
so interrogated by
Mode S radar

Claim : Multilateration is the solution

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- A good tool for some applications (eg. surface surveillance or PRM) **during transition to ADS-B**
- Has a low cost of acquisition from supplier but is outweighed by high cost of ownership & complexity
 - Communication links
 - Multiple site ownership (lawyers, leases, power, shelter, management etc)
 - Ongoing “adjustment”
 - Failure modes & duplication issues (how do you test?)
 - Use of omni interrogators (1030Hz pollution)
 - Much higher cost than ADS-B alone
- Australia has 2 WAM systems for enroute & PRM applications
 - No plans for more.
 - Hopes to replace all existing WAM systems with ADS-B

Precision Runway Monitoring (PRM) using multilateration used at Sydney



Airservices Australia uses multilateration for

- a) Surface movement surveillance
- b) Enroute ATC surveillance (WAM)
- c) Precision runway monitoring at Sydney airport (WAM)

Graphic courtesy of Airservices Australia

Some Mandates

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State	What	When effective	Comments
Australia	At or above FL290 All IFR all levels	Dec 2013 Feb 2017	DO260 & SA ON accepted Looking at TSO199 for GA
USA	Most aircraft in controlled airspace	Jan 2020	DO260B Required
Europe	Aircraft operating IFR >5,700KG or >250KTAS cruise	June 2020	DO260B Required & SA ON accepted
UAE	All IFR	Jan 2020	DO260B Required
Singapore	At or above FL290 on specified routes	Dec 2013	DO260 & SA ON accepted
Vietnam	At or above FL290 on specified routes		DO260 & SA ON accepted
Hong Kong	At or above FL 290 on airways L642 and M771.	Feb 2016	DO260 & SA ON accepted
Indonesia	At or above FL290	Jan 2018	DO260 & SA ON accepted
Taiwan	At or above FL290 on two routes All flights at or above FL290	Sept 2016 Dec 2019	DO260 & SA ON accepted
Colombia	All airspace	Jan 2020	DO260B
China	Proposed and currently under consultation	July 2019 Dec 2022	DO260 DO260B
New Zealand	NPRM released - All aircraft above FL245 Proposed - All aircraft in controlled airspace	31 Dec 2018 31 Dec 2021	DO260 (with forward fit for DO260B) Looking at TSO199 for GA
Canada	No mandate proposed. Preferential service in Hudson Bay		DO260 & SA ON accepted

DO260 and SA ON GPS

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- DO260B has more functionality, eg
 - Better for Surface Surveillance
 - Supports Selected altitude warning
 - Is required by some air-air applications
- DO260, DO260A and DO260B have identical accuracy
 - But REPORTED accuracy is different
 - Accuracy is a function of GPS geometry
 - Radar has no reported accuracy nor reported integrity
- SA aware GPS provides better reported integrity and better reported accuracy.
 - Hence better availability for a defined containment radius
 - It is desirable. A forward fit requirement exists in Australia.



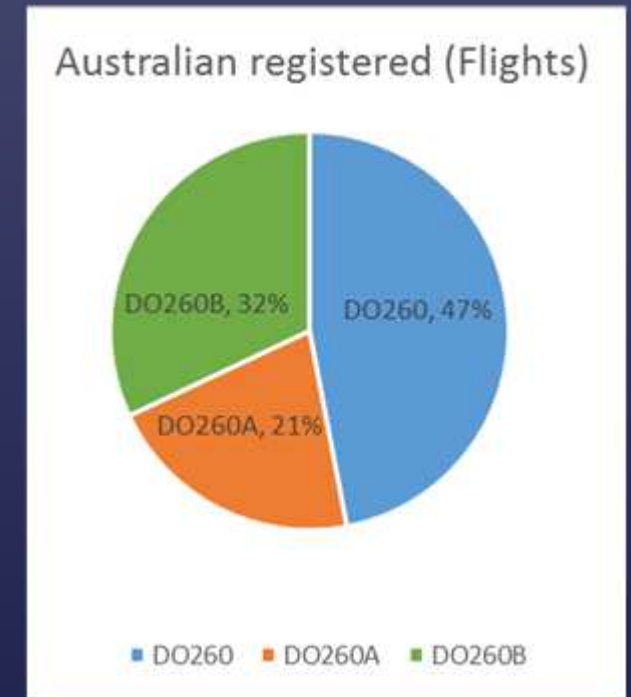
ADS-B is used in the Tasman sea thanks to an ADS-B receiver on Lord Howe Island and Oceanic controllers have radar and ADS-B "on-screen".
Picture is a landing by ADS-B equipped Dash 8 at Lord Howe Island

