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Emerging Aviation Technologies

NATIONAL AVIATION POLICY ISSUES PAPER

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Emerging Aviation Technologies

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Contents

Executive summary

Purpose

This paper is the first step towards development of a national policy for the management of drones and other emerging aviation technologies. The paper identifies opportunities and risks associated with these technologies, outlines some of the current approaches for managing these issues and proposes an approach to policy development. It is a starting point for ongoing discussion and collaboration between government, industry and the broader community to develop a comprehensive national policy that will allow Australia to benefit from the considerable opportunities provided by emerging aviation technologies whilst effectively managing the risks and impacts associated with their use.

Introduction

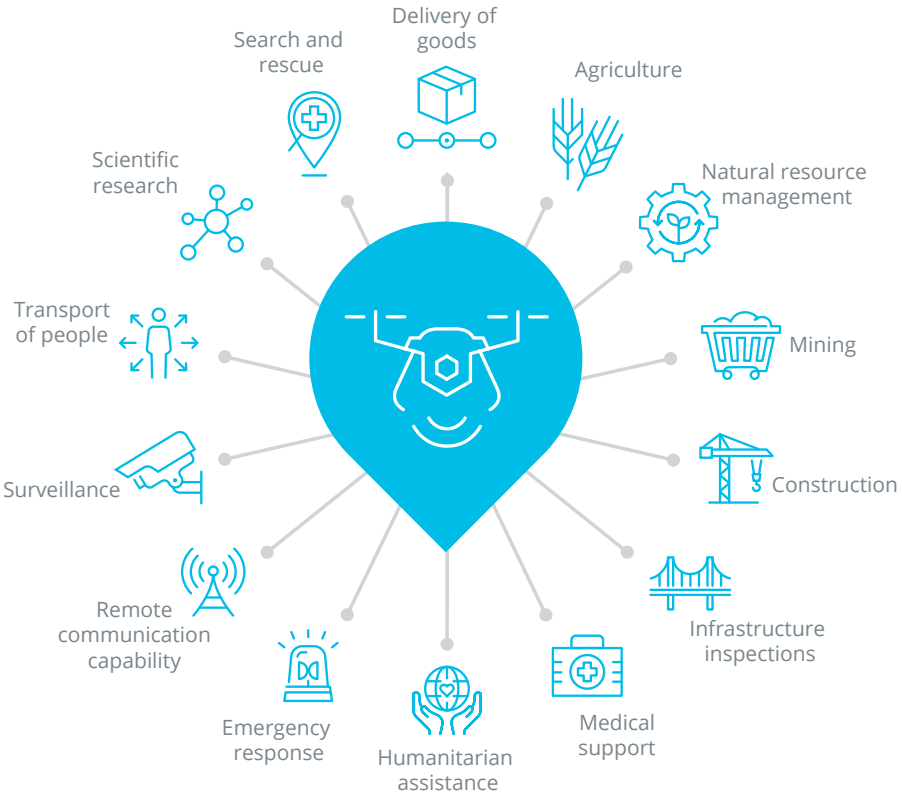
Australia is no stranger to adopting new technology and innovation. Australia was one of the first countries in the world to regulate the operation of drones in 2002. Australia was also the first country in the world to welcome regular commercial urban drone delivery services in April 2019.

Over the last few years, the growth in new emerging aviation technologies such as drones and electric vertical take-off and landing (eVTOL) vehicles is creating even more opportunities for new ways of doing things. New industries are being created and we can clearly see new concepts that were once considered things of the distant future.

While the technology itself is both important and impressive, it is the applications of this technology where the real potential for significant economic and social benefits exist. It is simply more than enabling technology for technology's sake; it is unlocking the tangible benefits and use cases this technology can facilitate.

There have been a number of estimates of the market value of these new emerging technologies, many of which quote figures in the hundreds of billions of dollars. For example, PwC, a consulting and professional services firm, estimated in 2017 that the market value of drone powered businesses was around AUD $163 billion[1]. Many estimates project growth in the sector to continue at significant rates. While it is difficult to predict the exact market value, it is clear these technologies will be transformative and will change how and where we live.

It is likely there will be an early impact on a range of industry sectors through productivity gains. We are just at the beginning of utilising and understanding this technology, and there is significant potential for further growth as technology improves, the scale of operations increase and we discover new applications for drones.



Utilising drones and eVTOL vehicles enables the opportunity to carry out many tasks in the abovementioned industries cheaper, safer and more efficiently. The flow on increase in productivity and sustainability for these industries will boost economic development and jobs. Such technology will likely create a shift in the job market, creating new sectors for operation and maintenance, but also new jobs working with this technology in existing industries.

In recognition of this potential, the Australian Government is developing a national whole-of-government framework to manage new aviation technologies, such as drones and eVTOL vehicles. A National Policy on Emerging Aviation Technologies is the first step in this process.

Noting the potential economic and social benefits, the rationale for a national policy is to provide certainty for industry investment and provide a clear policy and legal framework that actively encourages and facilitates the use of this technology. However, the policy and legal framework will also include a range of measures to mitigate potential risks and impacts on the community. It is vital that these technologies operate in a manner that is safe, secure and considerate of the community and the environment.

The emergence of this sector also provides an opportunity to examine the regulatory approach. There is an opportunity for the Australian Government to utilise technology in the way we regulate. There is also scope to reduce the regulatory burden for industry through greater coordination and consistency between the numerous different government regulators.

A national whole-of-government policy approach to emerging aviation technologies will place Australia well to capitalise on our willingness to be an early adopter of new technology and to attract greater investment, jobs, and economic growth. Such technology also has the ability to enhance and revolutionise not just the broader aviation sector, but also many other industries.

Scope and context

This paper predominantly discusses issues with reference to the use and operation of drones and eVTOL operations. This paper does not apply to the military use of drones and is of limited relevance to larger drones that will have the ability to transit international airspace. It is also noted that the use of drones by law enforcement, government authorities, and search and rescue operations will continue to require special arrangements and authorisations which are not discussed in this paper.

Have your say

The Australian Government invites written submissions on the proposed policy outcomes articulated in this paper to inform the direction of the National Emerging Aviation Technologies policy.

Questions to guide the development of submissions include:

- Do you agree with the proposed core principles for the National Emerging Aviation Technologies policy?
- Will the proposed approach to policy development adequately allow for the future direction, operations and investments of your business/organisation?
- Are there any other approaches that could benefit the sector?
- What level of service and regulation do you expect from the Government?
- What are your expectations of the Government's role and responsibilities in the management of drones and eVTOL vehicles?
- What are the key opportunities that these new technologies could deliver for Australia?
- What are the most significant barriers to realising these opportunities?
- What issues or actions should the government prioritise to facilitate the growth of emerging aviation technologies?
- To what extent should Australia's approach be harmonised with approaches taken in other countries?
- Are there other issues that the Australian Government should consider?

All submissions will be published on the Department of Infrastructure, Transport, Regional Development and Communication's website unless marked 'confidential'. Submissions or questions should be provided no later than 31 October 2020 to:

Director, Airspace and Emerging Technologies
Department of Infrastructure, Transport, Regional Development and Communications
Email: drones@infrastructure.gov.au

Alternatively, send via post to: GPO Box 594, CANBERRA ACT 2601

What are the next steps?

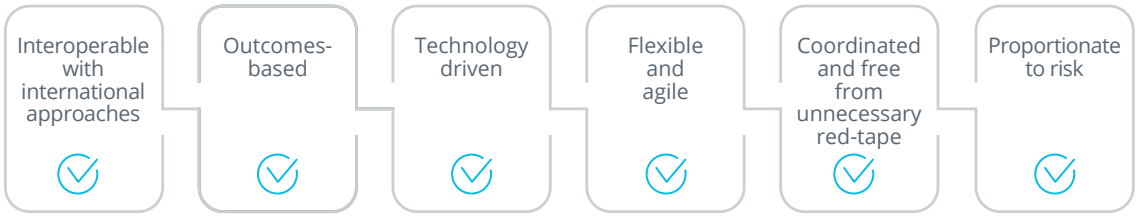
The Australian Government will commence a broad process of consultation with industry, state and territory governments and the wider community on the issues identified in this paper. As part of this process, the Department of Infrastructure, Transport, Regional Development and Communications will establish an Industry Advisory Group to coordinate industry input in the development of the national policy framework. This group will be supported by workshops and working groups of relevant stakeholders to drive progress on specific issues, such as Unmanned Traffic Management.

