

Submission: 101

Anonymous

Please see my comments in the attached copy of the consultation document.



Australian Government

**Department of Infrastructure, Transport,
Regional Development, Communications, Sport and the Arts**

ADS-B Mandate Cross Agency Working Group

Potential future expansion of Automatic Dependent Surveillance Broadcast (ADS-B) mandate in Australia

Consultation Paper

September 2025



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Introduction

The continued growth in the size and scope of Australia's aviation sector poses new challenges for the safe and efficient operation of Australia's airspace. The potential benefits of increased use of Automatic Dependent Surveillance Broadcast (ADS-B) capability for users of Australia's airspace have been the subject of discussion among aviation stakeholders for some time, most recently in the 2024 Aviation White Paper which signalled a clear policy intention to explore an expansion of the existing ADS-B mandate. Currently ADS-B is only required for flights under Instrument Flight Rules (IFR), or those above 29,000 ft.

A working group was established under the White Paper, involving participants from the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts (the Department), the Civil Aviation Safety Authority (CASA) and Airservices Australia, to advise on implementing a universal ADS-B mandate to Australian airspace. Representatives of the Australian Transport Safety Bureau (ATSB), the Australian Maritime Safety Authority (AMSA) and the Department of Defence (Defence) are also represented on the working group to contribute their expertise and bring critical sector-specific perspectives to the work of the group. The working group first convened in October 2024.

This consultation paper reflects the collaboration between government agency representatives to develop a balanced and informed proposal for stakeholder consideration. Whilst we acknowledge the participation of each agency in the working group, this paper does not reflect Australian Government policy, or the final position for any given agency, as each continues to consider its individual and independent responsibilities for aviation in Australia.

Purpose of this consultation

This paper is divided into two parts. Part A is an executive summary which outlines the considerations and benefits of an expanded ADS-B mandate, culminating in the proposed model. Part B summarises in further detail what ADS-B is, how it works, and how it's been regulated in Australia to date. It explores the potential benefits and challenges of different ADS-B related technologies and applications in the context of aviation safety and industry development. This leads to the presentations of a contextualised model for a mandate to support a phased take up of ADS-B technology.

While the consultation welcomes feedback from any interested party, those most likely to be impacted by a wider ADS-B mandate are those not covered under the current requirements for operations under IFR. These include, but are not limited to:

- Visual Flight Rules (VFR) operators, such as those within the following sectors
- General aviation (GA), recreational and private operators
 - Agricultural aviation and other low altitude aerial work
- Emerging aviation technologies such as remotely-piloted aircraft systems (referred to in this paper as drones) and AAM.

In addition to VFR operations, this paper also proposes an expansion in current requirements to mandate ADS-B IN capability for IFR operations in the short to medium term. This proposal is likely to impact air transport operators and current IFR operators so feedback from these operators is encouraged.

The working group is mindful that, while all stakeholders support progress to make skies as safe as possible, such progress will bring about additional cost. This could range from the purchase and installation of equipment, to the time required to amend standard operating procedures, and extra maintenance requirements.

The working group has sought to balance cost with benefit, and adopt a risk-based approach to what is proposed. It is important for pilots, owners and operators (crewed and uncrewed alike) to provide feedback through this consultation process so that Government is presented with advice which reflects their views.

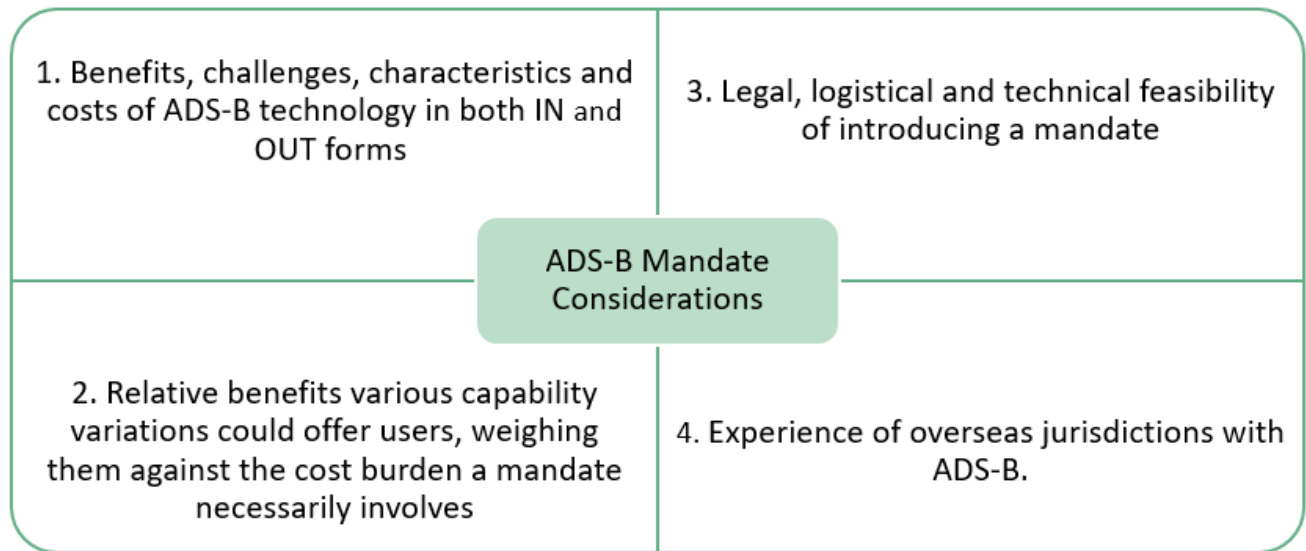
Part A – Executive Summary

1.1 Overview

Automatic Dependent Surveillance – Broadcast (ADS-B), has long been recognised as bringing substantial safety and capacity benefits for both crewed and uncrewed aircraft.

The Australian Government’s 2024 Aviation White Paper (2024 Aviation White Paper) stated that ‘widespread use of ADS-B technology will be necessary to support the safe and efficient operation of Australia’s future airspace’.

As a result, a cross-agency working group (the working group) was tasked with providing advice to the Australian Government by the end of 2025 on implementing a universal ADS-B mandate across all Australian airspace. The working group considered:



ADS-B technology is available in a variety of sizes and configurations and importantly, ADS-B OUT and ADS-B IN are two distinct functions. ADS-B OUT is the capability of an aircraft to broadcast their flight information automatically. ADSB-IN is the capability of a ground station or aircraft to receive and display ADS-B information.

In this document the following descriptions have been used to summarise the ways in which aircraft may provide ADS-B OUT and ADS-B IN capability:

Approved ADS-B equipment – Approved Mode S transponder with ADS-B OUT capability, connected to an approved GNSS (e.g. GPS) position source.

Approved EC device – A small ADS-B transmitting device, generally portable, that does not meet the same technical performance standards as approved ADS-B equipment. As at September 2025, Approved EC devices could be purchased for around \$1,000.

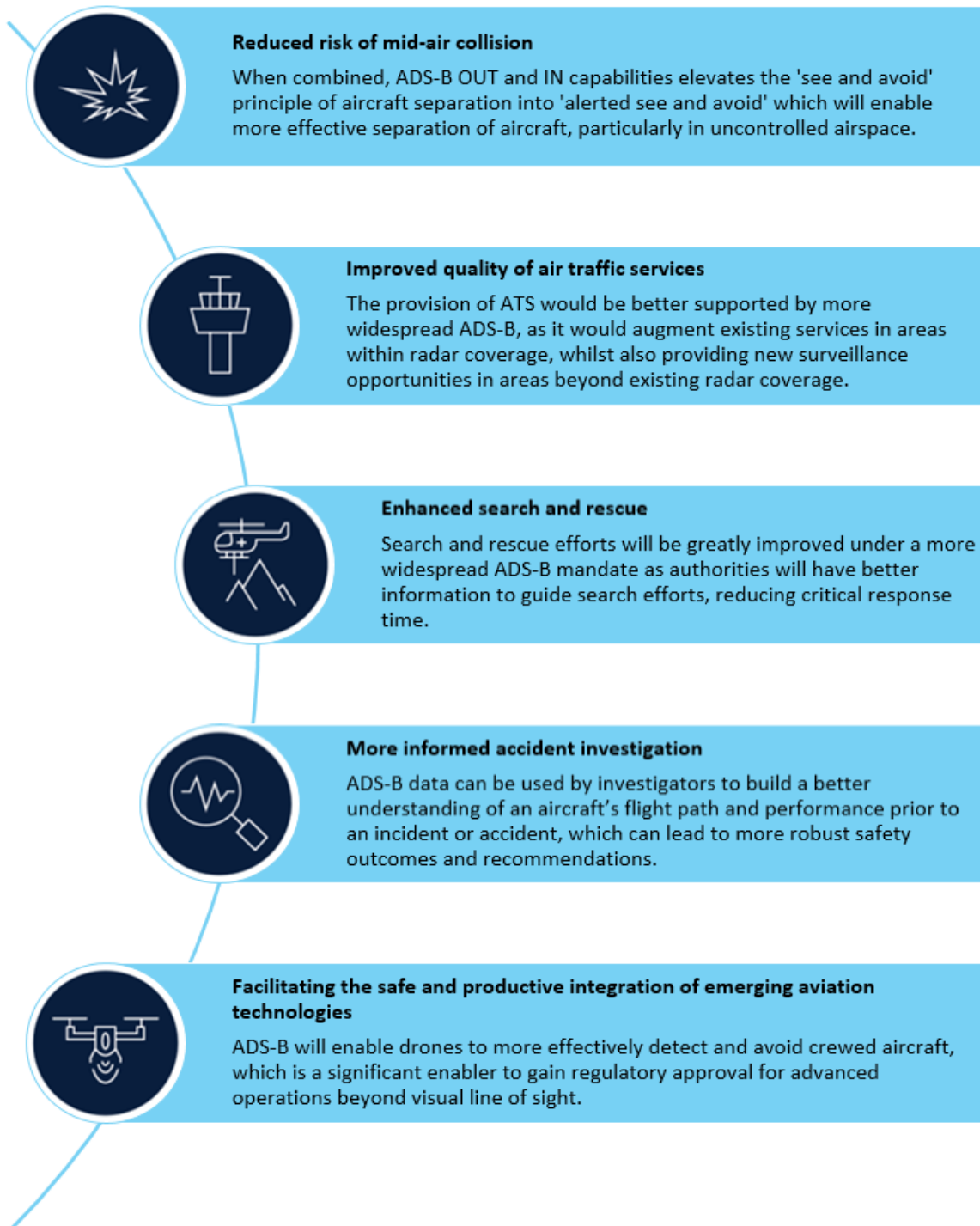
ADS-B receiver – device that has ADS-B IN functionality and provides visual and/or aural information to a pilot.

An ADS-B receiver could be in the form of an integrated ADS-B IN system, an EC device with ADS-B IN capability, or another system providing a similar function through an entire flight. For drone operations, ground based ADS-B receivers are suitable.

A description of approved ADS-B equipment and approved EC device can be found in Appendix C – Glossary.

1.2 Key benefits of an expanded ADS-B mandate

The working group distilled ADS-B's role in enhancing aviation safety and industry growth into five key benefits:



1.3 Potential model in brief

The working group has developed a potential model (the model) for a mandate, with an implementation timeline, for discussion and feedback by aviation stakeholders and the community (See Figure 1 and Figure 2). Feedback is also sought on variations to the potential model, and alternative approaches. This feedback will inform the Department's advice to Government at the end of 2025 on a future mandate of ADS-B.

Visual Flight Rules (VFR)

Overall, the model proposes a staged introduction of ADS-B OUT capability for all aircraft operating under VFR, including the use of approved electronic conspicuity (EC) device in some circumstances.

The model would see aircraft operating under VFR in class A, D, E and G airspace equipped with ADS-B OUT from 2028.¹

For Class D, E or G airspace, operators could choose between approved ADS-B equipment or approved EC devices. This would be supplemented in 2033 by a requirement for all capable aircraft² operating in Class B and C airspace to be equipped with approved ADS-B equipment.

A transition to approved ADS-B equipment for all capable VFR aircraft in all airspace is envisaged in the long term, at a time to be determined beyond 2033. Equipment requirements under an ADS-B mandate would be in addition to existing requirements relating to carriage and use of transponders.

The working group has proposed ADS-B IN capability using a suitable receiver be required from 2028 for all capable aircraft operating under VFR. This reflects the fact that much of the safety benefit of ADS-B technology is enabled only once both OUT and IN functionality is activated, and by the fact that approved EC devices in Australia can be capable of both OUT and IN functionality.

Instrument Flight Rules (IFR)

For aircraft operating under instrument flight rules (IFR), which are already required to use ADS-B OUT, the proposal is to mandate the use of ADS-B IN for all capable aircraft in all airspace from 2033.

Drones

To future-proof an ADS-B mandate for drones, consideration must be given to the type and quantity of operations today, as well as those expected in the future. The working group proposes a requirement for ADS-B IN capability from the end of 2028 for all beyond visual line of sight (BVLOS) drone operations, either by way of onboard equipment or a ground-based ADS-B receiver.

The working group also proposes all small drones operating above 400 feet above ground level (AGL), along with all medium and large drones have ADS-B OUT capability from the end of 2028. This can be achieved by either an approved EC device or approved ADS-B equipment. Certain exemptions are provided as appropriate for niche drone operations, such as indoor³, tethered or sheltered operations, which do not carry significant risk of mid-air conflict.

Advanced air mobility (AAM)

The model would also require all AAM aircraft to be fitted with both ADS-B OUT and ADS-B IN capability from the end of 2028.