ICAO APANPIRG – adopted DO260

The Retrofit challenge

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- Whilst DO260B and SA aware are better and desirable
 - most fleets have a large percentage of DO260 aircraft
 - It is usually somewhat expensive to swap to DO260B
 - More than software – needs pin wiring
 - A good case can be made that DO260 & SA ON are good enough for current applications but probably not good enough for the generational paradigm shift required in future.
- One strategy is to accept DO260 initially and slowly transition to DO260B later
 - Avoids having to immediately retrofit half the fleet



Graphic courtesy of Airservices Australia

Summary

- ADS-B is mature and in operational use for separation for more than a decade.
 - Higher performance surveillance at lower cost (compared to radar)
- There is cost of delay
 - Higher safety risk compared to alternative - depending on environment
 - Radar cost of ownership
 - Delay of benefits to airlines



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ADS-B in Australia

GPS-Squitter



Department of Transportation
Federal Aviation Administration

- ADS-B Technology was flying in 1994
- It is now widely fitted and time for Industry to derive maximum benefit
- Why delay?

Thank you for your attention.

Questions ?



The Australian ADS-B mandate

- See <https://www.casa.gov.au/standard-page/key-timelines>
- See CAO 20:18
<https://www.legislation.gov.au/Details/F2016C01077>

Mandate extract :

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ADS-B in Australia

9B.3 If an aircraft carries ADS-B transmitting equipment for operational use in Australian territory, the equipment must comply with an approved equipment configuration.

9B.4 If an aircraft carries serviceable ADS-B transmitting equipment for operational use in Australian territory, the equipment must transmit:

- (a) a flight identification that corresponds exactly to the aircraft identification mentioned on the flight notification filed with ATC for the flight; or
- (b) if no flight notification is filed for the flight — a flight identification that is:
 - (i) for an aircraft registered on the Australian Civil Aircraft Register and operating wholly within Australian territory — the aircraft's registration mark; or
 - (ii) for an Australian aircraft registered by a RAAO — in accordance with the organisation's operations manual; or
- (c) another flight identification directed or approved by ATC.

9B.5 If an aircraft carries serviceable ADS-B transmitting equipment that complies with an approved equipment configuration, the equipment must be operated continuously during the flight in all airspace at all altitudes unless the pilot is directed or approved otherwise by ATC.

9B.6 If an aircraft carries ADS-B transmitting equipment which does not comply with an approved equipment configuration, the aircraft must not fly in Australian territory unless the equipment is:

- (a) deactivated; or
- (b) set to transmit only a value of zero for the NUCp or NIC.

Note It is considered equivalent to deactivation if NUCp or NIC is set to continually transmit only a value of zero.

9B.7 However, the equipment need not be deactivated as mentioned in paragraph 9B.6 if the aircraft is undertaking an ADS-B test flight in V.M.C. in airspace below FL 290.

9B.8 On and after 12 December 2013, any aircraft that is operated at or above FL 290 must carry serviceable ADS-B transmitting equipment that complies with an approved equipment configuration by meeting the conditions for approval set out in Appendix XI.

9B.9 An aircraft:

- (a) that is manufactured on or after 6 February 2014; and
- (b) that is operated under the I.F.R.;

must carry serviceable ADS-B transmitting equipment that complies with an approved equipment configuration by meeting the conditions for approval set out in Appendix XI.

9B.10 On and after 2 February 2017, an aircraft:

- (a) that is manufactured before 6 February 2014; and
- (b) that is operated under the I.F.R.;

must carry serviceable ADS-B transmitting equipment that complies with an approved equipment configuration by meeting the conditions for approval set out in Appendix XI.