These consultations, together with the submissions received in response to this paper, will be used to inform the development of a National Emerging Aviation Technologies Policy statement. This policy statement will then form the basis of any legislative, regulatory or functional change as necessary, settle roles and responsibilities within government, and guide action plans for the development of processes and procedures. Any legislative or regulatory change processes to implement policy outcomes will also include separate consultation consistent with Australian Government processes.

Core principles

The following core principles will underpin a National Emerging Aviation Technologies Policy:

We will achieve this through a market management approach that is:



Summary of proposed approach to policy development

1. Airspace integration

The Australian Government, in partnership with industry, will develop a UTM system that would support a combination of centralised government services and industry-provided services that will facilitate fair and competitive access to airspace and mitigate a wide range of risks and impacts.

2. Safety

The Civil Aviation Safety Authority will maintain its commitment to the primacy of safety, while taking a responsive, modern and evidence-based approach to safety regulation and the certification of new aviation technology that provides scope for innovation and flexibility, having regard to the inherent risks of the operating environment, other airspace users and the travelling public.

3. Security

The Australian Government will lead the development of a proportionate and evidence-based approach to managing security risks associated with drones and eVTOL vehicles that is adaptable to changing circumstances and technologies while ensuring a secure operating environment.

4. Noise

The Department of Infrastructure, Transport, Regional Development and Communications will develop and manage a national regulatory approach to noise management that encourages quieter operations consistent with local community considerations.

5. Environment

The Australian Government will lead the development of a consistent, balanced and proportionate approach to manage the impacts on wildlife and the environment, including the enjoyment of nature areas and cultural sites.

6. Privacy

The Australian Government will lead the development of a nationally consistent approach for managing privacy concerns that balances the impacts on privacy with the needs of drone and eVTOL operations.

7. Electric Vertical Take-Off and Landing Vehicles

The Australian Government will work with all relevant stakeholders to develop measures for safe, efficient, considerate and reliable eVTOL operations in a competitive market that supports safe, efficient and equitable access for all airspace users.

8. Infrastructure

The Australian Government will lead the development of a coordinated and informed approach to infrastructure planning, investment, requirements and approvals.

9. Technology trials

The Australian Government will develop an approach that fosters partnerships between government and industry to promote shared outcomes and learning with the goal to support the commencement of future commercial operations.

10. Central coordination

The Department of Infrastructure, Transport, Regional Development and Communications will coordinate an ongoing whole-of-government policy approach to manage future challenges associated with emerging aviation technologies to ensure a consistent and coordinated approach to regulation across issues and jurisdictions.

Technology landscape

What are drones and eVTOLs?

Drones are a colloquial term for what are referred to as Remotely Piloted Aircraft Systems (RPAS) in Australian legislation. The International Civil Aviation Organization (ICAO) uses RPAS in its materials. Other common terms include Unmanned Aerial Systems (UAS). 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.

Formally, under the Australian civil aviation legislation, RPAS is defined as "a set of configurable elements consisting of a remotely piloted aircraft, its associated remote pilot station (or stations), the required command and control links and any other system elements that may be required at any point during the operation of the aircraft." [2]

While helicopters and other vertical take-off and landing craft (fixed wing and tilt-rotors) have been around for some time, the emerging use of electric engines and light-weight composite materials has enabled the design and development of eVTOL aircraft that promise cheaper and more efficient operating economics. Such eVTOL aerial vehicles are being positioned to initially operate in the airspace system as aerial taxis in a manner similar to helicopters (such as the Uber Elevate project), before transitioning to autonomous operations in the future.

The use of eVTOL aircraft is also referred to as Urban Air Mobility for city-based operations, Regional Air Mobility (RAM) for longer range urban to regional and intra-regional services, while the National Aeronautics and Space Administration uses the term Advanced Air Mobility to refer to eVTOL operations in urban and regional areas.

Applications

Drones and eVTOL operations can undertake a number of functions that can be broadly categorised as:

1. Data gathering, surveillance and communication
    a. This can include functions such as aerial photography, infrared imaging, gas collections and assessment and terrain mapping to name a few.
    b. The use of specialist sensors and drone technology has been used in agriculture to assist with monitoring and detection of crop issues[3]. Drones are also utilised to inspect infrastructure at heights or at a distance, such as electricity pylons and power-lines.
    c. Data gathering can be done with live streaming of the data, or with the data being held on the drone and available once the drone has completed its flight.
    d. High-altitude drone platforms that can remain in-flight for long periods of time and can serve as surveillance or support communication systems in a similar role to a satellite.
2. Payload deployment
    a. This refers to a drone carrying an object and then delivering it to a particular location. Initial operations in Australia are being undertaken to support small commercial items (such as pharmaceuticals, food and beverages[4]). In Rwanda drones are utilised to safely and quickly deliver urgent medical supplies, including blood for transfusions[5].
    b. Payload deployment can also refer to a dynamic deployment, such as aerial spraying of an agricultural area.
3. Recreational
    a. Large numbers of people operate drones for recreational use.
    b. There are also sports drones, such as for use in drone racing.
4. Transport
    a. This would look to supplement existing transport options in cities by eVTOL vehicles. These vehicles are being developed to undertake longer distance operations between different urban or regional centres.
    b. There are no existing commercial operations at present. However, work on trials and planning for eVTOL operations have been announced in Dubai, Los Angeles, Dallas-Fort Worth, Singapore and Melbourne[6].
    c. It is likely that initial operations will utilise piloted eVTOL vehicles, however it is envisaged that eVTOL operations will eventually become autonomous in the future.

Drone technology is advancing rapidly, and new applications are continuing to be developed. A significant current difference between drones and more traditional aircraft is that, in most cases, drones are a more affordable and accessible tool. While traditional aircraft are used for many of the same or similar functions, the low cost, ease of use and reduced safety risk of drones has supported functions becoming more readily available. The use of drones can also reduce the time taken to complete dull, dirty and dangerous tasks.

Drones in Australia

Smaller drones are readily available at an accessible cost point that enables use by a large proportion of the population. Many of the drones used commercially are manufactured to detailed specifications for a particular purpose.

There are no concrete numbers on how many drones are currently in use in Australia. Estimates have ranged from 50,000 recreational users through to over one million. The rate of drone ownership in America, covering all types of uses, is approximately 8 per cent [7]. A conservative estimate of 5 per cent of Australians owning a drone, would see over 1.2 million drones operating in Australia.

Data for the use of commercial drones is based on the numbers of people who hold either a remote pilot licence or a remote operator certificate. As of mid-June 2020, there are over 16,300 remote pilot licence holders and over 1,900 remote operator certificate holders. There is also data collected by the Civil Aviation Safety Authority (CASA) regarding commercial drone operations carried out in the 'excluded category' operations. These data sets are useful, but they still do not provide the complete picture of the actual figure of both commercial and recreational drones operating in Australia.

There are many small and large companies working to develop eVTOL vehicle concepts. Some eVTOL vehicles are modelled on familiar helicopter-influenced designs, while others are unique. There are a range of concepts in design that include multiple rotors, fixed and rotating wing, and prop and electric jet engines. At current estimates, the first eVTOL vehicles are expected to enter service in Australia around 2023–2025, and will initially include a pilot.

Economic benefits of drones

Countries around the world are investing heavily to take advantage of the significant economic, social and environmental opportunities that new technologies can bring. Australia's ongoing economic success depends on its ability to harness technological advances to improve existing businesses, create new products and markets, and enhance daily life.