¹ For further detail on classes of airspace, refer to Appendix A.

² Aircraft capable of supporting approved ADS-B equipment's weight, space and power requirements.

³ A description of indoor, sheltered and tethered operations can be found in Appendix C.

Other models

The potential model is designed to provide a starting point for discussion, but the working group has also asked for stakeholder views on other models, including mandating various narrower classes of operations for VFR aircraft in 2028 (See Figure 1).

Figure 1 Potential model and alternatives for ADS-B mandate – VFR

	End of 2028			End of 2033			Beyond 2033			Final outcome		
	Device required		Airspace applicable	Device required		Airspace applicable	Device required		Airspace applicable	Device required		Airspace applicable
VFR	Approved EC device or approved ADS-B equipment	➔	All capable aircraft in classes D, G, E	Approved ADS-B equipment	➔	All capable aircraft in classes B, C	Approved ADS-B equipment	➔	All capable aircraft in all airspace	Approved ADS-B equipment	➔	All capable aircraft in all airspace
	Approved ADS-B equipment	➔	All capable aircraft in class A									
	ADS-B receiver	➔	All capable aircraft in all airspace							ADS-B receiver	➔	All capable aircraft in all airspace
	VFR Alternative 1 – Select aerodrome model.											
	Approved EC device or approved ADS-B equipment	➔	All capable aircraft at selected aerodromes / regions (top 10)	Approved ADS-B equipment	➔	All capable aircraft in classes A, B, C, D, E	Approved ADS-B equipment	➔	All capable aircraft in all airspace	Approved ADS-B equipment	➔	All capable aircraft in all airspace
	Approved ADS-B equipment	➔	All capable aircraft <= 400ft (not T/O or Ldg)									
	ADS-B receiver	➔	All capable aircraft in all airspace							ADS-B receiver	➔	All capable aircraft in all airspace
	VFR Alternative 2 – RPT aerodrome model.											
	Approved EC device or approved ADS-B equipment	➔	All capable aircraft, in vicinity of aerodromes where RPT services operate	Approved ADS-B equipment	➔	All capable aircraft in classes A, B, C, D, E	Approved ADS-B equipment	➔	All capable aircraft in all airspace	Approved ADS-B equipment	➔	All capable aircraft in all airspace
	ADS-B receiver	➔	All capable aircraft in all airspace									
	VFR Alternative 3 – Certified aerodrome model.											
	Approved EC device or approved ADS-B equipment	➔	All capable aircraft, in vicinity of certified aerodromes	Approved ADS-B equipment	➔	All capable aircraft in classes A, B, C, D, E	Approved ADS-B equipment	➔	All capable aircraft in all airspace	Approved ADS-B equipment	➔	All capable aircraft in all airspace
	ADS-B receiver	➔	All capable aircraft in all airspace									
KEY: ADS-B-OUT ADS-B-IN												

KEY: ADS-B-OUT ADS-B-IN

Figure 2 Potential model for ADS-B mandate - IFR, drones and AAM aircraft

	End of 2028			End of 2033			Beyond 2033			Final outcome	
	Device required		Airspace applicable	Device required		Airspace applicable	Device required		Airspace applicable	Device required	Airspace applicable
IFR										Approved ADS-B equipment	→ All aircraft in all airspace
				ADS-B receiver	→	All aircraft in all airspace				ADS-B receiver	→ All aircraft in all airspace
Drones	Approved EC device or approved ADS-B equipment	→	Drones classified as small and operating above 400ft #							Approved EC device or approved ADS-B equipment	Drones classified as small and operating above 400ft #
		→	Drones classified as medium and large, regardless of altitude *								Drones classified as medium and large, regardless of altitude *
	ADS-B receiver	→	All BVLOS operations							ADS-B receiver	→ All BVLOS operations
AAM	Approved ADS-B equipment	→	All aircraft in all airspace							Approved ADS-B equipment	→ All aircraft in all airspace
	ADS-B receiver	→	All aircraft in all airspace							ADS-B Receiver	→ All aircraft in all airspace

Drone ADS-B OUT Exclusions:

#	Sheltered operations
*	Tethered, indoor, sheltered operations, model aircraft when operated at CASA-approved sites.

KEY:

ADS-B-OUT

ADS-B-IN

1.4 How to have your say

We are seeking your views on the potential model and alternatives for an ADS-B mandate as presented in this paper.

The questions below are intended to guide your feedback and responses. You may choose to respond to the questions or provide a separate response, including alternative options or approaches. Any supplementary information provided may also inform future decision making.

We invite feedback by 27 October 2025 via the [‘Have Your Say’](#) portal.

Do you support an ADS-B mandate? Why or why not?

- If so, what airspace and/or aircraft types would you include in it?

Can you provide feedback on the potential model (Figure 1 and Figure 2)?

- Do you consider the model to be sensible and achievable? Why or why not?
- What aspects of the model would you retain, alter, or discard? Why or why not?
- What impact would the model have on your operations, if applicable?
- ☐ What are the estimated costs that you might incur in complying with this mandate?
- ☐ What are the potential benefits for your operation?
- Were the model adopted as government policy, when should all VFR aircraft in all airspace be fitted with approved ADS-B equipment (currently ‘beyond 2033’)?
- Are the proposed weight and height limits for drones, above which an ADS-B OUT mandate would apply, appropriate?

Are any of the alternate options outlined at Figure 1 a better way forward? Why or why not?

Noting the Government’s ADS-B rebate program, have you fitted ADS-B to your aircraft? Why or why not?

1.5 Next steps

Your responses will inform the working group’s recommendations to Government about the expansion of the ADS-B mandate in Australia. This will include providing Government with your feedback on the proposals in the Consultation Paper. The working group will report to Government by the end of 2025.

This will not be the last opportunity to provide feedback if the Government decides to expand the ADS-B mandate.

Any ADS-B mandate expansion would require an update to the civil aviation safety regulatory rules. CASA would consult on any proposed rule changes and invite feedback from government departments, commercial businesses, industrial and consumer groups, aviation industry bodies, other relevant bodies and organisations and the broader public.

Part B – Discussion Paper

2. What is ADS-B and how does it work?

ADS-B is a surveillance technology that combines an aircraft's positioning source, aircraft avionics, and receiving infrastructure (ground and airborne) to create an accurate surveillance interface between an aircraft and other aircraft or air traffic services (ATS). Figure 3 is a graphical representation of the generation, transmission and reception of ADS-B.

Figure 3 Graphical representation of ADS-B (source: CASA)



ADS-B OUT involves an aircraft determining its position using global navigation satellite system (GNSS). A transmitter then broadcasts that position, along with data such as identity, altitude and velocity. In Australia, ADS-B data is broadcast every half-second on a 1090 MHz digital data link.

Traditional radar surveillance is where a transponder only broadcasts when interrogated by a radar system, whereas ADS-B is an:

- Automatic - requires no pilot input or external interrogation
- Dependent - depends on accurate position and velocity data from the aircraft's navigation system (e.g. GNSS⁴)
- Surveillance - provides aircraft position, altitude, velocity, and other surveillance data to facilities that require the information
- Broadcast - information is continually broadcast for monitoring by appropriately equipped ground stations or aircraft.

ADS-B technology includes two components:

- ADS-B OUT – transmission of an aircraft's position and other information
- ADS-B IN – capability of a pilot, operator or air traffic control to both receive and present ADS-B information from transmitting aircraft.

⁴ GNSS is the Global Navigation Satellite System, commonly known in Australia as GPS.

2.1 ABS-B OUT

This paper discusses two forms of ADS-B OUT technology:

- approved ADS-B equipment
- approved EC devices (electronic conspicuity).

Each type of technology has pros and cons such as strength of transmission and weight, as summarised in Table 1.

Table 1 Features of approved ADS-B equipment compared to approved EC devices.

Approved ADS-B equipment	Approved EC devices
Installed, powered or integrated as a primary aircraft system	Lightweight, portable and battery and/or USB cable powered
Quality of transmissions suitable for air traffic control service	Quality of transmissions not suitable for air traffic control service, but useful for enhancing pilot situational awareness
Produces higher power transmissions	Produces lower power transmissions
Must be installed by a Licenced Aircraft Maintenance Engineer (LAME)	Easy to install and does not require a LAME
Higher cost option	Relatively lower cost (from around \$1,000)
Authorised in accordance with international technical standards	

Australia allows different levels of certification and capability for ADS-B OUT equipment, depending on flight category and aircraft operation. For flights operated under IFR, the only ADS-B OUT option is approved ADS-B equipment.

For flights operated under VFR, a broader range of ADS-B OUT options are useable:

- for the rare high-level operation (e.g. high altitude balloon flights operating above 29,000 ft), approved ADS-B equipment is required
- where a flight is expecting to receive an Air Traffic Service (ATS) surveillance separation service via ADS-B (beyond the coverage of conventional secondary surveillance radar), approved ADS-B equipment is required⁵.

Otherwise, where an aircraft operator or owner wishes to use ADS-B OUT to aid situational awareness, either approved ADS-B equipment or approved EC devices may be used, but are not currently required. Either fitment will be capable of supporting the provision of ATS outside of controlled airspace, noting that ATS services may be limited for aircraft equipped with EC devices. Another consideration for an aircraft operator or owner is that fitment of ADS-B OUT to their aircraft may also assist the more rapid location of their aircraft in a distress situation.

⁵ For aircraft like light sport aircraft or those with an experimental certificate, the rules permit equipment that is not authorised to the relevant technical standards, but nevertheless provides the same surveillance capability as if it were authorised under those standards.

2.2 ADS-B IN

Realising the full benefits of ADS-B OUT requires another party to receive the signal and display the information in a safe and useful way. ADS-B IN consists of an on-board radio receiver that receives and then processes ADS-B OUT transmissions from any aircraft within radio range. The received ADS-B OUT data is then displayed for pilot reference, as a fixed display on the instrument panel or via a portable tablet or electronic flight bag (EFB), or through the remote control display of a drone. In some cases, the cockpit display for an approved EC device is incorporated into an electronic flight instrument system. Many systems produce an aural message or warning.

While fitting ADS-B OUT could be seen as making a commitment to the safety of other airspace users by enabling them to see nearby aircraft, ADS-B IN would be a commitment to an operator's own safety by enabling them to see other aircraft and maximise situational awareness.

In addition to assisting in aircraft separation, ADS-B IN can be used for advanced functionality, such as enabling two aircraft to follow each other directly (called in-trail procedures), or cockpit display-assisted visual separation.

ADS-B IN is already a factory option for some new air transport aircraft. There are also several low-cost ADS-B IN products that are available for both air transport aircraft and general aviation aircraft. For uncrewed aircraft, ADS-B IN equipment can be either ground based or fitted to the aircraft. Which system an operator uses could be determined by the equipment and its performance capability, by the aircraft being operated or by the personal preference of the operator.

2.3 Other technologies

The options available to Australian aviation in addition to ADS-B to manage the risk of mid-air collision and enable the integration of uncrewed aircraft includes other technologies such as FLARM, Remote ID and ADS-L. These are further discussed in Appendix B – Other technology.

3. ADS-B regulation 2009–2025

In response to the 2009 Aviation White Paper, CASA developed proposals for aircraft communication, navigation and surveillance equipment for the following decade. The plan included adoption of global navigation satellite system (GNSS) and broad adoption of ADS-B.

Public feedback on the proposals was mixed:

- passenger transport sector respondents were generally supportive of the proposal
- the GA sector respondents were generally accepting of the need for possible solutions to future air traffic management (ATM) needs, while also expressing cost concerns
- the sport and recreational sector respondents, both industry organisations and individuals alike, opposed any requirement for ADS-B carriage in Class G and Class E airspace⁶.

As a result, the proposal was refined considering the feedback received, with the outcome being the current mandate, implemented by February 2017, which requires the use of ADS-B OUT for:

- any aircraft (IFR or VFR) operating above 29,000 ft
- new IFR aircraft
- existing IFR aircraft.

As a result of the feedback, ADS-B OUT was not mandated for VFR aircraft, however it was considered that a mandate would be likely from around 2020. Such a mandate was intended to align with similar requirements planned for introduction at that time in the United States of America (USA).

Since the introduction of the original mandate in 2017, Australia's aviation safety agencies have continued to advocate for wider use of ADS-B. To this end, the National Aviation Safety Plan⁷ includes an ongoing action for the Department and CASA to work together on encouraging voluntary ADS-B fitment.

In 2022, the Australian Government announced the ADS-B Rebate Program⁸ to support general and recreational aviation operators to install ADS-B in their aircraft. In 2024 the program was extended to 2027, and its scope expanded to include equipment that offers ADSB-OUT, ADSB-IN, or both, to owners of Australian-registered aircraft operating under both VFR and IFR.