9B.12 Paragraphs 9B.8 to 9B.11 do not apply to an aircraft if:

- (a) the aircraft owner, operator or pilot has written authorisation from CASA, based on a safety case, for the operation of the aircraft without the ADS-B transmitting equipment; or
- (b) the equipment is unserviceable for a flight, and each of the following applies:
 - (i) the flight takes place within 3 days of the discovery of the unserviceability;
 - (ii) at least 1 of the following applies for the flight:
 - (A) flight with unserviceable equipment has been approved by CASA, in writing, subject to such conditions as CASA specifies;
 - (B) the unserviceability is a permissible unserviceability set out in the minimum equipment list for the aircraft and any applicable conditions under subregulation 37 (2) of CAR 1988 have been complied with;
 - (iii) ATC clears the flight before it commences despite the unserviceability.

ADS-B standard

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Part A

Approved equipment configuration

- 1 An equipment configuration is approved if it complies with the standards specified in Part B or Part C of this Appendix.

Part B

ADS-B transmitting equipment — standard for approval

- 2 ADS-B transmitting equipment must be of a type that:
 - (a) is authorised:
 - (i) in accordance with (E)TSO-C166(), or a later version as in force from time to time; or
 - (ii) by CASA, in writing, in accordance with:
 - (A) ATSO-C1004a, or a later version as in force from time to time; or
 - (B) ATSO-C1005a, or a later version as in force from time to time; or
 - (b) meets the following requirements:
 - (i) the type must be accepted by CASA as meeting the specifications in RTCA/DO-260 dated 13 September 2000, or a later version as in force from time to time; and
 - (ii) the type must utilise HPL at all times HPL is available; or
 - (c) is otherwise authorised, in writing, by CASA for the purposes of subsection 9B of this Civil Aviation Order as being equivalent to one of the foregoing types.

GNSS position source equipment — standard for aircraft manufactured on or after 8 December 2016

- 3 For an aircraft manufactured on or after 8 December 2016, the geographical position transmitted by the ADS-B transmitting equipment must be determined by:
 - (a) a GNSS receiver of a type that is authorised in accordance with (E)TSO-C145a or (E)TSO-C146a, or a later version as in force from time to time; or
 - (b) a GNSS receiver of a type that is authorised in accordance with (E)TSO-C196a, or a later version as in force from time to time; or
 - (c) a GNSS receiver or system which meets the following requirements:
 - (i) is certified by an NAA for use in flight under the I.F.R.;
 - (ii) has included in its specification and operation the following:
 - (A) FDE, computed in accordance with the definition at paragraph 1.7.3 of RTCA/DO-229D;
 - (B) the output function HPL, computed in accordance with the definition at paragraph 1.7.2 of RTCA/DO-229D;
 - (C) functionality that, for the purpose of HPL computation, accounts for the absence of the SA of the GPS in accordance with paragraph 1.8.1.1 of RTCA/DO-229D; or
 - (D) another equivalent system authorised in writing by CASA.

Note The following GNSS receivers meet the requirements of clause 3, namely, those certified to (E)TSO-C145a or (E)TSO-C146a, or later versions, or those manufactured to comply with (E)TSO-C196a.

GNSS position source equipment — standard for aircraft manufactured before 8 December 2016

- 4 For an aircraft manufactured before 8 December 2016, the geographical position transmitted by the ADS-B transmitting equipment must be determined by:
 - (a) a GNSS receiver or system that complies with the requirements of clause 3, other than sub-subparagraph 3 (c) (ii) (C) which is optional; or
 - (b) an equivalent GNSS receiver or system that has been approved in writing by CASA.

Note The following GNSS receivers meet the requirements of clause 4, namely, those certified to (E)TSO-C145a or (E)TSO-C146a, or later versions, or those manufactured to comply with (E)TSO-C196a. Some later versions of GNSS receivers certified to (E)TSO-C129 may also meet the requirements, i.e. those having FDE and HPL features incorporated.

Altitude source equipment — standard

- 5 The pressure altitude transmitted by the ADS-B transmitting equipment must be determined by:
 - (a) a barometric encoder of a type that is authorised in accordance with (E)TSO-C88a, or a later version as in force from time to time; or
 - (b) another equivalent system authorised in writing by CASA.

Aircraft address — standard

- 6 Unless otherwise approved, in writing, by CASA, the ADS-B transmitting equipment must:
 - (a) transmit the current aircraft address; and
 - (b) allow the pilot to activate and deactivate transmission during flight.