Growth in the Drone industry

Early investment and growth in the drones industry occurred in the 1990s focused on military uses. This is now shifting with civil commercial and recreational use competing with the military market in volume and as contributors to economic impacts [8]. In 2018, it was estimated that three quarters of all drones sold over 250g were for professional or commercial use [9].

While the value per unit of military drones means that they continue to hold the largest share of the market by value, the growth rate for sales is highest in the commercial sector and it is expected this sector will dominate the market in coming years. One projection is for a 380 per cent growth rate for commercial use between 2018–2022. This is in contrast to a 42 per cent growth rate for recreational users over the same period [10].

The commercial drone market alone was been calculated at AUD$19 billion in 2018 and is expected to grow to $60 billion by 2024 [11].

The research and development stages of drones are attracting large amounts of investment. Over USD$985 million in investor funding, as venture capital, went to the drone industry in 2018 [12]. These investments are largely located in the United States with Israel, Japan, China, Switzerland and Belgium also attracting large investments.

The demand for jobs within the drone industry is growing and is viewed as an area where insufficient skills could be a risk to further business expansion and market growth[13]. Jobs in the drone sector are concentrated in the platform and software areas. There is a large demand for software engineers in both these areas.

As the security risk from drones becomes more prevalent across the globe, there is concurrently an increasing market for counter-drone technology. Australia has a small number of suppliers of counter-drone technologies that are seeking to establish manufacturing facilities in Australia, in turn creating a number of highly skilled jobs.

There has been a consistent view that the drone industry is delivering economic boosts to regions and countries. The growth in drones has occurred so rapidly that any estimates of economic impact are quickly outdated.

The drone value chain, or the processes and activities that are required to support the drone industry is large. It encompasses the development of hardware components for drones; assembly of drones; software that supports the operation of drones; software and technology to support value added services delivered by the drones – such as specialised cameras or sensors; infrastructure requirements; and associated services such as legal and training requirements [14].

A 2017 examination of the impact of commercial drones indicated that the actual value of drone commercial activity in the United States had grown from AUD$56 million to $1.4 billion in the space

of five years (2012–2017) [15]. It is predicted that in a further 10 years it will grow to an annual impact of between AUD$43 to $65 billion [16]. This covers all aspects of the drone value chain.

There has been no significant published analysis of the potential economic impacts of drones in Australia. Some insight is available from the current drone delivery business now operating in Australia. The operator, Wing, has submitted that once to scale, drone delivery could add $30 to $40 million in additional revenue for Australian Capital Territory (ACT) businesses and reduce delivery costs by $12 million by 2030[17]. The establishment of the initial Wing trial resulted in an investment of over $5 million in the ACT. The ACT government noted that the engagement with emerging business, including but not limited to drones, will deliver ACT a competitive advantage and increase employment and business opportunities [18].

This potential for broad economic growth that attracts investment and leads to job creation was also noted in the Queensland Drone Strategy 2018, which lists "attracting national and international investment" as its number one objective[19]. Wing is also operating in Queensland.

Social benefit from drones

Drones are being used in many different innovative applications that provide important social benefits. A clear benefit in some sectors is the ability of drones to reduce the exposure of workers to hazardous tasks.

Drones are currently used in search and rescue in Australia. For example, the Little Ripper drones operated on the Gold Coast can deploy a flotation device to a swimmer experiencing trouble in the water. Long range beyond visual line of sight (BVLoS) drones are used in other countries to deliver blood, medications and vaccines to people in remote areas. Around the world, drones are being used to deliver essential items to vulnerable or isolated people during the COVID-19 pandemic. The use of drones for last mile delivery of small products has the potential to replace millions of road kilometres by cars and trucks.

While occupational health and safety is well developed in Australia, there are people who lose their lives while at work. In 2017, 190 workers were fatally injured at work in Australia [20]. Over 70 per cent of these deaths occurred in three industries: transport, postal and warehousing; agriculture, forestry and fishing; and construction. There are fatalities every year associated with construction, aerial application jobs such as agricultural spraying and firefighting and electrical work. All of these are sectors that have potential productivity gains to be made from the use of drones. The reduction in workplace harm is a further benefit to be considered.

The use of drones has already facilitated the collection and surveying of new data sources for scientific research. This includes various wildlife and environmental data, such as crocodile eggs, whale mucus and damage caused by natural disasters, that would otherwise be dangerous or difficult to collect. Improving access to drone technology will support further scientific research and analysis across a range of different research areas.

With eVTOL vehicles having quieter electric engines and using battery technology, the noise and carbon emissions are lower than cars, trucks, helicopters and existing fixed-wing aircraft.

National emerging aviation technology market

Drones and eVTOL aircraft are part of an emerging market, and despite rapid growth in recent years the sector has only realised a fraction of its economic potential. As the market grows there will undoubtedly be business opportunities and growth in the number of services that can be provided. However, risks and impacts associated with safety, security, noise, privacy and the environment will also emerge and increase in significance.

The Government's approach to managing this emerging market varies considerably in maturity depending on the issue at hand. For safety, a robust regulatory framework has been developed over a number of years. Other issues, such as noise and privacy, have only recently emerged as significant areas of public concern and government policy and regulations are currently being developed as the sector grows.

Effective management of these issues could include both industry developed standards and services as well as government regulation and centralised service delivery. For the industry to thrive, the approach will need to be as efficient as possible to minimise the costs for operators and their customers.

As the volume of aircraft increases and more operators seek to share the same airspace, new approaches will be required to ensure that industry operates in a manner that is safe, equitable, secure and consistent with community expectations. New services and technology, such as Unmanned Traffic Management, will also be required to support the continued growth of the industry.

Evolution in the market

The characteristics and capabilities of new aircraft types, such as size, quietness, payload, range, and altitude will continue to be developed in the near future. Increasing automation in both aircraft and their supporting systems and processes will also continue to change the shape of the industry, both for new aircraft types and traditional aviation. Contemporary limitations, including those related to battery life, noise or speed, are likely to be overcome through future technological innovation and refinement.

At the same time, new technology will facilitate new services and solutions to manage risks and social impacts associated with aircraft operations. Increasing automation in regulatory processes and government service delivery offers significant opportunities to reduce costs to industry. The following three technology horizons present an example of how the market could evolve in coming years.

HORIZON 1
Short term
over next ~5 years

Trials and early operations of new aircraft types and services, occurring in limited locations around Australia.

- Multiple and concurrent drone operations in the same airspace;
- Commencement of initial eVTOL operations; and
- Design, development and implementation of the first phase of a national unmanned traffic management (UTM) system.

HORIZON 2
Medium term
~5–10 years

Industry continues to mature with increasing volumes of new aircraft and services operating in a range of locations, supported by new infrastructure.

- Implementation of UTM to manage a broad range of risks and impacts;
- Complete integration of eVTOL operations with UTM system;
- eVTOL operations in regional areas; and
- Increased automation of eVTOL and drone operations.

HORIZON 3
Long term
~15–30 years

Drones and eVTOLs are commonplace, providing a wide range of highly automated services across Australia in a fully integrated aviation system.

- Autonomous eVTOL and drone operations; and
- A single airspace management system to manage all air traffic.

To manage this change, the National Emerging Aviation Technologies Policy Statement will not be a static document. As technology and the market for emerging aviation technologies continues to evolve, government and industry approaches to managing the sector must also continue to adapt. Policy, regulatory and functional settings will continue to be reviewed and reformed to keep pace with the changing sector.

International approaches

Traditional aviation is built on the development of international standards, translated into national laws that enable such a global industry to operate in a similar fashion around the world. This approach has worked well for traditional aviation, which as a sector has historically been characterised by incremental change, with perhaps the only exception being the advent of the jet engine.

The rapid growth and advancement in drone technology applications has disrupted the existing approach for managing aviation. Governments around the world have struggled to keep up with the changing technological landscape. Similarly, international processes for regulation and standard setting have struggled to keep pace with the sector.