⁶ A description of Australian airspace classes can be found at Appendix A –Australian airspace architecture

⁷ The Australian National Aviation Safety Plan 2024–2027—October 2024

www.infrastructure.gov.au/sites/default/files/documents/the-australian-national-aviation-safety-plan-2024-2027-october2024-6november2024.pdf

⁸ Automatic Dependent Surveillance Broadcast (ADS-B) Rebate Program – Round 2 | business.gov.au

www.business.gov.au/grants-and-programs/automatic-dependent-surveillance-broadcast-rebate-program-round-2

4. International introduction of ADS-B technology

The mandated use of ADS-B in key overseas jurisdictions has steadily increased in the last decade, with variation in terms of the timing and breadth of mandates:

- In the USA, ADS-B OUT has been mandatory since 2020 for all aircraft in most controlled airspace.⁹ Following a mid-air collision between a passenger aircraft and a military helicopter in January 2025, the Rotorcraft Operations Transparency and Oversight Reform (ROTOR) Act was tabled in the USA. If it comes into law, all aircraft in controlled airspace must be equipped with ADS-B IN within three years.
- Canada's air navigation service provider, NAV CANADA, made ADS-B OUT mandatory in Canada's Class A airspace in August 2023 (above 18,000 ft). Then in May 2024, it became mandatory in Class B airspace (above 12,500 ft). Mandates in Class C, D and E airspace will be determined no sooner than 2028
- in Europe, ADS-B OUT is mandated for all aircraft operating IFR with a maximum take-off weight (MTOW) of 5700 kg or greater, and/or a maximum cruising airspeed greater than 250 knots
- New Zealand has required all aircraft operating in all controlled airspace to be equipped with ADS-B OUT since 2023. ADS-B forms the primary source of surveillance information for aircraft separation in New Zealand airspace.

The role of ADS-B to support the integration of uncrewed aviation technologies in future airspace planning and flight management regulation is recognised in ADS-B mandates across the world:

- the European Union Aviation Safety Agency (EASA) U-Space concept¹⁰ requires VFR aircraft in U-Space to be equipped with ADS-B OUT to enable uncrewed aviation to support detect and avoid action
- in Canada, NAV CANADA has utilised space-based ADS-B since 2019. This has expanded and improved ADS-B surveillance coverage in Canada's airspace. It is anticipated increased ADS-B coverage, and subsequent increased uptake, will support drone 'detect and avoid' capabilities installed by several leading drone manufacturers in Canada
- in the USA, the Federal Aviation Administration (FAA) chartered the Beyond Visual Line of Sight (BVLOS) Aviation Rulemaking Committee to provide safety recommendations relating to the future expansion of BVLOS operations by uncrewed aircraft.

It is clear from these international efforts, that several nations have moved or are moving towards ADS-B as a crucial element to increase aircraft surveillance, particularly as space-based ADS-B¹¹ becomes more readily available.

Several jurisdictions also recognise ADS-B as playing an important role in enabling the integration of emerging aviation technologies into airspace. Broader mandates of ADS-B are seen as a mechanism to enable ADS-B-equipped drones and AAM platforms to effectively separate through 'detect and avoid' actions.

The working group will continue to monitor international developments in the use and application of ADS-B in formulating its advice to Government.

⁹ Classes A, B and C airspaces, Class E airspace above 10,000ft in the 48 contiguous States and the District of Columbia, Class E airspace above 3,000ft over the Gulf of Mexico, and within 30 NM of designated airports.

¹⁰ U-Space airspace is a concept where concentrated uncrewed aviation operations are enabled by digital systems and rules which allow for integrated airspace and separation achieved through U-Space service providers.

¹¹ Instead of utilising traditional radio receiver towers on the ground, space based ADS-B uses satellites which allows for 100 percent global surveillance using the same ADS-B signal that aircraft already transmit.

5. ADS-B's role in enhancing aviation safety and industry growth

ADS-B has long been recognised as bringing substantial safety and capacity benefits. The Eleventh International Civil Aviation Organisation (ICAO) Air Navigation Conference in 2003 endorsed ADS-B, and recommended that States recognise ADS-B as an enabler of ICAO's Global Air Traffic Management Operational Concept (GATMOC)¹². The GATMOC provides direction to achieve an integrated, harmonised and globally interoperable ATM system. Aligned with the GATMOC, the ICAO Global Air Navigation Plan (GANP)¹³ is ICAO's highest air navigation strategic document and plan to drive the evolution of the global air navigation system. It is supported by the Aviation System Block Upgrade (ASBU)¹⁴ framework which includes several ADS-B elements as part of worldwide efforts towards ATM modernisation.

The advance in uncrewed aircraft technology and operations and the impending introduction of AAM aircraft have introduced new risks. The increase in mining operations has resulted in an increase in aerodrome density in areas like the Pilbara, and an increased traffic mix of large jet-powered and small piston-powered aircraft. Soon, uncrewed aircraft are likely to join that mix. A similar mix of aircraft can be found on firegrounds operating in often hazardous conditions with varying degrees of visibility.

ADS-B OUT equipment in crewed aircraft will be an important part of efforts to improve safety. It will produce benefits including increased 'visibility' for pilots of uncrewed aircraft, to more accurate provision of traffic information services and the resulting increased situational awareness, all of which can contribute to equitable access and shared responsibilities in airspace. ADS-B OUT will also be important, considering the same integration and visibility reasoning, on large uncrewed aircraft such as AAM. Benefits to the aviation industry of integration of crewed and uncrewed will be maximised when uncrewed operators can have visibility of all aircraft in vicinity.

In that context, the key objectives of an expanded ADS-B mandate include:

- reduced risk mid-air collisions, between crewed aircraft, and between crewed and uncrewed aircraft
- facilitation of the safe and productive integration of emerging aviation technologies
- improved quality of ATS
- increased search and rescue efficiency
- more informed accident investigation.

5.1 Reduced risk of mid-air collision

ADS-B significantly reduces the risk of a mid-air collision by providing situational awareness to pilots and greater visibility to air traffic control. Pilots, and VFR pilots in particular, have long operated on the principle of 'see and avoid', by looking out for other airspace users and avoiding them, including through voice communications. In effect, ADS-B turns the 'see and avoid' concept into 'alerted see and avoid'. The use of ADS-B IN gives pilots the advantage of knowing where to direct their attention.

5.1.1 Crewed aviation

Domestic and international passenger travel is forecast to increase annually, by 2.6 per cent and 2.7 per cent respectively, from now to 2050, as shown in Figure 4)¹⁵.

Much of the growth is expected to be at capital city airports (2.4 per cent year-on-year) however passenger numbers through non-capital city airports are also forecast to increase by similar amounts (1.9 per cent a

¹² ICAO Doc 9854 - GATMOC

https://www2023.icao.int/Meetings/anconf12/Document%20Archive/9854_cons_en%5B1%5D.pdf

¹³ Home - ICAO GANP Portal <https://www4.icao.int/ganportal/>

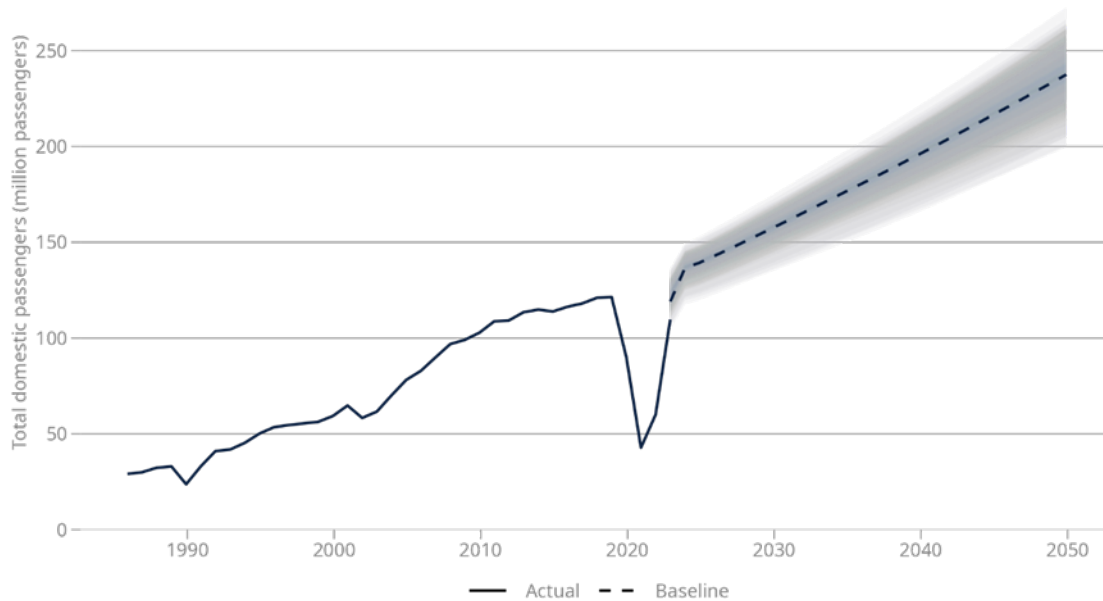
¹⁴ ASBU Threads - ICAO GANP Portal

<https://www4.icao.int/ganportal/ASBU/Thread/Pdf?IDs=17&ShowPart1=true&ShowPart2=true>

¹⁵ Australian aviation forecasts – 2024 to 2050 www.bitre.gov.au/publications/2024/australian-aviation-forecasts-2024-2050

year). This forecast growth will naturally result in an increase in air transport and an associated increase in the risk of mid-air collision, especially when the growth in uncrewed aviation is also considered.

Figure 4 Actual and forecast domestic air passengers, 1985–2050 (Source: BITRE, 2024)



In the vicinity of non-controlled aerodromes, collision risk mitigation is the responsibility of the pilots who are operating aircraft with a wide range of capabilities and equipment. This ranges from new generation high capacity jet aeroplanes with multiple navigation, communication and traffic alerting systems to ultra-light aircraft with a single pilot and perhaps one radio, to helicopters large and small. While operating procedures have been effective to date, they are not without shortcomings, with several recent examples of mid-air collisions.

Case Study - Mid-air collision involving Piper PA-44-180 Seminole and Beech D95A Travel Air¹⁶

Around midday on 19 February 2020 a Beech D95A Travel Air, and a Piper PA44-180 Seminole, collided mid-air approximately 8 km south of Mangalore Airport, Victoria. The Travel Air was approaching Mangalore Airport from the south, on descent to conduct a practice instrument approach, while the Seminole was southbound on climb from Mangalore to Essendon Airport.

Both aircraft were operating under the IFR in non-controlled airspace and were fitted with ADS-B OUT equipment. The pilots of each aircraft had been provided with traffic information about the other aircraft prior to the collision in accordance with ATS procedures.

As part of the investigation into the mid-air collision, the ATSB identified concerns around the pilots' ability to visually identify the other aircraft in time to take evasive action. The ATSB undertook an aircraft performance and cockpit visibility study to determine at what times the aircraft may have been visible to the crew of the opposing aircraft.

The ATSB study found the pilots of both aircraft were unlikely to have acquired the other aircraft visually due to meteorological factors, aircraft closing speed and shielding of the opposing aircraft by cockpit structure with 2 of the 4 pilots likely having the opposing aircraft shielded from their view at key moments. The ATSB analysis indicated that even in clear conditions, more favorable to visual acquisition, the closing speed and shielding by the aircraft structure would have limited opportunities to acquire the other aircraft.

¹⁶ ATSB Aviation Investigation AO-2020-012 www.atsb.gov.au/publications/investigation_reports/2020/aa/ao-2020-012

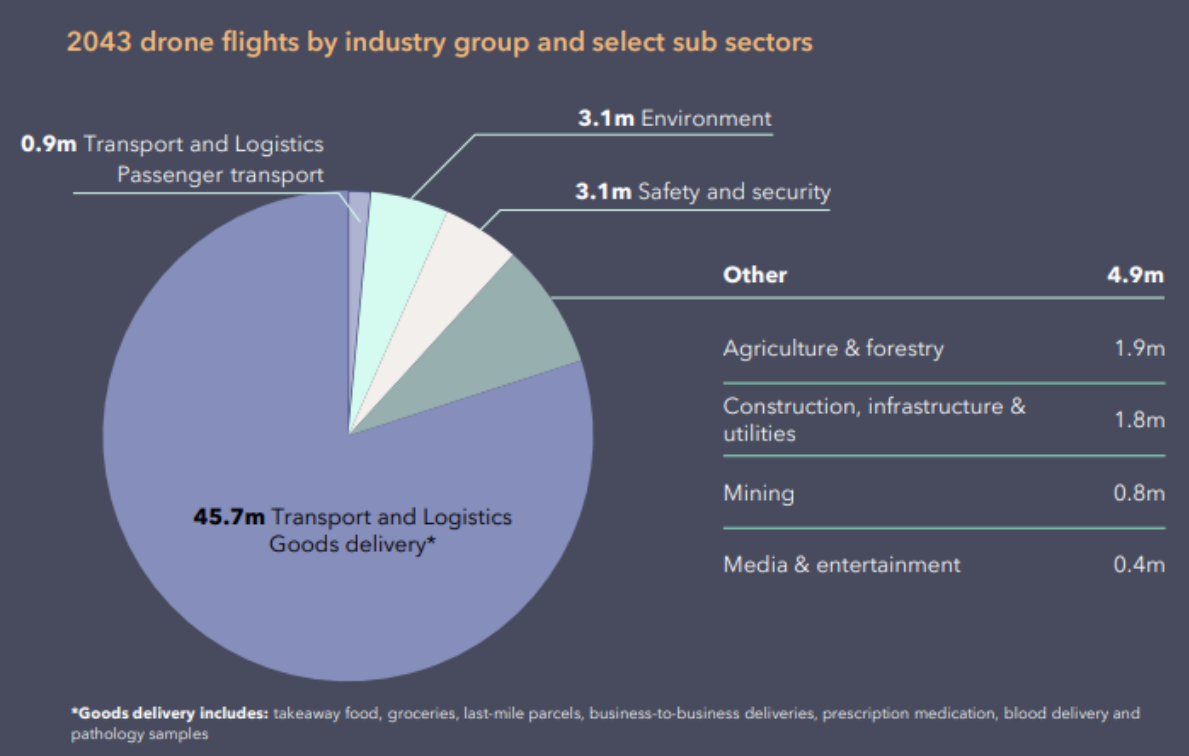
Neither accident aircraft was equipped with ADS-B IN systems. The ATSB study showed that had the aircraft been equipped with this technology the pilots would have been alerted to the position of the other aircraft much earlier than by visual acquisition. Both a cockpit display of traffic information with an ADS-B traffic alerting system or an electronic conspicuity device connected to an electronic flight bag application could have provided this.