Note The requirement in paragraph 6 (b) is met if the ADS-B transmitting equipment has a cockpit control that enables the pilot to turn the ADS-B transmissions on and off.

ADS-B standard

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ADS-B in Australia

Part C

Alternative approved equipment configuration — standard for aircraft manufactured on or after 8 December 2016

7 For an aircraft manufactured on or after 8 December 2016, an equipment configuration is approved if:

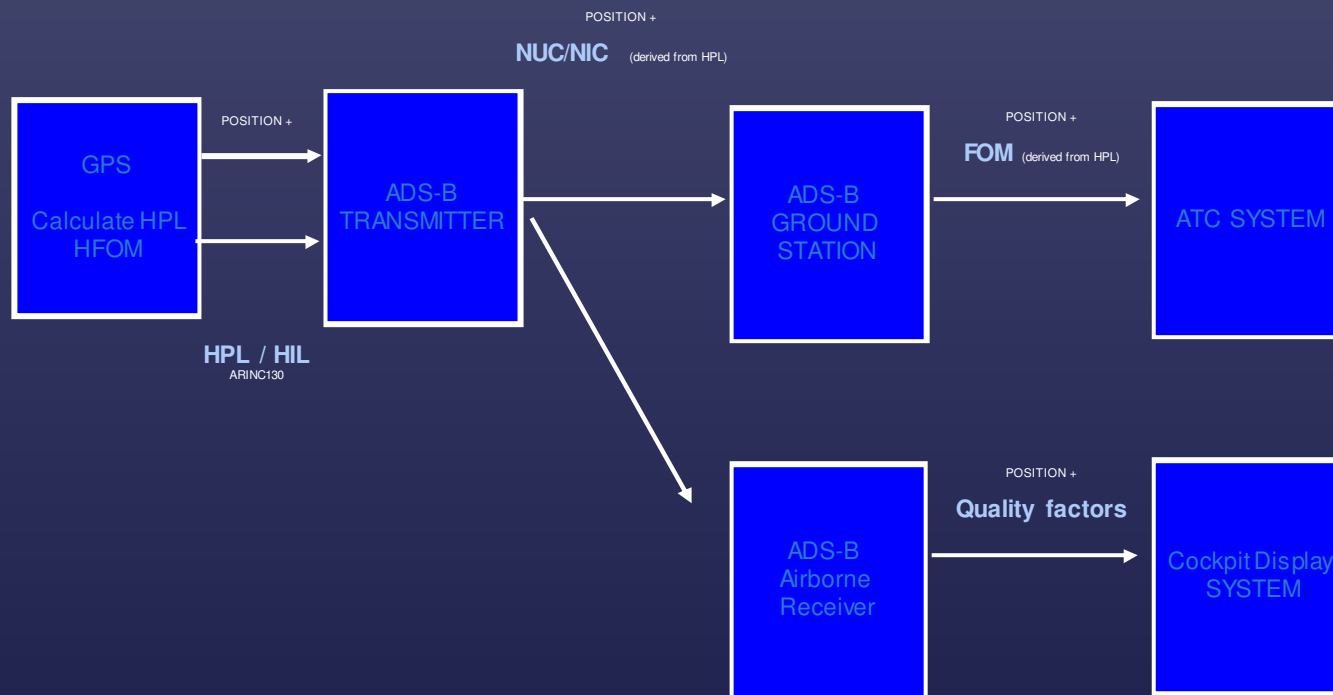
- (a) it has been certified by EASA as meeting the standards of EASA AMC 20-24; and
- (b) the aircraft flight manual attests to the certification; and
- (c) the GNSS receiver or system complies with the requirements of clause 3 in Part B.

Alternative approved equipment configuration — standard for aircraft manufactured before 8 December 2016

8 For an aircraft manufactured before 8 December 2016, an equipment configuration is approved if:

- (a) it has been certified by EASA as meeting the standards of EASA AMC 20-24; and
- (b) the aircraft flight manual attests to the certification; and
- (c) the GNSS receiver or system complies with the requirements of clause 4 in Part B.

ADS-B Reported Quality



Philosophy : The user decides if the data is good enough to use for the application!