Current approaches vary considerably across the globe, as different countries are at different levels of maturity in their policy and regulatory approach to the emerging aviation technologies. While some countries are still developing their initial approach to the regulation of the sector, other countries have relatively mature regulatory frameworks and have published detailed concepts of operations for proposed systems related to UTM and Urban Air Mobility[21]. Some countries are considering new approaches to the management of aircraft focused on industry developed standards and services, with others focusing on more traditional models of government regulation and centralised service delivery.

At this early stage in the development of the sector, there is no clear consensus as to what represents international best practice. Despite this, there is much that can be learned from other countries' experiences and Australia is engaging with many leading jurisdictions to share knowledge and align our policy and regulatory settings where appropriate.

There are a range of initiatives amongst national and international civil aviation authorities attempting to develop consensus around international regulatory harmonisation and implementation of regulatory frameworks to ensure that drones and eVTOL aircraft will be safely used and regulated.

The International Civil Aviation Organization (ICAO) is a specialised agency of the United Nations, which sets standards and recommended practices (SARPs) for international civil aviation. Much of ICAO's work to date has focused on the development of SARPS for larger drones which have the potential to cross national borders. However with increased calls from ICAO member states for ICAO to develop a harmonised international approach to regulate smaller drones, ICAO is in the process of developing Model UAS Regulations, which offer a template for states to adapt or supplement their existing regulations.

The Joint Authorities for Rulemaking on Unmanned Systems (JARUS) is comprised of a group of experts from various national aviation authorities and regional aviation safety organisations from 61 countries, the European Aviation Safety Authority and EUROCONTROL. JARUS' aim is to create a single set of technical, safety and operational requirements for the integration of drones into airspace management. JARUS has developed several guidance documents for the development of regulations for drones.

The International Transport Forum (ITF) at the OECD is a think tank for transport policy, which aims to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy. The ITF Working Group provides a forum to consider the potential of drones to improve future transport systems.

While there has been significant progress in various multilateral and international fora, further work will be required to clarify how these different processes will come together to create a single system of international regulations and standards.

The Australian Government will continue to engage with international processes, consider best practice examples from other jurisdictions and work in close partnership with industry to ensure the development of Australia's approach is interoperable with international standards as they are developed and appropriate for the evolving emerging aviation technology market.

Airspace integration

Airspace is a finite and public resource. As growth in manned and unmanned aviation traffic continues, the requirement to access airspace will increase. An aviation ecosystem that supports all aircraft to operate safely and efficiently is required.

Airspace integration needs to accommodate the differences in capabilities between manned aircraft and unmanned aircraft. Remote and autonomous piloting removes some of the elements that a traditional pilot is able to use, such as visual tracking, see and avoid, as well as potential for delays in or a lack of direct communication between Air Traffic Control (ATC) and the pilot.

Overview

The Minister for Infrastructure, Transport and Regional Development administers aviation legislation, including the Airspace Act 2007, Air Navigation Act 1920, Civil Aviation Act 1988, the Airservices Act 1995 and corresponding regulations, supported by policy advice from the Department of Infrastructure, Transport, Regional Development and Communications.[22] Australian administered airspace is regulated by CASA and administered under the Airspace Act 2007. Airservices Australia (Airservices) and the Department of Defence (Defence) are Air Navigation Service Providers (ANSP), and are responsible for the provision of air traffic services, which includes air traffic management (ATM) and ATC services within Australian administered airspace. The current regulatory framework requires Airservices to provide advice and information that is necessary for the safe and efficient conduct of flight, which includes directed traffic information to Instrument Flight Rules (IFR) flights on other IFR flights and known Visual Flight Rules (VFR) flights in Class G airspace.

Present day ATC relies upon sufficient information from communication, navigation and surveillance (CNS) systems in order to provide the service necessary for the airspace where the aircraft is operating.Drone and eVTOL capabilities in CNS systems will be a central issue in airspace integration.

Current approach to airspace integration

Commercial drone operators (other than the excluded category) can apply for access to controlled airspace near airports, or to fly at levels above 400ft (120 metres) above ground level (AGL). This is currently done through an application to CASA for assessment having regard to operational and airspace safety requirements. Should the operation be deemed to meet these safety requirements, it is then provided to Airservices Australia for an assessment regarding operational requirements to ensure the safe and efficient management of all aircraft, including drones, operating within controlled airspace. Approvals may be subject to other restrictions, such as geographic lateral limits, specific time blocks or specific communication requirements. The assessments consider the technical capability of the drones, including the navigation and communication systems being used.[23]

Passenger carrying eVTOL vehicles, for example, may enter controlled airspace, subject to being equipped with realtime communication and navigation systems. If piloted, initially they could be managed by the ATC within controlled airspace in a similar approach to comparable manned aviation operations.

Current regulations and strategies

Commonwealth strategies

Airservices Australia and CASA have commenced work to consider potential future uses of airspace and the implications for ATM. Current government airspace policy requires the consideration of safety of passenger transport services to be the most important priority in airspace administration, but is cognisant of the need for CASA and Airservices Australia to continue to work together on a practical basis to ensure the needs of all airspace users are thoroughly considered.

While entry by drones into controlled airspace is possible, if undertaken using the existing manual processes it could quickly become unmanageable for CASA and Airservices as the sector grows. There is also a lack of surveillance over drone operations and other aircraft, with the exception of Australia's 29 controlled aerodromes.

Currently ATC requires a certain amount of information in different classes of controlled airspace in order to provide a service. Traditional manned aircraft operating in relevant controlled airspace are able to provide this. Ensuring that drones and eVTOL operations are able to provide information to meet safety outcomes will be essential in the future development of airspace integration .

States and territories

Aviation is a Commonwealth responsibility. State and Territory governments have not traditionally had a role in air traffic management or airspace design. Due to the low altitude of many drone operations and the potential negative impact on the community, some local and state/territory governments have sought to introduce rules and restrictions on drone use in certain areas to control the social and environmental impact of drones in line with their community's preferences.

Proposed policy approach

The Australian Government, in partnership with industry, will develop a UTM system that would support a combination of centralised government services and industry-provided services that will facilitate fair and competitive access to airspace and mitigate a wide range of risks and impacts.

Integration of emerging aviation technologies into Australia's airspace will require re-thinking how airspace and aviation is managed. These emerging technologies, along with the policies, regulations and procedures that manage them, are collectively refered to by the Australian Government as the Integrated Airspace System (IAS).

A key element of the IAS will be the development of a new system of traffic management for unmanned and autonomous aircraft (UTM). It is anticipated that implementation of UTM will initially be modest, and focused on drone operations outside controlled airspace. Over time, UTM could expand to cater for other manned, unmanned and autonomous platforms, and may help facilitate the integration of these aircraft into controlled airspace and existing ATM systems.

Whilst still at the early stages of development, it is planned that Australia's UTM system will include a single centralised Government platform (a flight information management system (FIMS)) to facilitate access to authoritative national government data, provide centralised government services (once the degree of government services required is settled), and facilitate industry-provided services. The FIMS will also serve as the vital interface with the existing ATM system to enable safe, secure and efficient management of aircraft across all airspace.

The development of a FIMS will be led by Airservices Australia with an initial pilot program to be undertaken, in close consultation with industry, to gain an understanding of the technology capability available to build a FIMS. Industry and stakeholder feedback from this pilot program and broader consultation processes, as well as safety and regulatory input from CASA, will guide the initial policy approach and pathway for the development of a UTM system. This will include an approach for determining which services are provided by industry (UTM service suppliers), and which services are managed centrally through the FIMS.

CASA has also developed an RPAS Digital Platform as a first step to provide information to drone operators about where it is safe to fly. In the short-term this platform could also provide additional functions, such as support for automated approvals in controlled airspace (in collaboration with Airservices). CASA will continue to manage a digital drone registration system, which will interface directly with the FIMS. CASA will provide safety regulatory oversight of the UTM system and operations, including safety oversight of the FIMS.