While effective radio communication remains the primary means of self-separation in non-controlled airspace, the targeted and accurate information provided by ADS-B IN can provide the pilot significant assistance.

5.1.2 Mid-air collision between crewed and uncrewed aircraft

While there were about 1.5 million drone flights in Australia in 2023, the maturing sector is forecast to see that number reach 60 million by 2043 as shown in Figure 5 ¹⁷. The largest growth is expected to be in goods delivery services followed by environmental services flights, and safety/security flights. Passenger transport flights are also expected to emerge as AAM technology evolves to enable air travel to compete with ground travel on rural and regional routes.

Figure 5 2043 drone flights by industry group and select sub sectors (Source: Scyne Advisory, 2024)



One important consideration in the context of this growth is the ability to support safe interactions between aircraft of all types, crewed and uncrewed. This interaction will be important across all airspace types and many areas of Australia, and relying on existing aircraft equipment and procedures is unlikely to maintain the safety levels we all expect from aviation.

Uncrewed aircraft will increasingly seek to operate commercially in the same airspace as crewed aviation. In such cases, the see and avoid principle, so vital to maintaining separation of crewed aviation, will not work, due to drones and AAM being remotely piloted.

Accordingly, the risk of mid-air collision between crewed aircraft and uncrewed aircraft will increase. The increasing size and weight of uncrewed aircraft, from small quadcopter drones, through to passenger-carrying AAM aircraft, means the consequences of a collision are likely to increase in severity. The risk will grow from

¹⁷ Sizing the future drone and advanced air mobility market in Australia February 2024 www.airservicesaustralia.com/wp-content/uploads/2024/02/Sizing-the-Future-Drone-Industry-in-Australia_February.pdf

suburban areas, where drones perform ‘last mile’ deliveries, and low levels commonly below 400 ft AGL, to rural and regional areas and higher altitudes from sea level to altitudes above 10,000 ft.

ADS-B IN is relatively straightforward for uncrewed aircraft to adopt to detect nearby aircraft to mitigate the risk of mid-air collision. However as outlined previously, ADS-B IN relies on other aircraft having ADS-B OUT to be truly beneficial.

5.2 Improved quality of air traffic services

5.2.1 Surveillance capabilities in Air Traffic Management

Provision of ATS in Australia’s busier and more complex airspace corridors and terminal areas have traditionally been supported only by a network of approach and en-route radars, focusing on providing coverage within controlled airspace.

Since its introduction in 2005, the use of ADS-B in surveillance has continued to evolve. It has:

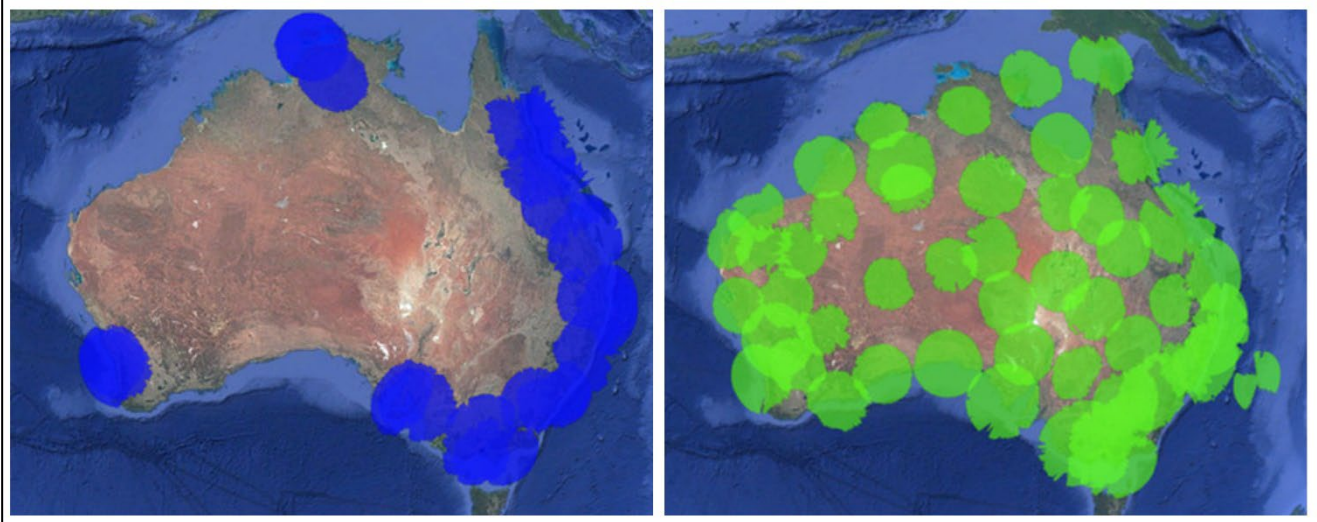
- transformed ATS in upper airspace across the entire continent in a way previously not achievable, nor cost effective with radar technology
- augmented existing services in areas within radar coverage
- provided new surveillance opportunities in non-controlled airspace outside of radar coverage.

When aircraft are under surveillance and in receipt of ATS, surveillance provides many safety benefits, including alerting air traffic control (ATC) to:

- aircraft emergencies initiated by transponder activation
- deviations from route and/or level intentions
- potentially unsafe situations (such as unintended penetration of active Special Use Airspace or projected proximity to other traffic).

Currently, ADS-B transmissions are detected by a network of terrestrial ground stations and displayed to ATC. ADS-B ground stations used to support ATS are typically deployed to provide coverage within controlled airspace (Classes A, C, D and E) to support the provision of surveillance *separation*. Consequently, ADS-B surveillance coverage within Class G airspace is generally limited due to line-of-sight limitations from ground-based infrastructure (similar to VHF radios), as shown in Figure 6. ADS-B coverage in Class E and G airspace is also used to support the provision of surveillance-derived *traffic information*, being generally timelier and more accurate than pilot report-based traffic information. In complex or busy environments in non-controlled airspace, ADS-B can be a potential cost-effective mechanism for improving service quality where surveillance does not currently exist.

Figure 6 Representative coverage of radar (blue) and ADS-B (green) at 10,000 ft (Source: Airservices Australia)



While limited at lower altitudes, the line-of-sight nature of ADS-B transmissions enables increased coverage from each ground station with increased altitude. Figure 7 shows that at an altitude of 25,000 ft, ADS-B coverage is almost Australia wide, compared with the very limited coverage by traditional radars in inland areas.

Figure 7 Representative coverage of radar (blue) and ADS-B (green) at 25,000 ft (Source: Airservices Australia).

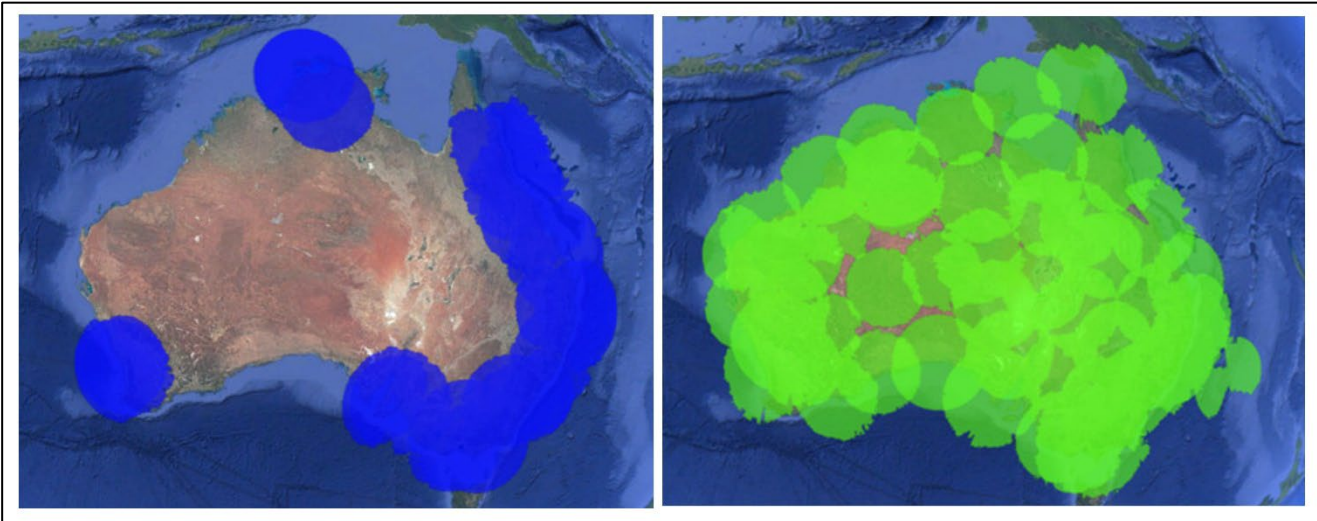


Figure 6 and Figure 7 depict theoretical coverage where the provision of ATS to aircraft with approved ADS-B equipment could be expected. As EC devices typically have a lower power output, areas where ATS may be supported through EC device fitment may be reduced, i.e. have reduced range of coverage from the ground-based ADS-B receiver used by ATC.

Importantly, it must be recognised that the ADS-B coverage from ground stations discussed here is relevant only to matters associated with the provision of ATS. Even when outside coverage of a ground station, ADS-B OUT transmissions from aircraft can be received directly by aircraft fitted with ADS-B receivers when within range. Depending on the type of equipment and installation, that range can be hundreds of kilometres.

5.2.2 Future ATS surveillance in Australia

Future ATS surveillance in Australia is likely to prioritise the use of ADS-B in areas of low to medium air traffic volume and complexity, whereas areas of high traffic and complexity would still require conventional radar surveillance. Increased uptake of ADS-B will assist this transition to a cooperative-only surveillance environment. For example, the current surveillance technology covering Tasmania will require a refresh in the

coming years, with ADS-B being considered as the preferred technology driving better value (through lower cost to implement) for airspace customers. In this scenario, for ATS service quality to be maintained, aircraft will have to be fitted with approved ADS-B equipment.

ATS surveillance via satellite-based ADS-B receivers is an emerging capability and will factor into the long-term surveillance strategy. Satellite-based ADS-B can fill in the ‘gaps’ created by either terrain shielding or line-of-sight limitations of ground-based receivers (see Figure 6 and Figure 7), which would significantly boost ATS surveillance (and associated ATS service quality) in areas where installation of new ground-based receivers would not be cost effective. Satellite-based ADS-B can also provide surveillance where ground-based coverage is not possible (i.e. oceanic airspace), which would improve airspace efficiency, capacity and safety in those areas previously unable to have surveillance coverage.

ADS-B is also considered an important component of a future uncrewed aircraft system traffic management (UTM) ecosystem. The Australian Government and the emerging aviation technology industry are working in partnership to introduce a framework for a future UTM which will better enable management of drones and AAM aircraft. The UTM Action Plan¹⁸ outlines the regulations, infrastructure, standards, anti-collision technologies, role and responsibilities, risk-based rules and services that will be required into the future. ADS-B is cited in the Action Plan as a critical enabler to a future UTM given the previously detailed role it could play in enabling uncrewed operators to detect and manage interactions with other aircraft.

Case Study – ADS-B Information used to prevent intrusion of active Restricted Airspace

An aircraft en-route to a Class D aerodrome is cleared to commence an instrument approach. The aircraft starts its approach but fails to make the required turn, resulting in a track likely to infringe an active restricted area and, if a continuous descent profile is continued, has the potential to result in flight into terrain.

Scenario 1 – aircraft not equipped with ADS-B OUT

With no ADS-B and no radar, the tower controller must rely on pilot reports to monitor progress through the approach. Therefore, it would not be possible for the tower controller to proactively identify the incorrect tracking or altitude.

The aircraft continues into the restricted area and descends below the minimum safe altitude. When the expected progress report is not received, the tower controller contacts the pilot who must determine where they are and how best to maneuver, adding to their confusion.

Scenario 2 – aircraft equipped with ADS-B OUT

The tower controller observes the aircraft’s ADS-B position has failed to make the required turn and is heading directly towards an active restricted area. The tower controller is able to issue an immediate safety alert to the pilot and suggests tracking advice to remain clear of the restricted airspace and arrest descent.

Once established clear of the restricted area and at a safe altitude, the aircraft is again cleared for the approach and lands without further incident.

¹⁸ UTM (Uncrewed aircraft system Traffic Management) Action Plan <<https://www.drones.gov.au/policies-and-initiatives/policies/uncrewed-traffic-management>>

5.3 Enhanced search and rescue

AMSA is responsible for providing Australia's aeronautical search and rescue (SAR) service. Its Joint Rescue Coordination Centre (JRCC Australia) maintains 24 hour, 7 days a week readiness to coordinate the response to aviation emergencies and accidents across Australia's vast SAR region which covers the combined Brisbane and Melbourne Flight Information Regions, or around 10 per cent of the earth's surface. AMSA works closely with Airservices Australia and Defence Air Traffic Services during aviation emergencies.

In the event of an aircraft in distress, SAR efforts can be seriously hampered when the distress location is not known. Without an accurate distress location, the search area can be large and delay the rescue of survivors which can be critical to survivability.