It is expected that the design and implementation of Australia's IAS including UTM will be an ongoing process over a number of years, and the Australian Government will continue to work in close partnership with industry to ensure the approach, development and deployment of the system remains appropriate as technology and the requirements necessary from the IAS continue to evolve.

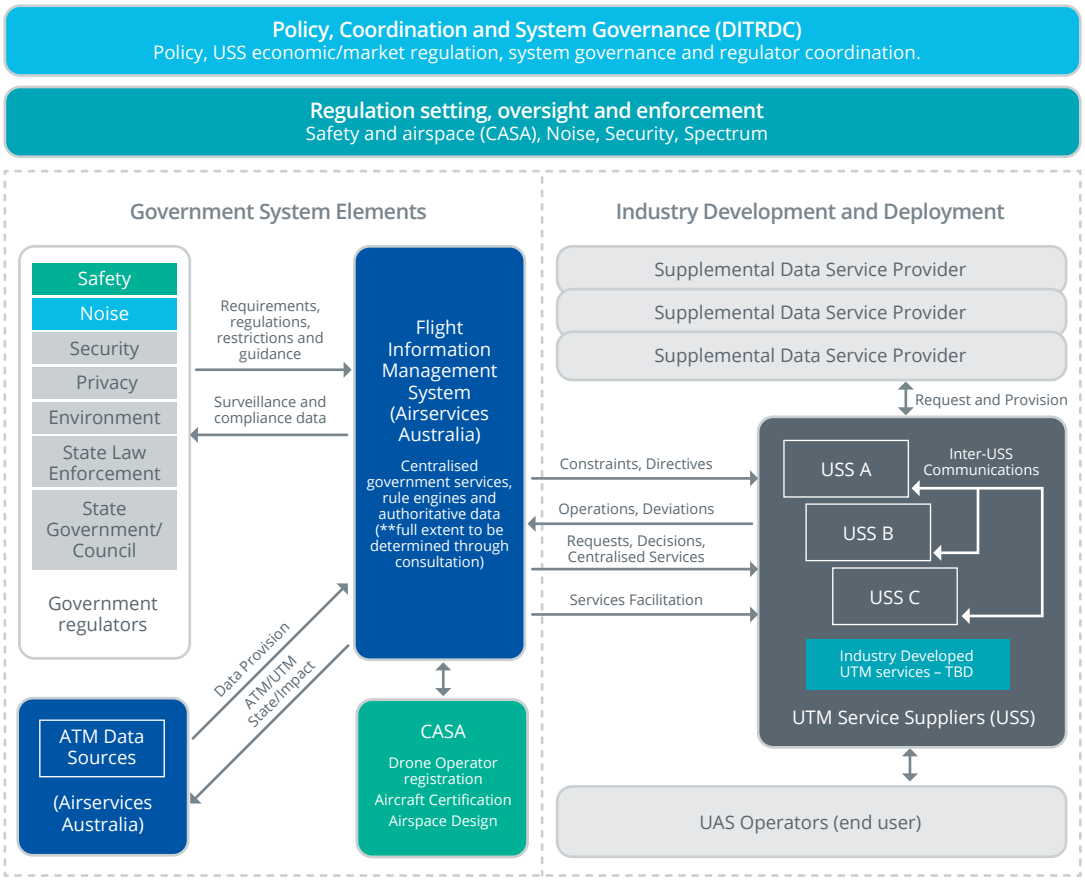
While UTM will be the system to manage drones and eventually eVTOL operations, the Department of Infrastructure, Transport, Regional Development and Communications will separately lead the development of a new National Airspace Policy to provide clarity and a future direction for the

management of airspace, including the integration of drone and eVTOL operations. This will help inform where UTM services could be required as a risk mitigator to ensure that safety is maintained as the volume of drone services grow and become more complex. It could also assist in ensuring other regulatory requirements are met.

As the IAS develops, the FIMS may be used to support awareness and compliance with a range of regulatory requirements specified by relevant government regulators, including rules related to security, privacy, noise and environmental impacts. This will require coordination of regulatory requirements across different issues and jurisdictions (Commonwealth and State/Territory), to prevent duplication or inconsistency in regulatory regimes. Implementation of regulations through the FIMS could support dynamic, targeted and outcomes-focused approaches to managing drone risks and impacts that are not available using traditional methods of regulation. The approach to managing compliance to regulatory requirements through FIMS is expected to evolve over time as drone numbers increase, operational concepts develop, technology improves, and strategies for managing drone risks and impacts become more sophisticated.

The development, management and operation of Australia's UTM system is anticipated to be:

1. Implemented in an **iterative** manner;
2. Integrated and consistent with **whole-of-government policy** and broader airspace management objectives;
3. Applied with a **graduated** approach based on the risks and impacts relevant to particular volumes of airspace or locations;
4. Consistent and interoperable with the **existing ATM system** to facilitate safe integration of all airspace users;
5. Developed through **industry** consultation, collaboration and technological developments;
6. Consistent and aligned, where appropriate, with **international approaches**;
7. **Market driven** by competitive UTM Service Suppliers; and
8. Ensuring **fairness** for all users in implementation and operating rules, including equitable access to airspace.



The diagram above proposes an architecture to guide the development of the IAS in Australia, including UTM, noting that the design of the system will be subject to extensive consultation with industry. The system will help manage and coordinate regulations set by several regulators and agencies, and will be supported by governance arrangements that reflect the shared responsibility and interests for drone issues across Commonwealth and State/Territory jurisdictions.

Safety

The Minister for Infrastructure, Transport and Regional Development administers the Civil Aviation Act 1988 and associated regulations, supported by policy advice from the Department of Infrastructure, Transport, Regional Development and Communications [24]. CASA is the aviation safety regulator and carries out its statutory functions in accordance with the Civil Aviation Act 1988, which includes the requirement to regard the safety of air navigation as the most important consideration [25] and must also consider the cost to users of Australian airspace. CASA also regulates Australian administered airspace on behalf of the Australian Government.

Safety is a fundamental issue that requires consideration as the use of drones increases. Regulations should ensure that the level of safety expected by the Australian community is achieved and maintained, while also enabling operations to occur in a manner that promotes flexibility for innovation.

This regulatory challenge is being faced by government and aviation safety regulators across the world [26]. It is complicated by the current limited evidence on the nature and magnitude of the risk posed to other airspace users and people and property on the ground [27]. CASA is currently managing a university research project to gain a better understanding of the future use of emerging technologies in Australian airspace.

At a high-level, the current aviation regulatory framework in Australia and in many other parts of the world relies on numerous interrelated concepts to ensure a safe environment. These are:

- regulation of systems, training, pilots and equipment;
- certificated aircraft, including regulatory oversight of maintenance; and
- regulation and administration of airspace.

Certification for large drones is assessed on a risk-based approach, having regard to the specific circumstances of operations. Where it is deemed formal certification is not required, drones may be subject to other necessary safety requirements, such as adhering to maintenance schedules or being restricted from operating in certain areas of airspace.

Managing safety for rapidly evolving technological issues can be difficult in the absence of evidence. The building of the evidence base, on drone use and the potential risks drones may pose, will continue. This evidence gathering is being undertaken domestically and internationally and will be used to ensure that regulatory settings are appropriate and proportionate.

As with any type of regulated activity, non-compliance needs to be addressed and regulations adapted to keep pace with innovation. Ensuring there is appropriate education, surveillance and where required, enforcement of regulations is crucial. While the majority of drone users will operate, or intend to operate within the existing rules, there will be some who do not understand the rules, or who choose to deliberately ignore the rules.

Current issues

Drone operations have the same categories of safety risks as any other aircraft. The risks are:

- Air risks – drone colliding with another aircraft. This can be split into three further categories:
  - drone colliding with manned aircraft;
  - drone causing a loss of control event between itself and a manned aircraft; and
  - drones colliding with another drone
- Ground risks - drone collision with person or property on the ground

Unlike traditional aviation, however, where any collision represents a serious safety incident, the level of risk associated with a drone collision is dependent on what the drone collides with. Despite their widespread use and fast rate of uptake, there are very few documented drone accidents or collisions. There have been multiple reports of air proximity events between drones and manned aircraft, although it is understood that in some reported proximity events the reporter was not certain they actually saw a drone.

The lack of reported accidents involving a drone, while itself positive news, means that assessing the risk sometimes only relies on evidence that is based on laboratory work or theoretical data. The paucity of real-world evidence has raised questions on how an acceptable level of safety for drone operations can best be determined to underpin appropriate and proportionate safety standards. CASA, as part of its work to maintain appropriate regulatory safety standards, has previously commissioned two key pieces of research.

One of these research pieces examined the potential damage a drone may inflict on a traditional manned aircraft [28]. The other piece of research examined the potential for injury to a person on the ground from a drone [29]. Internationally, research into the potential safety risks continues to occur using simulations and theoretical data [30].

The time and resource constraints involved in conducting research studies highlights the continuing need to collaborate with international partners and industry. This will support access to current and emerging evidence to help develop proportionate regulatory approaches to safety. It will also

promote international harmonisation and interoperability where appropriate for the benefit of facilitating industry operations.

A proportionate response is used as different operating environments pose vastly different risk profiles: operating in an urban environment with other aircraft and ground-based obstacles presents a vastly different risk profile to a farmer operating a drone on a farm in regional Australia or a drone operating over the high seas.

Air risks

The aviation environment is seeing sustained growth. The increasing number of drone operations is occurring simultaneously with increasing numbers of manned aircraft operations. Estimates for Australian air traffic have indicated a potential doubling of aircraft flights between 2012 and 2030 [31] (although these estimates could change due to the impact of COVID-19). Despite the growth in both drone and manned operations, to date there have been no confirmed collisions between drones and manned aircraft in Australia [32].

A further way to consider air risks is to consider reported air proximity events [33]. An air proximity event is when a drone creates a hazard to a manned aircraft or is sighted in the proximity of another aircraft. The rate of air proximity events is growing. In the period January 2012 through to June 2017, there were 242 air proximity events recorded in Australia with the rate increasing each year. The data for the period January 2016 to June 2017 recorded 114 air proximity events. As many of these reports are unconfirmed, the risk to safety is hard to quantify.

Data from the Australian Transport Safety Bureau (ATSB) indicates that 96 per cent of air proximity events occurred at heights greater than 400ft [34] (most aircraft do not operate below 500ft AGL). The majority of drones, despite having the technical capability to operate above 400ft, are subject to a regulatory operating ceiling of 400ft if operating under the standard operating conditions for recreational or excluded category operations.

A secondary effect of managing air risks is when a drone prevents manned flights from occurring. This can occur in the vicinity of airports or heliports and can result in the grounding of emergency response craft, such as firefighting planes or medical rescue helicopters. The delay in emergency response times can have a critical impact on the emergency aircraft's mission. Managing air risks in all settings needs to continue to consider both planned air traffic and unexpected air traffic such as emergency aircraft operations.

The consideration of air risks will continue to evolve. Currently, management of air risks, that could include a collision with a drone, is focused on the impact on manned aircraft operations, whether this be a collision or other action taken by the manned aircraft pilot to avoid a collision. The introduction of autonomous passenger aircraft will require the development of new risk management strategies that could be supported by technological enhancements.

Ground risks

There is no single data set for determining the number of incidents occurring domestically or internationally from drones involving ground risks. In Australia, there were 47 reported terrain collisions from drones between January 2016 and June 2017 [35]. It is expected that most recreational drone collisions with terrain would go unreported as there is no requirement to report such an

incident in many circumstances, particularly as these collisions do not significantly impact safety in most cases.

There is limited documentation of injuries in Australia with most documented cases minor in nature. There have been no fatalities in Australia as a result of a drone colliding with a person. With the exception of military uses, there is limited documentation of any international fatalities from drone collisions.

Risks to people on the ground can be from a drone flying into a person, or the drone or debris from a drone falling onto a person. These may have different consequences and require different mitigations which could vary considerably based on the size and design of the drone. Transport safety regulators and investigators domestically and internationally are advocating for close monitoring of drone safety occurrences as well as the need for continued research to ensure a detailed evidence base [36] to develop robust risk mitigation strategies.

Insurance against risk

Most commercial drone operators make the business decision to hold insurance to cover for any damage or injury caused as part of managing the risk of their operations. Recreational users that are members of some drone organisations carry insurance as part of their membership. The requirement to hold insurance is often a condition of engagement by organisations procuring drone-based services.

There are a range of models in other sectors where third-party insurance has been mandated, such as for vehicles. However, it remains to be seen whether this would be an appropriate mechanism for drones, especially considering the disparate risk profiles of operations across the drone sector. Aviation traditionally has operated free from mandated compulsory third-party insurance for damage to property or injury, although many industry operators hold insurance policies to cover a range of scenarios as a part of their risk management processes.

Any decision to implement an insurance scheme for drone operators will need to be informed by relevant drone accident data, be proportionate to the risk profile of operations, be consistent with a holistic approach to regulation and complement the suite of various approaches available to manage risks and impacts from the use of drones. International approaches have included an insurance service as an optional industry developed UTM service.

Current regulation and strategies

There are current regulations in place to provide for the safe operation of drones in Australia. The introduction of Part 101 of the Civil Aviation Safety Regulations 1998 (CASR) in 2002 and the subsequent development of a supporting Manual of Standards (MOS) for commercial operations, is facilitating the effective regulatory oversight of maintaining aviation safety standards while allowing the continued use of drones [37]. This is supported by the Airspace Regulations 2007 which ensures the management of Australian-administered airspace to provide for the safety of all users of all airspace.

Broadly speaking, there are three safety mechanisms/layers currently provided for in Australian legislation. These are: the use of operating conditions, such as the Standard Operating Conditions (SOC), Part 101 of the CASR and legislative instruments; license requirements for certain drone operators; and approved access to certain types of operations such as within controlled airspace or BVLoS.

Drone operating rules

CASA has developed a range of rule categories to support the safe operation of drones in a range of different circumstances and situations. These categories set out a range of operating rules and requirements, including the distance drones must operate from people and airports among many. There are also dedicated rules around drone operations for payment, and rules that enable the use of drones on a person's own land. However, these categories of rules do not permit BVLoS drone operations. Drone operations outside of the rule categories must be approved by CASA.

CASA's operational regulatory approach utilises the Specific Operations Risk Assessment (SORA) tool developed by the Joint Authority on Rulemaking for Unmanned Systems (JARUS). The SORA allows for a specific set of issues to be considered relative to the proposed operation. It supports an adaptive regulatory approach that is consistent with the needs of a rapidly evolving industry while securing appropriate safety outcomes. The Office of Airspace Regulation (OAR) within CASA conducts airspace risk assessments in accordance with ISO 9001-2008 and ISO 31000 Risk Management.

Licence requirements

The Remote Pilot Licence (RePL), Remote Piloted Aircraft Operator's Certificate (ReOC) and Aeronautical Radio Operator Certificate (AROC) are all administered by CASA. The RePL certificate course provides safety related requirements and tailored training to suit numerous operating environments.

Some categories of rules for drone operations do not require a drone pilot to hold a RePL or ReOC, however there are safety accreditation requirements that may apply depending on the type and circumstances of drone operations.

Registration and accreditation

The introduction of a registration and accreditation scheme by CASA will support continued safety in drone operations. It will also improve the ability of other government agencies to address social nuisance, privacy, surveillance and noise concerns.

Registration of most drones and accreditation requirements for the majority of drone operators, both recreational and commercial, is being introduced progressively from 2020 [38]. The registration of drones will deliver a number of benefits, including incentivising safer operations, better information for security matters, and a database to support communication of safety messages or updates to legislation.