Large search areas can involve multiple aircraft and large groups of people. Accident sites can be in challenging locations such as rugged terrain, heavy vegetation, remote areas or at sea where a crashed aircraft can be difficult to find and which all come with safety risks for those searching by air, at sea, or on the ground.

In an emergency landing of an aircraft on water, it is critical for JRCC Australia to have the best possible last known position of the aircraft, noting that survivors may drift long distances in a short time, and the search area in oceanic areas expands with time.

For an aircraft in distress fitted with ADS-B OUT, JRCC Australia has access to satellite and ground-based ADS-B flight data which, when combined, provides coverage for the entire Australian SAR Region. JRCC Australia can immediately review this ADS-B data to assist with locating the last known position of ADS-B OUT equipped aircraft, which significantly reduces the search area improving the ability to rapidly locate the distress site and rescue survivors. This data supplements other distress position information which may be available such as Air Traffic Services radar surveillance data, distress beacon activation, or a mayday call.

SAR aircraft fitted with ADS-B IN can also monitor other aircraft fitted with ADS-B OUT in the vicinity of a search operation which helps with management of collision avoidance and improves safety of operations.

Case Study – VFR aircraft reported missing

JRCC Australia is alerted of a VFR aircraft which has failed to arrive on a flight from Cooktown to Coen, Queensland. The alert is raised by a friend of the pilot who is holding a flight note and is waiting at Coen aerodrome to meet the pilot and one passenger. Three hours of daylight remain.

No distress calls or distress beacon have been detected. The flight note shows the pilot had planned to fly coastal to Port Stewart then direct to Coen, a total of about 225 nautical miles. The flight is outside Air Traffic Service radar coverage.

Scenario 1 – aircraft not equipped with ADS-B OUT

A quick air search of the planned route before last light followed by an electronic night search does not locate the overdue aircraft.

A search for the following day is planned by multiple search aircraft with ground rescue units mobilised. The crashed aircraft is located near the end of that second day's search in heavy vegetation 6 nautical miles south of the flight planned track about halfway to the destination.

Both occupants had initially survived but succumbed to their injuries in the hours immediately following the crash.

Scenario 2 – aircraft equipped with ADS-B OUT

JRCC Australia examines satellite-derived ADS-B OUT data for the aircraft which quickly provides the aircraft's actual track and last known position.

A rescue helicopter from Cairns is dispatched to commence a visual search in the vicinity of the last detected ADS-B OUT position and locates the crashed aircraft about 300 metres from that last detected position.

The helicopter rescues the two injured survivors 30 minutes before last light and airlifts them to hospital.

5.3.1 Reduced cost and environmental impact

SAR operations can be complex and often involve several assets responding by air, land and sea at considerable expense. In addition to improving SAR response times and the potential life-saving benefits this brings, ADS-B's role in reducing search times can also reduce cost and environmental impact.

There is a cost saving opportunity in reducing search time, as more rapid location of accident sites enabled by ADS-B will also bring down the costs associated with response operations and importantly increases the availability of those assets for other emergencies.

Equally, a reduced operating time will also reduce the environmental impact of SAR aircraft, vessels and vehicles and their associated emissions.

5.4 More informed accident investigations

The ATSB improves safety and public confidence in aviation through their independent 'no blame' investigation of transport accidents and safety occurrences, influencing sector safety action and fostering safety awareness.

Evidence collection is a critical phase in the ATSB investigation process. Investigators gather available evidence which is later analysed to paint as detailed a picture of the occurrence as possible.

5.4.1 Early access to the site

Early access is important to minimise any potential disturbance of the accident site as the positioning of the wreckage, debris and any ground scars may provide valuable insight to investigators. As outlined in the previous scenarios, ADS-B can support more rapid search and rescue response to an accident. This can subsequently enable accident investigators to access the site sooner, minimising the risk of site disruption or deterioration in adverse environments.

5.4.2 Detailed flight profile data

ADS-B offers investigators valuable information, which can be particularly beneficial during an investigation in a remote area where there is quite often limited evidence available. ADS-B broadcasts may include:

- precise position (latitude/longitude) based on GPS
- position integrity/accuracy
- barometric and geometric altitudes
- vertical rate (rate of climb/descent)
- track angle and ground speed (velocity)
- emergency indication (when emergency code selected).

This suite of detailed data can be used by investigators to build a better understanding of an aircraft's flight path and performance prior to an incident or accident, which can lead to more robust safety outcomes and recommendations.

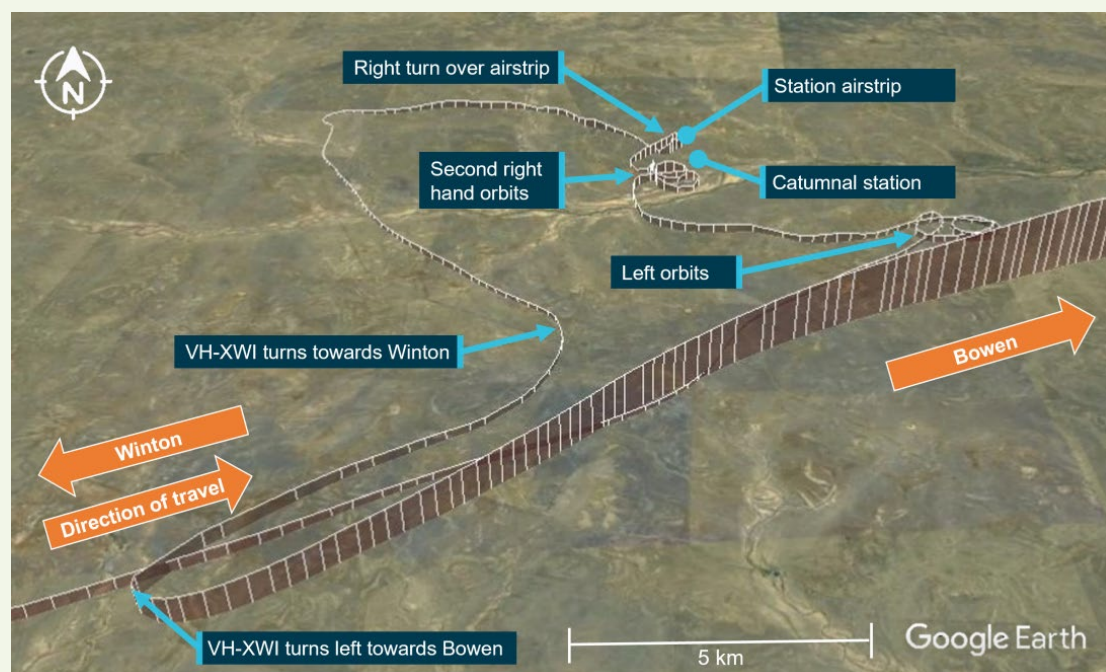
ATSB identified safety issues and recommendations play a critical role in improving transport safety and public confidence. ADS-B data supports detailed analysis, strengthening the opportunity for the sector to learn, identify trends and seek to reduce the overall risk of accident occurrence in the future.

Case Study – VFR into IMC and in-flight break-up ¹⁹

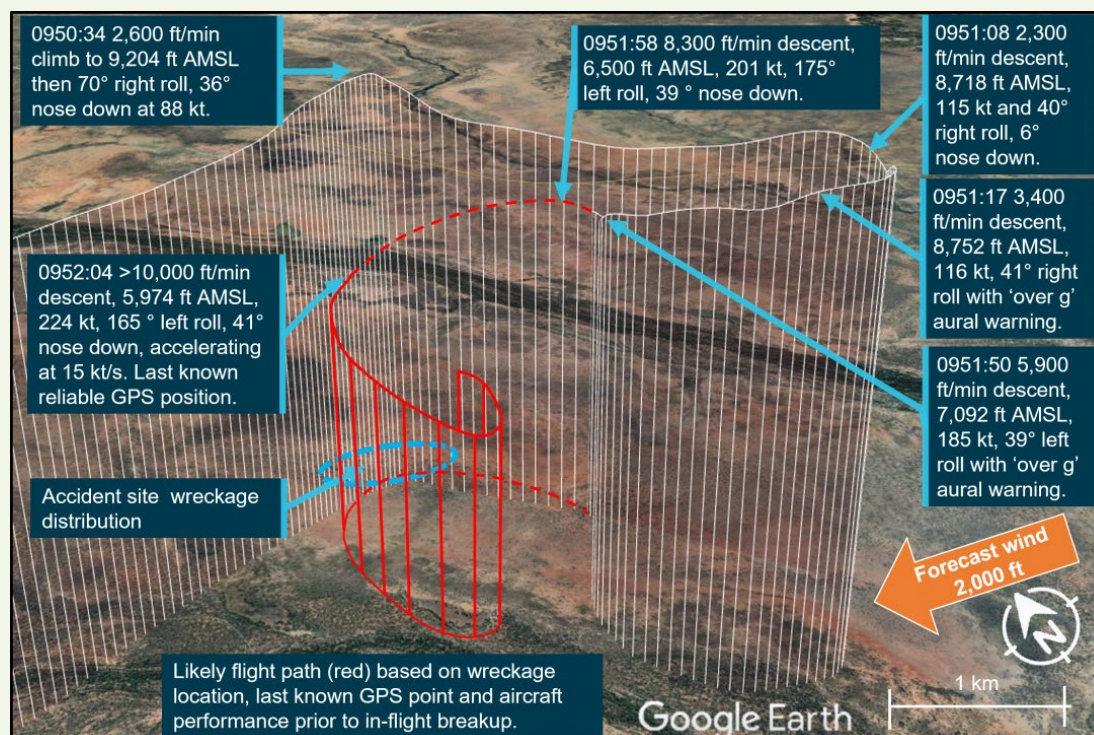
In one example, ADS-B data allowed investigators to create a detailed picture of a Vans RV-7A's flight path prior to its collision with terrain in remote Queensland in April 2021. During this accident, the non-instrument rated pilot – who was fatally injured – likely entered instrument meteorological conditions before becoming spatially disorientated, resulting in loss of aircraft control.

The ADS-B flight path reconstruction enabled the investigation to determine the sequence of events and the factors that contributed to the aircraft breaking up in flight.

Figure 8 Flight Path of VH-WXI in the vicinity of Catumnal Station (Source: Google Earth with Aireon data, annotated by the ATSB.)



¹⁹ ATSB Aviation Investigation AO-2021-017 < VFR into IMC and in-flight break-up involving Van's Aircraft RV-7A, VH-WXI, 90 km south of Charters Towers, Queensland, on 23 April 2021 | ATSB>

Figure 9 VH-WXI accident sequence (Source: Google Earth with Dynon data, annotated by the ATSB)

5.5 Facilitating the safe and productive integration of emerging aviation technologies

With the projected growth in emerging aviation technologies, Australia's airspace is expected to become increasingly congested. The integration of uncrewed platforms into airspace is a complex undertaking, and broader uptake of ADS-B will be a critical enabler amongst a suite of policy, regulatory and technical solutions.

Emerging aviation technologies are set to contribute between \$9.4 billion to \$20.7 billion to Australian real Gross Domestic Product over the 20 years to 2040.²⁰ Australia can capitalise on this economic opportunity by meeting the challenge of airspace integration, through the design regulations and airspace conditions which support the operation of uncrewed aircraft alongside existing established forms of aviation.

A broader ADS-B mandate will play a significant role in integrating different aircraft by:

- enabling uncrewed aircraft to utilise ADS-B to detect and avoid other aircraft
- reducing the complexity in regulatory pathways for advanced BVLOS and AAM operations, which is currently restricting the growth of the uncrewed industry
- enabling Australia to reap the economic and productivity benefits derived from an advanced uncrewed aviation technology industry.

²⁰ [Deloitte Access Economics - Economic Benefit Analysis of Drones in Australia, 2020](#)

5.5.1 ADS-B enabled detect and avoid

In VFR conditions, pilots use visual identification to ‘see and avoid’ other aircraft operating in their vicinity. Uncrewed aircraft are unable to do this and must rely on other methods. All currently available methods have significant limitations. For example, limiting drone operations to visual line of sight, or extended visual line of sight, significantly limits the scope of operations that can be conducted with emerging aviation technologies. Other potential solutions, such as utilising non-cooperative detection technologies which can detect other aircraft in the drone operating area without relying on those aircraft having some form of electronic conspicuity equipage, is not cost or weight-effective at the current time.²¹

ADS-B electronic conspicuity is the most established and commonly used equipment for VFR aircraft in Australia and provides a reliable and cost-effective method for uncrewed aircraft to detect other nearby aircraft. An ADS-B OUT mandate on VFR aircraft would enable drone and AAM operators to rely on ADS-B receivers to detect crewed aircraft in their vicinity and thereby maintain separation.

This could be achieved through VFR aircraft carrying either approved ADS-B equipment or an approved EC device, as both options could support sufficient Tactical Mitigation Performance Requirements (TMPR) to allow drones to operate in areas of higher intrinsic air risk.

VFR aircraft could thus be detected via on-board ADS-B receiver or through ground or space-based ADS-B detection which is then transmitted to the remote pilot. ADS-B receivers are a low-cost and low weight detection solution for drone operators, and many commercially available drones are already equipped with ADS-B receivers built in. For example:

- DJI, a large drone provider in Australia, provides ADS-B-IN technology, which it refers to as DJI AirSense, in many of its commercial-off-the-shelf aircraft
- Drone manufacturer Autel has ASDB-IN available in the Autel EVO II Enterprise drone series.

5.5.2 Beyond Visual Line of Sight (BVLOS) drone operations

BVLOS drone operations are complex and are currently assessed using the specific operations risk assessment (SORA) framework. This SORA framework requires drone operators to determine the initial air risk (inherent risk of collision with other aircraft in the area) of their intended operations, which then enables sufficient mitigations to be planned with the aim of reducing the initial air risk to a lower level.

The SORA framework requires drone operators to:

- gain sufficient evidence to demonstrate low levels of intrinsic air risk, even in remote locations, when claiming a lower risk airspace
- conduct extensive stakeholder engagement or perform extended monitoring of airspace use as reliable data (i.e. all airspace users) is not available
- outline appropriate mitigation tactics based on the air risk level to maintain separation with other aircraft.

Assessing and approving these operations is difficult for CASA as:

- assessing this evidence is often a complex process that requires significant resources from CASA assessors, and the large volumes of applications is leading to long wait times and approval times for complex drone operations

²¹ Includes onboard technology such as optical sensors, LIDAR or RADAR equipment. Such technology is prohibitive in cost and weight, and regulatory pathways to certify this equipment are still being developed. In the case of ground-based detection technologies (such as RADAR), Australia has limited coverage, particularly at the lower operating altitudes of most drones. In the US, North Dakota has sought to establish a state-wide detection network to enable BVLOS flights, investing \$48 million USD so far into the Vantis network. This kind of technology is not cost-effective to install to support drone operations in Australia and is being used less frequently in favour of cooperative detection methods such as ADS-B and Secondary Surveillance Radar (SSR).

- without drone operators meeting the standards for higher air risk levels, it is difficult for CASA to approve an operation if the air risk is anything other than very low.

As a result:

- BVLOS operations face a high regulatory burden and long wait times to gain approval
- CASA has not yet been able to approve a complex BVLOS drone operation in ARC-c²² or ARC-d airspace, which is in part because operators do not currently have practical pathways to see and avoid the majority of airspace users
- because methods of see and avoid technology are limited, even mature and experienced operators face high regulatory burdens.

A mandate for ADS-B OUT on VFR aircraft would have considerable positive impact on drone operators to undertake assessments and seek approval for BVLOS operations by improving the ability of drone operators to assess air traffic and intrinsic air risk. Drone operators would be able to rely on ADS-B OUT signals from either approved ADS-B equipment, or approved EC devices, to enable appropriate mitigation tactics through detect and avoid aircraft separation.

5.5.3 Overcoming regulatory barriers for drones and AAM can unlock significant economic and productivity potential for Australia

The drone industry is reaching an inflection point. Drones have been adopted at a steady rate for simpler tasks such as inspections or photography which can be typically conducted under visual line of sight rules.

However, there will be a rapid acceleration in drone uptake for more advanced BVLOS operations should industry be supported with enabling policy and regulatory processes. This includes activities such as drone delivery and transport, long-range infrastructure or environmental inspections and emergency response activities.

AAM operations are anticipated to launch in Australia in the late 2020s. Advantages of AAM compared to traditional aviation include their lower cost, noise levels and infrastructure requirements. AAM is also expected to become increasingly automated over time, further reducing costs. AAM aircraft may commence operating under VFR flight rules but will transition to automated remotely-piloted operations to increase operating efficiencies, and this transition will rely on solutions which enable AAM to effectively separate from crewed aircraft and drones.

CASA's RPAS and AAM Strategic Regulatory Roadmap²³ outlines the broader strategy and planning to safely integrate these technologies into Australia's airspace and future regulatory system, however in past industry consultation, the development of an ADS-B OUT mandate for VFR aircraft has been consistently identified as one of the highest priority policy recommendations by the emerging aviation technologies sector.

An advanced drone industry will provide wide ranging benefits across the Australian economy. The benefits will be particularly noticeable in certain sectors listed below. The operations in these sectors which in the future may be undertaken by drones operating BVLOS, have traditionally been undertaken by crewed aviation.

For crewed aviation, these operations are historically high-risk activities, requiring a high degree of aviation skill and focus from pilots operating at very low-level, near to obstacles and often in remote locations.

Using drones to undertake these activities beyond visual line of sight will not only provide cost savings, but also offers an alternative to placing pilots and crew into high risk operating environments.

These economic and productivity benefits rely on the appropriate means to integrate complex BVLOS drone operations into Australian airspace. A broader mandate for ADS-B is essential to support and deliver these benefits.

²² ARC-c and ARC-d are Air Risk Classifications applied during the SORA process. [Specific operations risk assessment | Civil Aviation Safety Authority](#)

²³ See [RPAS and AAM Strategic Regulatory Roadmap](#)

Table 2 Estimated cost savings per industry sector

Sector	Example applications	Cost Savings ²⁰ (Medium uptake scenario)
Agriculture, forestry and fishing	Crop and livestock monitoring	\$3,488 million
	Crop spraying	
	Mustering	
	Environmental assessments	
Mining	Mine surveying and mapping	\$2,480 million
	Site safety inspections and surveillance	
Utilities	Inspection of critical utilities infrastructure (wind farms, powerlines)	\$453 million
Construction	Inspection and surveillance during major construction	\$1,345 million

6. Potential model in context

It is clear to the working group that widespread use of ADS-B OUT and ADS-B IN technology would provide significant safety benefits for the Australian aviation industry, all aircraft, crewed and uncrewed alike. Such an outcome would see the risk of mid-air collision greatly reduced.

Uncrewed aircraft would be better integrated into our skies, which would enable this emerging sector to grow and provide economic benefit and cost savings to a wide range of Australian industries.

Search and rescue and accident investigation efforts would be made simpler and safer, the quality of air traffic services would be increased, and the industry well placed to implement the future ATS tool of choice.

However, an across-the-board mandate like that may be difficult to implement and, in the short to medium term, may represent a disproportionate burden on operators when considered alongside perceived safety and other benefits.

The working group has therefore proposed a stepped introduction of ADS-B OUT and ADS-B IN functionality, balancing the relative urgency and cost of installation for each logical group of operations – VFR aircraft, IFR aircraft, drone and AAM aircraft. The proposal includes milestones commencing from the end of 2028, and five years hence (end of 2033), which would see incremental increases in required functionality.

A third milestone has been included which would see approved ADS-B OUT functionality, in addition to some form of ADS-B IN, required for all capable aircraft in all Australian airspace, at some point beyond 2033. In safety terms, this represents the ultimate safety outcome. However, the working group has intentionally left timing for this milestone undefined, in recognition of the need to account for unforeseen technological and other developments in the intervening period.

6.1 VFR aircraft

Figure 10 Potential model for VFR aircraft

	End of 2028		End of 2033		Beyond 2033		Final outcome	
	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable
VFR	Approved EC device or approved ADS-B equipment	→ All capable aircraft in classes D, G, E	Approved ADS-B equipment	→ All capable aircraft in classes B, C	Approved ADS-B equipment	→ All capable aircraft in all airspace	Approved ADS-B equipment	→ All capable aircraft in all airspace
	Approved ADS-B equipment	→ All capable aircraft in class A						
	ADS-B receiver	→ All capable aircraft in all airspace					ADS-B receiver	→ All capable aircraft in all airspace

KEY: ADS-B-OUT ADS-B-IN

The design of the milestones for VFR aircraft is intended to build on existing rules for carriage of surveillance equipment, while realising the benefits of ADS-B without unnecessary delay, and also balancing the cost, regulatory and administrative burden on the sector (Figure 10).

6.1.1 ADS-B OUT

The initial milestone for VFR aircraft, proposed for the end of 2028, would see aircraft operating in Class D, E or G airspace carrying ADS-B OUT equipment. This is in addition to today's requirements for the carriage of transponders, which remain in place²⁴. The additional ADS-B OUT equipment required could be in the form of an approved EC device, or approved ADS-B equipment.

²⁴ For example, the requirement to carry a transponder for operations above 10,000 ft in Glass G airspace, but not below 10,000 ft in Class G airspace.

As previously discussed, drones and AAM operations are forecast to grow in the coming years and mandating the carriage of ADS-B OUT equipment in Class G airspace is an important part of integrating uncrewed operations into Australian airspace. The rationale for grouping Classes D, E and G is based on similarities between operating requirements for VFR aircraft, in particular separation requirements, across those classes of airspace.

End of 2028

The option of meeting the requirements of the mandate through use of an approved EC device in 2028 provides a low-cost transition for crewed aircraft operating in non-controlled and lower-trafficked areas to get increased safety benefits while also enabling the integration of new technologies.

In relation to operations in Class A airspace, the distinction between operations above and below 29,000 ft is not mentioned because this model of mandate includes an additional requirement to today's transponder fitment. Under the proposal, all aircraft operating in Class A airspace, regardless of altitude, would be required to fit approved ADS-B equipment. The very small number of flights under VFR in Class A airspace would mean negligible impact on operators.

End of 2033

The second milestone for VFR aircraft would see the introduction of a requirement for approved ADS-B equipment to be fitted to any aircraft operating in Classes B or C airspace, while leaving the previously introduced requirements for Classes D, E and G in place.

Mandatory carriage of ADS-B equipment in airspace classes B and C is not necessary today because those areas are all within radar coverage; fitment of an appropriate transponder meets the needs of Air Traffic Services. However, as conventional surveillance radar sites reach obsolescence and are retired, ADS-B as the preferred surveillance system of ATS will be increasingly important. The proposal to require approved ADS-B is driven by an appreciation that the data transmitted by approved EC devices is not of a suitable quality for the provision of ATC services.

The working group is mindful of the difficulties commonly experienced by operators seeking to fit approved ADS-B equipment owing to the shortage in qualified Licensed Aircraft Maintenance Engineers and equipment. The milestone at the end of 2033 has been proposed with an eye to providing adequate time for aircraft owners, operators and maintainers to source and install the necessary equipment.

Beyond 2033

The final step in developing a universal ADS-B OUT mandate for VFR operations would apply to all operations in all airspace. This final milestone would remove approved EC devices as an option and would result in a requirement for all VFR aircraft, in all airspace, being fitted with approved ADS-B equipment. Recognising that pilots and operators may have recently purchased approved EC devices, this final milestone is intentionally a long-term objective, taking account of the prevailing technological, traffic and sectoral conditions beyond 2033.

6.1.2 ADS-B IN

Fitting ADS-B OUT equipment to VFR aircraft would achieve some of the benefits expected from an equipment mandate however for maximum benefits to be achieved, pilots must be able to detect other aircraft, as well as being detected by others. Consistent with experience of the Australian Government's ADS-B Rebate Program, many VFR operators may choose to use an approved EC device to meet the ADS-B OUT mandatory requirements. These devices typically incorporate ADS-B IN technology, therefore mandating ADS-B IN would impose minimal additional burden while producing a significant benefit for the industry.

In addition to EC devices with both ADS-B OUT and ADS-B IN functionality, dedicated ADS-B receivers are available, including low-cost portable receivers. In cases where aircraft are already fitted with approved ADS-B equipment, using those low-cost ADS-B receivers is a simple, relatively low cost of way of delivering the benefits of ADS-B to operators.

6.2 IFR aircraft

Figure 11 Potential model for IFR aircraft

	End of 2028		End of 2033		Beyond 2033		Final outcome	
	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable
IFR							Approved ADS-B equipment	All aircraft in all airspace
			ADS-B receiver	All aircraft in all airspace			ADS-B receiver	All aircraft in all airspace

KEY: ADS-B-OUT ADS-B-IN

Complementing the existing requirement for approved ADS-B equipment in IFR aircraft, the model would see ADS-B receivers in all capable aircraft in all airspace by the end of 2033 (Figure 11).

When operating in cloud or at night, pilots may not be able to employ the see and avoid technique and so must rely on other procedures and equipment. An ADS-B IN capability would bring considerable safety benefits to the IFR fleet as an additional mitigator to the risk of mid-air collision, particularly important when operating larger air transport aircraft in the vicinity of smaller aircraft.

However, fitting ADS-B receivers to large passenger aircraft presents a significant challenge as many large passenger aircraft were designed and built with few means of installing the technology. This probably reflects the fact that, in many countries, the nature of the airspace is such that air transport operations can be conducted entirely in controlled airspace and ADS-B IN capability is therefore not a significant consideration. This contrasts with Australia's operating environment, where larger passenger aircraft often operate in Class E or G airspace, to Class D aerodromes or non-controlled aerodromes.

Limited historical demand for ADS-B IN has resulted in few options being developed to retrofit ADS-B IN capability to larger pressurised aircraft. In addition, some currently available portable ADS-B receivers may not function effectively (due to factors such as interference by heated windscreens).

Nonetheless, the working group is aware of promising technological developments which have the potential to result in a viable ADS-B IN solution for many aircraft hitherto unable to accommodate one, and of one device currently available that the manufacturer has advised would be suitable for use in large aircraft.

In the context of a general scarcity of current options to fit ADS-B receiver capability for large aircraft, the working group has proposed a 2033 implementation date for ADS-B IN capability for IFR aircraft. Any resulting regulatory requirement would be contingent on a viable solution being widely available ahead of the settled implementation date. The potential application of an ADS-B IN mandate to foreign aircraft operating into Australia would also need to be carefully considered and settled.

In the event that the 2033 implementation date were adopted, it would also be open to IFR operators to fit an ADS-B receiver to their aircraft and avail themselves of the safety benefits sooner than the deadline, were such an option available.