Enforcement and education

The presence of regulations by themselves is not sufficient to ensure operations are conducted consistently within the applicable rules. The effective implementation of appropriate education and enforcement strategies is needed to deliver results. There will need to be different strategies and approaches for commercial drone operators than those targeted at recreational drone operators.

Education on the regulatory requirements for recreational drone operators has been largely supported by online communication. This has included the CASA website and the Know Your Drone campaign. This communication is complemented by the availability of safety literature at the point of sale, such as a pamphlet in a box, however not all drone retailers and manufacturers have adopted the inclusion of the pamphlet.

Enforcement strategies reflect a principle of proportionate action and can include criminal or administrative action. Currently both CASA and law enforcement have access to, and use, enforcement strategies to support safe, responsible and legal drone operations. CASA is only authorised to take action in response to demonstrable or apparent breaches of the aviation legislation. The possibility of criminal prosecution for some offences involving the use of drones is open to state, territory and other Commonwealth law enforcement authorities, as well as CASA.

To support compliance with the range of operational requirements, it is envisaged that continued promulgation of safety messages and legal requirements will ensure existing and new users remain alert to the requirements they need to meet in order to operate drones in accordance with the regulations. A range of mechanisms can be employed to assist with enforcement of safety requirements, such as delegation of powers to issue infringement notices. CASA is in continuing dialogue with state, territory and Commonwealth law enforcement authorities to enhance efforts to deter, prevent and respond accordingly to the unsafe and unlawful use of drones.

Proposed policy approach

The Civil Aviation Safety Authority will maintain its commitment to the primacy of safety, while taking a responsive, modern and evidence based approach to safety regulation and the certification of new aviation technology that provides scope for innovation and flexibility, having regard to the inherent risks of the operating environment, other airspace users and the travelling public.

A safety framework that is robust and flexible is required to actively enable current and future drone operations. With the safety regulatory framework implemented in 2002 and 2007, ongoing reviews of safety standards and relevant regulations are required to ensure they are appropriate to facilitate and encourage modern and reliable drone operations, including BVLoS operations on a wider scale. A regulatory approach that is modern, responsive and appropriate must continue to evolve to keep pace with the developments of the drone industry to enable the projected growth and scale of the industry.

A regulatory approach to provide a pathway for long-term approvals for drone operations by appropriately qualified RePL and ReOC holders could be considered. This could include providing a regulatory pathway to enable long-terms approvals for drone operations within controlled airspace, subject to an ATC clearance. Such an approach would provide certainty for drone operators seeking to respond to market demand for safe and regular drone operations, including within controlled airspace.

To assist the take-up of drones to contribute to economic development in regional Australia, especially industries such as agriculture and mining, fit-for-purpose rules are required for BVLoS drone operations in rural and remote areas of Australia. These standards will have regard to the risk profile of operations over regional and remote areas. The Australian Government is currently exploring new classes of airspace and operating areas to accommodate a variety of drone operations. Industry will need to be closely involved in the design of suitable airspace to support such economic development opportunities.

Special airspace arrangements for drone operations could assist in the response to emergencies and natural disasters such as the major bushfire crisis of early 2020. This could include safety standards to enable drones to assist with manned aviation during future firefighting and disaster recovery operations where appropriate, such as by providing imagery.

With drone and eVTOL technology continuously advancing, continuing to develop and update fit-for-purpose safety standards will be necessary to enable local testing and development of unmanned aircraft, which will support local investment and the establishment of research and development programs in Australia.

To further support testing, research and development, CASA will need to continue to build its capability to provide certification of new unmanned aircraft, including other electric and digital aviation components such as electric engines. As part of this, the Australian Government will work to ensure arrangements are settled with key international partners for mutual recognition of certification of new aviation technologies. Without such mutual recognition with key economies, certification in Australia will be of limited value to international companies.

CASA will continue to work with government agencies and education providers to ensure education and training programs align with the necessary competencies for drone and eVTOL licences and approvals.

Security

Drone technology has the potential to offer significant benefits to the Australian economy and way of life. However, the malicious, unlawful, or inadvertent misuse of drones and the data they collect can pose a risk to public safety, be deliberately used to facilitate or commit a wide range of unlawful acts which may potentially disrupt or threaten the security of our airspace, community, infrastructure and nation.

Existing regulation in Australia controls where drones can fly, who can use them and what level of training or licensing is required. However, these frameworks were not intended to manage the security risks posed by the malicious use of drones. It is necessary to ensure the regulatory framework supports actions required to address malicious drone use.

In December 2018, reported drone sightings at Gatwick Airport caused major travel disruption in the United Kingdom, costing the aviation industry an estimated $91m AUD [39]. Further drone sightings occurred at Heathrow Airport on 8 January 2019 and led to the temporary grounding of flights. Events such as these highlight the vulnerability of infrastructure assets to relatively unsophisticated disruptions or attacks.

The risk posed by drones can also arise from the general public who may, either intentionally or unknowingly, operate a drone in a manner that poses a risk to the safety and security of people, property, businesses and other services.

Areas where drones pose a risk could include:

- Critical first response operations – these operations often include aerial services that are vulnerable to drone activities.
- Prisons – these sites may be vulnerable to drone operations that utilise payloads to facilitate contraband deliveries or to engage in surveillance of prison activity.

- Government, Defence and business sites – these sites may be targeted by drones used as both kinetic and cyber weapons for image and signals gathering, cyber espionage, data exfiltration sabotage, payload deployment or kinetic attack.
- Critical infrastructure – these sites will have a variety of potential vulnerabilities to drone operations including intelligence gathering, payload deployment and kinetic attack.
- Crowded places or special events – vulnerable to drone operations being used for payload deployment, surveillance of security vulnerabilities and kinetic attack.

The cyber threat associated with drones is also becoming more prominent. Both recreational and commercial operators are at risk of unauthorised access of sensitive information, intellectual property and other data if they operate drones on unsecure networks or using unencrypted communication links.

Threat assessment [40]

Australia's national terrorism threat level remains at 'probable' meaning intelligence indicates that individuals or groups possess the intent and capability to conduct a terrorist attack in Australia. It is assessed that an attack would most likely use methodologies involving weapons and tactics that are low cost and relatively simple, including basic weapons, explosives and/or firearms. While drones are not specifically mentioned in Australia's National Terrorism Threat Advisory System, they cannot be excluded as a possible methodology. It is not just in the terrorist space that drones pose a security risk, as drones can also pose other threats, for example espionage.[41]

Current regulation and strategies

Safety regulation

The upcoming introduction of drone registration (as noted in the safety section) will facilitate the management of potential security risks as the identification of the drone owner is likely to become easier and not dependent on physical interdiction of the aircraft or pilot. The accreditation scheme will promote a greater understanding of drone operating rules, which may reduce the potential for drone intrusions into sensitive areas.

There are existing provisions for the establishment of protective airspace that could limit the operation of drones in certain areas for certain periods of time. Any person is able to apply to the OAR within CASA to seek an assessment for the establishment of protective airspace. Currently, protective airspace can only be established for safety, environmental or national security reasons, with the overriding provision of enabling the safety of flight.

The OAR is undertaking research to consider special airspace types that could be used to mitigate security issues. At this point in time there is no ability under the Airspace Regulations 2007 to prohibit drones or any other aircraft type from specific airspace unless for a military necessity. This work is ongoing.

Geo-fencing

The current approach to geo-fencing relies upon a combination of a system to broadcast data about boundaries and the internal systems and software of the drone to accept and abide by the confines

of the boundaries. Other drones include software about the confines of boundaries, but this relies on users regularly updating this information. In both situations, implementing a geo-fencing system requires cooperation between the drone manufacturer and government authorities. Work is also required within government to determine and coordinate appropriate areas for geo-fencing.

A UTM could effectively provide a system to control 'no-fly' areas. This approach would provide a central mechanism through which geo-fencing could be coordinated and would allow the implementation of dynamic and real-time updates in response to emerging events. It would also assist in ensuring the airspace is not overly fragmented and that legitimate drone use is not unduly inhibited in security sensitive environments.