6.3 Drones

Figure 12 Potential model for drones

	End of 2028		End of 2033		Beyond 2033		Final outcome	
	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable
Drones	Approved EC device or approved ADS-B equipment	→ Drones classified as small and operating above 400ft #					Approved EC device or approved ADS-B equipment	→ Drones classified as small and operating above 400ft #
		→ Drones classified as medium and large, regardless of altitude *						→ Drones classified as medium and large, regardless of altitude *
	ADS-B receiver	→ All BVLOS operations					ADS-B receiver	→ All BVLOS operations

KEY:

ADS-B-OUT

ADS-B-IN

Drone ADS-B OUT Exclusions:

#	Sheltered operations
*	Tethered, indoor, sheltered operations, model aircraft when operated at CASA-approved sites.

Drones come in a wide range of shapes and sizes, and they are growing in number within Australian airspace. In formulating the model for drones (Figure 12), the working group has considered the exponential growth projected for such drones into the future, the impact of that growth on the risks associated with collision between drones and crewed aircraft, and the risk of overcrowding displays for air traffic control or other flight crew, to best enable integration of these emerging aviation technologies into the future.

6.3.1 ADS-B IN

Drone operators will benefit significantly from broader fitment of ADS-B OUT, as paired with an ADS-B receiver, as this would enable them to detect and avoid other aircraft. This addresses a key challenge the uncrewed industry experiences in progressing from visual line of sight operations, where drones are operated within sight of a remote pilot at all times, to BVLOS drone operations which are impacted by the lack of suitable detection technologies.

This is not to suggest that detect and avoid will be the sole risk mitigation strategy, nor even the primary means for separation. Drones are sophisticated systems and operators deploy a mix of strategies to support safe operations, however ADS-B enabled detect and avoid undoubtedly provides an important last line of defence, enabling the approval of BVLOS drone operations.

The working group proposes a mandate for all BVLOS drone operations to be equipped with an ADS-B receiver, enabling safe separation from other aircraft when the drone is not within sight of the remote pilot. Given drones are operated remotely, this may be achieved by either a receiver built into the aircraft, or by a ground-based ADS-B IN receiver.

6.3.2 ADS-B OUT

Under the proposal, from the end of 2028, ADS-B OUT would be required for drones according to the following weight and airspace breaks:

ADS-B OUT required for	Any drone categorised as small and operating above 400 ft AGL	Any drone categorised as medium or large, regardless of altitude
Exclusions²⁵	Sheltered operations	Tethered operations Indoor operations Sheltered operations Model aircraft when operated at CASA-approved sites.

This position is a potential starting point for ADS-B OUT in drones which balances two key risks; an oversaturation of ADS-B OUT by an ever-increasing number of drones in the sky on one hand, as against the increasingly serious consequences in the event of a collision with drones of increasing weight on the other.

With growing numbers of drones in the sky, a mandate for all drones to transmit ADS-B OUT would create a significant volume of traffic information. Too much ADS-B OUT information would be distracting, drawing the focus of on-board pilots away from operating their aircraft, or alternatively, pilots of crewed aircraft may deliberately filter out ADS-B inputs, reducing the utility of ADS-B to prevent mid-air collision. Additionally, mandating ADS-B carriage in all drones could saturate the 1090 MHz frequency, reducing the ability of ATC to provide effective services.

Drones operating BVLOS would be equipped with ADS-B IN to enable them to detect and avoid aircraft equipped with ADS-B OUT. However, the working group has also considered the role of ADS-B OUT in mitigating the potential mid-air collision risks posed by larger drones, as well as those operating at higher altitudes where they would increasingly interact with crewed aviation, as we move towards more integrated skies.

To suitably balance these considerations, it would be beneficial as an additional layer of protection for crewed aircraft to be able to detect drones which pose greater risk. As such the working group proposes that all small drones operating above 400 ft AGL, along with all medium and large drones, would be required to equip with ADSB-OUT from the end of 2028. Tethered, indoor and sheltered operations would be exempt from the ADS-B OUT carriage requirements. This reflects the nature of these types of operations, and that they would not occupy the same airspace as crewed aviation.

Mandating ADS-B OUT only for medium and large drones, and small drones operating above 400 ft AGL, the risk of saturating the ADS-B frequency can be reduced. High density drone operations (i.e. drone delivery services) typically occur below 400 ft AGL. As such, high density drone operations are less likely to contribute to a saturation of the 1090 MHz frequency. Even with the lack of ADS-B OUT capability for those drones, the risk of mid-air collision with crewed aircraft would not increase (due to their minimum altitude limit of 500 ft AGL).

The electronic conspicuity of micro, very small and small drones operating below 400 ft AGL is still considered important, however the working group acknowledges other streams of work across government, such as the UTM action plan²⁶, where other technologies, systems and rules are being considered for these smaller drones to safely integrate them into Australian airspace.

²⁵ A description of indoor, sheltered and tethered operations can be found in Appendix C

²⁶ UTM (Uncrewed aircraft system Traffic Management) Action Plan < <https://www.drones.gov.au/policies-and-initiatives/policies/uncrewed-traffic-management>>

As previously outlined, this position serves as a starting point in balancing the potential oversaturation of ADS-B OUT by drones, against its utility in preventing mid-air collision. As the sector matures there will be increasing numbers of drones operating BVLOS, with increasing levels of ADS-B OUT transmission. It is not clear what additional quantum of ADS-B transmissions will negatively impact the ATM system and also pilots using ADSB-IN for situation awareness in the cockpit. Accordingly, there may be a need to impose conditional ADS-B requirements where ADSB OUT is required in some circumstances, but in other contexts, such as in busier areas, there may even be situations where ADSB OUT transmission is not permitted by drones into the future to manage an increasing oversaturation risk.

6.4 AAM aircraft

Figure 13 Potential model for AAM aircraft

	End of 2028		End of 2033		Beyond 2033		Final outcome	
	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable
AAM	Approved ADS-B equipment	→ All aircraft in all airspace					Approved ADS-B equipment	→ All aircraft in all airspace
	ADS-B receiver	→ All aircraft in all airspace					ADS-B Receiver	→ All aircraft in all airspace

KEY: ADS-B-OUT ADS-B-IN

From the end of 2028 all AAM aircraft would be required to use approved ADS-B equipment, and an ADS-B receiver (Figure 13).

This would have minimal impact on the AAM sector as whilst some AAM aircraft will initially operate under the VFR, AAM aircraft will be configured to eventually operate under the IFR or a future version of the IFR tailored to autonomous AAM operations. Accordingly, ADS-B OUT is already mandatory under the IFR, and ADS-B IN would be readily incorporated into remote operating systems.

7. Alternative models – operations under the VFR

Figure 14 Potential alternative models for mandates in VFR operations

	End of 2028		End of 2033		Beyond 2033		Final outcome	
	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable	Device required	Airspace applicable
VFR Alternative 1 – Select aerodrome model.								
	Approved EC device or approved ADS-B equipment	→ All capable aircraft at selected aerodromes / regions (top 10)	Approved ADS-B equipment	→ All capable aircraft in classes A, B, C, D, E	Approved ADS-B equipment	→ All capable aircraft in all airspace	Approved ADS-B equipment	→ All capable aircraft in all airspace
	Approved ADS-B equipment	→ All capable aircraft ≤ 400ft (not T/O or Ldg)						
	ADS-B receiver	→ All capable aircraft in all airspace					ADS-B receiver	→ All capable aircraft in all airspace
VFR Alternative 2 – RPT aerodrome model.								
	Approved EC device or approved ADS-B equipment	→ All capable aircraft, in vicinity of aerodromes where RPT services operate	Approved ADS-B equipment	→ All capable aircraft in classes A, B, C, D, E	Approved ADS-B equipment	→ All capable aircraft in all airspace	Approved ADS-B equipment	→ All capable aircraft in all airspace
	ADS-B receiver	→ All capable aircraft in all airspace					ADS-B receiver	→ All capable aircraft in all airspace
VFR Alternative 3 – Certified aerodrome model.								
	Approved EC device or approved ADS-B equipment	→ All capable aircraft, in vicinity of certified aerodromes	Approved ADS-B equipment	→ All capable aircraft in classes A, B, C, D, E	Approved ADS-B equipment	→ All capable aircraft in all airspace	Approved ADS-B equipment	→ All capable aircraft in all airspace
	ADS-B receiver	→ All capable aircraft in all airspace					ADS-B receiver	→ All capable aircraft in all airspace

KEY: ADS-B-OUT ADS-B-IN

The working group considered other models for an ADS-B mandate, all of which included the same milestone dates and varied only in the first phase application of the mandate to VFR aircraft.

The working group wishes to emphasise that there are many potential options, and those put forward above are provided as a means of stimulating thought and discussion among stakeholders. Other ideas are welcomed.

Alternative 1—Select aerodromes model.

The first alternative framework would see a narrower initial requirement in which ADS-B OUT would be mandated for VFR aircraft operating in the vicinity of certain aerodromes, and at low altitude where interactions with drones might be expected. The rationale is directed at addressing the risk of mid-air collision at aerodromes, not necessarily the busiest aerodromes in an area. For example, Sydney Kingsford Smith Airport is busy, but being in controlled airspace, the risk of mid-air collision is very low. The risk assessment of aerodromes that could be subject to an ADS-B mandate under Alternative 1 would include considerations such as the nature and volume of traffic and surrounding airspace class.

The intention is also to quickly mitigate the risk of mid-air collision at low altitudes where VFR aircraft and drones are likely to interact, without impacting operators in the rest of Class G airspace. Alternative one would result in delaying mandatory carriage of ADS-B in all of Class G airspace until beyond 2033, which is later than the working group considers ideal. This alternative also potentially introduces airspace complexity around these aerodromes within Class G airspace.

Alternatives 2 and 3—RPT aerodromes model & Certified aerodromes model.

A second and third alternative framework would initially address today's concerns for RPT operations at Class D and non-controlled aerodromes, and for operations at certified aerodromes in general. Australia's unique operating environment results in larger turbo prop and jet aeroplanes in the vicinity of small aeroplanes and helicopters, and the intention of these alternatives is to address the associated risks. VFR aircraft operating at such aerodromes would be required to carry an approved EC device or approved ADS-B equipment. Ideally, aircraft conducting RPT operations would also carry ADS-B receivers, if available.

All three alternative frameworks include the same requirement for VFR aircraft operating in Class A, C, D or E airspace to be fitted with approved ADS-B equipment from the end of 2033. All three alternative frameworks also consider mandatory carriage of approved ADS-B equipment in Class G airspace, but as a long-term milestone. In the short to medium term, approved EC devices provide an opportunity to reduce the rate of mid-air collisions and effectively support the integration of drones.

8. How to have your say

We are seeking your views on the potential model and alternatives for an ADS-B mandate as presented in this paper.

The questions below are intended to guide your feedback and responses. You may choose to respond to the questions or provide a separate response, including alternative options or completely new approaches. Any supplementary information provided may also inform future decision making.

We invite feedback by 27 October 2025 via the '[Have Your Say](#)' portal.

Do you support an ADS-B mandate? Why or why not?

- If so, what airspace and/or aircraft types would you include in it?

Can you provide feedback on the potential model (Figure 10, Figure 11, Figure 12, and Figure 13)?

- Do you consider the model to be sensible and achievable? Why or why not?
- What aspects of the model would you retain, alter, or discard? Why or why not?
- What impact would the model have on your operations, if applicable?
- ☐ What are the estimated costs that you might incur in complying with this mandate?
- ☐ What are the potential benefits for your operation?
- Were the model adopted as government policy, when should all VFR aircraft in all airspace be fitted with approved ADS-B equipment (currently 'beyond 2033')?
- Are the proposed weight and height limits for drones, above which an ADS-B OUT mandate would apply, appropriate?

Are any of the alternate options outlined at Figure 14 a better way forward? Why or why not?

Noting the Government's ADS-B rebate program, have you fitted ADS-B to your aircraft? Why or why not?

8.1 Next steps

Your responses will inform the working group's recommendations to Government about the expansion of the ADS-B mandate in Australia. This will include providing Government with your feedback on the proposals in the Consultation Paper. The working group will report to Government by the end of 2025.

This will not be the last opportunity to provide feedback if the Government decides to expand the ADS-B mandate.

Any ADS-B mandate expansion would require an update to the civil aviation safety regulatory rules. CASA would consult on any proposed rule changes and invite feedback from government departments, commercial businesses, industrial and consumer groups, aviation industry bodies, other relevant bodies and organisations and the broader public.

Appendix A—Australian airspace architecture

In Australia, there are two major types of airspace: controlled, and non-controlled.

Controlled airspace in Australia is actively monitored and managed by air traffic controllers. To enter controlled airspace, an aircraft must first gain a clearance from an air traffic controller.

Non-controlled airspace has no supervision by air traffic control so no clearance is required to operate in non-controlled airspace. Most light aircraft and helicopters operate outside or underneath controlled airspace (for example, aircraft that operate at low levels over Sydney Harbour).

In non-controlled airspace, pilots are often not visible to air traffic control but must still follow visual flight rules or instrument flight rules. In non-controlled airspace controllers do not provide separation but provide a Flight Information Service and Traffic Information Service to aircraft flying on instrument flight rules and on request to aircraft flying on visual flight rules.

As well as being broken into controlled or non-controlled airspace, Australian airspace is further divided into different classes, where internationally agreed rules for visual flight and instrument flying apply. Depending on how far and how high an aircraft wants to fly, it will pass through different classes of airspace, in which different rules will apply to it.

Figure 15²⁷ represents the classes of airspace in Australia and how they connect and overlap. The level of service an aircraft receives from air traffic control and the classes of airspace in which it can fly, are determined by whether it is operating under the VFR or the IFR.

Figure 15 Overview of structure of Australian airspace (Source: Airservices Australia)



Class A: This high-level en-route controlled airspace is used predominately by commercial and passenger jets. Only IFR flights are permitted and they require an ATC clearance. All flights are provided with an air traffic control service and are positively separated from each other.

²⁷ How airspace is managed - Airservices <<https://www.airservicesaustralia.com/about-us/our-services/how-air-traffic-control-works/how-airspace-is-managed/>>

Class C: This is the controlled airspace surrounding major airports. Both IFR and VFR flights are permitted and must communicate with air traffic control. IFR aircraft are positively separated from both IFR and VFR aircraft. VFR aircraft are provided traffic information on other VFR aircraft.

Class D: This is the controlled airspace that surrounds general aviation and regional airports equipped with a control tower. All flights require ATC clearance.

Class E: This mid-level en-route controlled airspace is open to both IFR and VFR aircraft. IFR flights are required to communicate with ATC and must request ATC clearance.

Class G: This airspace is non-controlled. Both IFR and VFR aircraft are permitted and neither require ATC clearance.

Note: Class B airspace is used in some countries where it surrounds the nation's busiest airports in terms of airport operations or passenger enplanements. Class B airspace is not currently used in Australia.

Appendix B—Other technology

The options available to Australian aviation to manage the ever-present risk of mid-air collision and enable the integration of uncrewed aircraft now and into the future include ADS-B and other technologies such as FLARM, Remote ID and ADS-R. These technologies and others are discussed in the following sections.

Digital traffic information providers

Digital platforms are being considered, developed and applied by the aviation industry to display traffic information to crewed and uncrewed pilots to support navigation and deconfliction. ADS-B is already harnessed in some of these platforms, but an expanded uptake of ADS-B would increase the utility of these digital platforms to pilots.

Electronic Flight Bag (EFB) traffic information

An information system for flight crew members which enables storing, updating, delivering, displaying and/or computing digital data to support flight operations or duties.

An EFB is designed to replace traditional paper products in an aircraft such as flight plans, charts and aircraft flight manuals to name a few. EFBs can also store and display a variety of aviation data or perform calculations such as those required to determine performance or weight and balance. The scope of the EFB system functionality may also include a range of other hosted databases and apps.

Some of those apps are capable of displaying non-ADS-B, or uncertified ADS-B, traffic information²⁸. In such cases, app providers collect position and performance data from other apps users and from uncertified ADS-B ground stations. In these cases, because the data is not direct air-to-air transmission, an app can only receive traffic data when connected to a mobile phone network.

EFBs are becoming commonplace in aviation, with 80 percent of GA and sports aviation pilots using one. They are a cost effective way of having a traffic information service readily available, albeit one with characteristics that may affect their ability to present traffic information. Apps will generally only show traffic information of other pilots using the same app and will not show traffic information of pilots using a different app provider²⁹. Once either pilot is outside range of the mobile phone network, traffic information cannot be received which can lead to it becoming unreliable. Additionally, app providers often use unofficial ADS-B ground stations to collect ADS-B data and these ground stations are often installed by private enthusiasts with little or no certification or other quality controls.

Uncrewed aircraft systems Service Suppliers (USS)

USS will offer digital apps and platforms to connect uncrewed aviation operators to the flight information management system, a data sharing platform at the core of the future UTM ecosystem. These platforms will enable Airservices to share flight information between air traffic control and crewed aircraft with uncrewed aircraft operators enabling a future integrated airspace.

Future work is slated to integrate ADS-B into the UTM ecosystem, whereby USS providers would be able to integrate ADS-B data and broadcast traffic information on their platforms for uncrewed aviation operators.

²⁸ ADS-B IN capable EC devices often require an EFB and appropriate app to display air-to-air ADS-B data. See sections above about ADS-B OUT and ADS-B IN for discussion on those.

²⁹ A separate app is available that consolidates data from multiple sources however it also relies on access to a mobile network.

FLARM

Founded in 2004 in the wake of several mid-air collisions, FLARM is a collision warning system, primarily used in gliders and glider tugs to alert pilots of potential mid-air collisions with other aircraft. Like ADS-B, it works by transmitting and receiving digital signals that convey the aircraft's position, flight path, and future trajectory, enabling pilots to avoid each other. However, while ADS-B focuses on transmitting this data for surveillance and tracking purposes, FLARM is specifically designed for collision avoidance.

FLARM is based on an encrypted, propriety system that is broadcast on different frequencies in different parts of the globe. Unfortunately, none of those frequencies are the 1090MHz frequency – the FLARM frequency range in Australia is the 917.0 – 926.6 MHz range. While not transmitting on 1090mHz, newer versions of FLARM can receive and process ADS-B transmissions, and provide visual and aural warnings of potential collision with ADS-B equipped aircraft.

The use of FLARM produces many of the benefits of ADS-B however there are several reasons why it is not suitable for use as a tool for managing the risk of mid-air collision in the wider Australian aviation landscape. Most importantly, the global standard for ADS-B is transmission on 1090 MHz. Because FLARM does not broadcast on the 1090 MHz frequency it's transmission cannot be received by other aircraft fitted with ADS-B IN, nor by ATIS in Australia.

Remote ID

Remote Identification is a technology that can be incorporated into drones to provide information such as a unique identifier, flight characteristics, information on the ground control station and details of the owner or operator. There are two types of remote ID, broadcast-only remote ID (BRID) and network-based remote ID (NRID). BRID transmits a signal which can be viewed or detected by receivers near to the drone, typically a range of about 3 km depending on the operating environment. NRID transmits through a network such as LTE, 4G, 5G or satellite based mobile network, which allows data to be received by any device with internet connectivity.

The Australian Government is considering options for a future Remote ID mandate given its potential to track illegal or suspicious drone activity, assist in management and response to drone related issues (noise, privacy, environmental concerns etc), and provide data to inform future policy and regulatory development.

Whilst Remote ID does provide location and tracking information it is not anticipated to be a standalone means of drone conspicuity. Drones are increasingly diverse with a broad range of very small to large aircraft. Different means of conspicuity will be important for different platforms. It is for this reason that Remote ID will have an important part to play as mandatory equipment in some types of drones however it may not be suitable as an industry wide anti-collision tool, and in this context ADS-B may be more appropriate.

ADS-B on UAT (978 MHz)

In some regions, ADS-B operate on two different frequencies: the global standard - 1090MHz and universal access transceiver (UAT - 978MHz). In the USA, UAT is aimed primarily at general aviation aircraft, while 1090 MHz ADS-B is mandated for operations above 18,000ft. The FAA provides rebroadcast services so that aircraft on different ADS-B frequencies are electronically visible to each other (called ADS-R). Additionally, the FAA provides uplink services on 1090MHz and UAT, including weather and aeronautical information and information about aircraft that are not transmitting ADS-B data but are fitted with a transponder. Within Australia, UAT is not implemented and there are no UAT re-broadcast services.

ADS-L

The European Aviation Safety Agency (EASA) is promoting Automatic Dependent Surveillance – Light (ADS-L) as a low-cost way to create ‘electronic visibility’ within airspace intended for operations by both crewed and uncrewed aircraft. ADS-L broadcasts a subset of the data broadcast by ADS-B equipment at a lower power and on a specific frequency band (868.2 – 869.525 MHz) as well as via mobile networks.

While ADS-L aims to be cheaper than approved ADS-B equipment, low cost ADS-B options already exist in Australia in the form of approved EC devices. Approved EC devices have the benefit of being compatible with other forms of ADS-B and for operating on the same frequency as approved ADS-B equipment. Accordingly, ADS-L does not appear to be an attractive option for Australia.

Appendix C—Glossary

Term	Description
AAM (advanced air mobility)	New concept in air transportation most often connected to the use of electric vertical take-off and landing (eVTOL) aircraft. AAM is not a single technology, but rather a collection of new and emerging technologies being applied to the aviation ecosystem, particularly in new aircraft types and equipage.
ADS-B	Automatic Dependent Surveillance – Broadcast
ADS-B IN	capability of an aircraft to receive ADS-B broadcasts from other aircraft
ADS-B OUT	capability of an aircraft or vehicle to periodically broadcast its position, velocity and other information derived from on-board systems in a format suitable for ADS-B IN capable receivers.
ADS-L	Automatic Dependent Surveillance – Light
AGL	Above Ground Level
AMSA	Australian Maritime Safety Authority
Approved ADS-B equipment	Equipment capable of ADS-B OUT operation on the ground and in flight, and that is 1 of the following: (a) an approved Mode S transponder with ADS-B capability connected to an approved GNSS position source; (b) an alternate ADS-B OUT equipment configuration meeting the requirements mentioned in section 26.72 of the Part 91 Manual of Standards; (c) another system approved under Part 21 of CASR as having a level of performance equivalent to a system mentioned in paragraph (a) or (b) * see section 26.16 of Part 91 (General Operating and Flight Rules) Manual of Standards 2020 - Federal Register of Legislation
Approved EC device	A small ADS-B transmitting device, generally portable, which is listed on the CASA website as an EC device model for which the manufacturer has made a valid declaration https://www.casa.gov.au/operations-safety-and-travel/airspace/communications-navigation-and-surveillance/surveillance-network-and-equipment#Electronicconspicuity(EC)devices
ATC	Air Traffic Control
ATM	Air Traffic Management
ATSB	Australian Transport Safety Bureau
BRID	Broadcast-only Remote ID
BVLOS	Beyond Visual Line of Sight
CASA	Civil Aviation Safety Authority
Drone	Uncrewed aircraft, typically referred to as Remotely Piloted Aircraft Systems (RPAS) in Australian legislation. RPAS is the correct Australian legal terminology, however, drones will be used in this document as it is the term most commonly understood in the broader community.
EASA	European Union Aviation Safety Agency
EC	Electronic Conspicuity
EFB	Electronic Flight Bag
FAA	Federal Aviation Administration
GA	General Aviation

Term	Description
GANP	Global Air Navigation Plan
GATMOC	Global Air Traffic Management Operational Concept
GNSS	Global Navigation Satellite System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
Indoor operations	<p>Use of an RPA or model aircraft in circumstances which meet all of the following requirements:</p> <ul style="list-style-type: none"> (a) the RPA or model aircraft is flown within a building, or another structure, or a naturally occurring or man-made space underground (a containment area); (b) the containment area is such that it is physically impossible for the RPA or model aircraft to escape and fly away during normal, abnormal or emergency operations; (c) entry of people to, and exit of people from, the containment area is controlled in such a way that in flying an RPA or model aircraft in the containment area a remote pilot will not infringe any provision of Part 101 of CASR concerning proximity of an RPA or model aircraft to people within or outside the containment area; (d) in the event that an RPA or model aircraft collides with any part of the containment area, no material from the RPA or model aircraft or the containment area can move or escape and cause injury to a person outside the containment area. <p>Note An example of a man-made space underground is a mine.</p> <p>See section 1.04 of Part 101 (Unmanned Aircraft and Rockets) Manual of Standards 2019</p>
JRCC	Joint Rescue Coordination Centre
LAME	Licensed Aircraft Maintenance Engineer
Large (drone classification)	<ul style="list-style-type: none"> (a) a remotely piloted aeroplane with a gross weight of more than 150 kg; or (b) a remotely piloted powered parachute with a gross weight of more than 150 kg; or (c) a remotely piloted rotorcraft with a gross weight of more than 150 kg; or (d) a remotely piloted powered-lift aircraft with a gross weight of more than 150 kg; or (e) a remotely piloted airship with an envelope capacity of more than 100 m³. <p>See Types of drones Civil Aviation Safety Authority</p>
Medium (drone classification)	<ul style="list-style-type: none"> (a) an RPA with a gross weight of more than 25 kg, but not more than 150 kg; or (b) a remotely piloted airship with an envelope capacity of not more than 100 m³. <p>See Types of drones Civil Aviation Safety Authority</p>
NRID	Network-based Remote ID
SAR	Search and Rescue
Sheltered operations	Drone flights conducted near a structure, such as a building, enabling them to stay within controlled parameters to promote safety and compliance.
Small (drone classification)	<p>An RPA with a gross weight of more than 2 kg, but not more than 25 kg</p> <p>See Types of drones Civil Aviation Safety Authority</p>

Term	Description
SORA	Specific Operations Risk Assessment
Space-based ADS-B	Use of satellites to receive signals from aircraft equipped with ADS-B OUT equipment, providing a global surveillance network.
Tethered operation	<p>Use of an RPA in circumstances in which an RPA is flown while securely attached to a lead that:</p> <p>(a) is no longer than 150 ft, unless a provision of this MOS provides for a longer lead; and</p> <p>(b) makes it impossible for the RPA to escape and fly away during normal, abnormal or emergency operations.</p> <p>See section 1.04 of Part 101 (Unmanned Aircraft and Rockets) Manual of Standards 2019</p>
UAT	Universal Access Transceiver
UTM	Uncrewed aircraft system Traffic Management
USA	United States of America
U-Space	A concept developed by EASA where concentrated uncrewed aviation operations are enabled by digital systems and rules which enable for integrated airspace and separation achieved through U-Space service providers.
USS	Uncrewed aircraft systems Service Suppliers
VFR	Visual Flight Rules
VFR aircraft	Aircraft operating under the VFR, including sport and recreation aircraft (Part 103 aircraft) and hot air balloons

Document control

Refer to the following table for the approver and latest version of this document.

Version	Release date	Approver	Reason for update
1.0	Sep 2025		Initial release of document.