Other counter-drone measures

Drone detection systems are available which can identify where a drone may be operating unlawfully and can also assist in identifying the location of the drone's pilot. Airservices Australia, Defence and CASA have deployed drone detection technology at 29 major airports.

Drones rely on radiofrequency spectrum, and some counter-drone security solutions intentionally cause interference to radiofrequency spectrum in order to either disrupt and disable a drone's communications links or use spectrum as a medium to exploit drone vulnerabilities.

However, there are a number of risks associated with the widespread deployment of this technology, particularly regarding interception or interference with radio communications, cyber-security, the safety of aircraft and potential for collateral damage. As a result, absent the appropriate delegations and exemptions, the deployment and use of these capabilities is generally prevented by legislation designed to manage these risks.

Law enforcement, government stakeholders and the Australian Communications and Media Authority (ACMA) have collaborated to facilitate the interim use of counter-drone capability by law enforcement, that would otherwise be prohibited under the under the Radiocommunications Act 1992**,** the Civil Aviation Act 1998 and relevant state surveillance legislation. There is a need for a robust, long-term approach to managing the risks associated with drones and counter-drone devices.

Proposed policy approach

The Australian Government will lead the development of a proportionate and evidence-based approach to managing security risks associated with drones and eVTOL vehicles that is adaptable to changing circumstance while ensuring a secure operating environment.

A comprehensive drone security framework is required to ensure the response to the security threat posed by drones is flexible as technology continues to advance, proportionate to account for both inadvertent and malicious misuse, and outcomes-focused.

A drone security framework should take a broad approach to managing the physical, cyber and socioeconomic risks associated with drones and include a range of policy and operational measures

to deter and mitigate the security risks associated with drones. Security is widely recognised as an important consideration and as such, the counter-drone capability element will be developed as a priority within and in parallel with, the broader drone security capabilities.

It is proposed that the framework will seek to encompass:

- sustainable and appropriate counter-drone measures to enable authorities and, where necessary, operators of critical or sensitive infrastructure, to have adequate capability to respond to and/or manage the potential threat posed by drones;
- consideration of police powers and training to ensure law enforcement have adequate authority and appropriate strategies to respond to threats;
- community education to deter nuisance drone activity (the majority of unlawful drone usage) and create a general awareness about drone security;
- cyber security measures;
- work to encourage an innovative and sustainable drone industry and to explore the development of a counter-drone industry in Australia; and
- other interrelated measures such as UTM, geofencing, drone registration and remote identification, which while not intended as solely a security measure, could have benefits for mitigating drone security risks.

Noise

Drones are not loud compared to most aircraft or road vehicles, however they emit an uncommon noise which can attract attention. This has raised concerns in some communities and has been a matter of focus in recent discussions on drone regulation in Australia [42]. The potential increasing concentration of drones into and above urban areas brings a focus onto how noise management is addressed.

It is clear that the current approach to noise regulation and the current legislative mechanisms designed to regulate noise emitted from aircraft are not suitable to regulate noise emitted from smaller drones. The operating profile of a drone is:

- significantly quieter and has a more contained noise profile than manned aircraft; and
- more agile within a smaller operating volume.

Current issues

Perception is a critical component of how the impact of drone noise is described. Noise is regarded as a highly subjective element of environmental issues. The complexities of people and their reactions to sound in a given scenario are difficult to predict. This makes assessing the impact of noise and determining appropriate solutions, including the setting of standards, difficult [43].

Determining the noise impact of a drone needs to account for variations in height, stage of operation and distance from the observer. There are different forms of sound measurement that can be used in the analysis of aviation noise. These range from weighted sound pressures to effective perceived

noise levels through to the Sound Exposure Level [44]. The impact of a noise will be further influenced by the environment in which the drone is operating and the conditions on any given day.

As well as there being no easy single measurement tool or threshold that can be applied, the noise from many drones is an atypical noise and potentially viewed by people as annoying [45]. The study of noise produced by drones and ways in that a standard could be established continues to evolve [46]. Simultaneously, drone manufacturers are working to adjust the level and type of noise generated, meaning that some noise research is quickly outdated as technology evolves.

Adding to this are popular public perceptions (and misperceptions) of drones. The willingness of the public to accept an inconvenience is often linked to their understanding of its purpose. This is easily illustrated by the public acceptance of helicopter noise near a trauma hospital, when in other settings it may trigger complaints. Some members of the community do not view current commercial operations as critical and this results in limited tolerance to the noise produced.

Drone operators have been proactive in modifying their business models in response to community concerns. They will likely be equally responsive to any regulatory settings around noise established at either Commonwealth or state and territory level. Drone operators and manufacturers are already collaborating to ensure noise impacts are continually lowered. This will enhance the likelihood of drone operations being permitted and commercially successful in communities.

Current regulations and strategies

Commonwealth

Certain aircraft are covered under the Air Navigation (Aircraft Noise) Regulations 2018 administered by the Department of Infrastructure, Transport, Regional Development and Communications. These regulations look to manage the noise impact of aircraft. They utilise standards that align with the SARPs promulgated by the ICAO.

Under the regulations, the majority of aircraft require either a noise certificate to operate or an exemption to operate without a noise certificate. Noise certificates detail the noise impacts produced by an aircraft.

Traditionally, aircraft are issued with a noise certificate at the time of their manufacture along with other certificates such as airworthiness and engine emissions certificates. These certificates are underpinned by ICAO standards.

A major difficulty with applying noise regulation to most drones is that there is a lack of existing standards or conventions for drone noise, and no process for noise certification. Aircraft noise has generally been in predictable patterns and scale that correlate to the location of airports and flight paths. Smaller drones do not have the same geographical positioning and limitations, being able to operate anywhere within the urban environment. This complicates the measurement of noise impact and exposure.

In addition to the aviation specific legislation, environmental legislation also covers noise impacts. The Commonwealth administers the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act), while each state and territory administers its own environmental legislation.

For traditional manned aircraft, the environmental assessment processes that are in place under the EPBC Act are called into play when Airservices or the OAR is looking to implement a plan for airspace management that is likely to have a significant impact on the environment. This includes consideration of community noise and aircraft emissions [47]. As many drones operate outside controlled airspace and do not require Airservices' involvement, this assessment process is not triggered. The introduction of a UTM to manage airspace integration could support improved noise management for drone operations.

Review of the Air Navigation (Aircraft Noise) Regulations 2018 – Remotely Piloted Aircraft and Specialised Aircraft

In June 2019, the Deputy Prime Minister Michael McCormack, Minister for Infrastructure, Transport and Regional Development, announced that the Department of Infrastructure, Transport, Regional Development and Communications would undertake a review of the Air Navigation (Aircraft Noise) Regulations 2018 to determine the appropriate scope of future noise regulation primarily for drones, eVTOL and specialised aircraft operations.

In considering the submissions received, the Department has developed recommendations, including a long-term whole of government framework for drones and eVTOL as well as some interim regulatory measures until the broader framework is established. These recommendations have been incorporated into the proposed policy approach below.

State

State and territory governments have general responsibility for ground-based noise impact (under environmental protection or nuisance laws) in their jurisdictions. State and territory noise or nuisance regulations and guidelines do not generally impose a decibel limit on objects. Instead they consider, on a case by case basis a number of factors to determine if the noise is inappropriate for that location at a particular point in time.

Depending on the sound of a drone, it may be viewed as having the same impact as the sound of a piece of mechanical machinery, such as lawn mower, being operated in an urban area. The assessment of noise needs to take into account the volume, character, timing, number of people impacted and broader community expectations.

Proposed policy approach

The Department of Infrastructure, Transport, Regional Development and Communications will manage a national regulatory approach to noise management that encourages quieter operations consistent with local community considerations.

An interim, risk-based approach to the regulation of drone noise will be developed to manage the noise impacts from commercial drone operations. This approach will focus on operations that are likely to have significant noise impacts, and will aim to provide flexibility to operators to develop different concepts of operation, whilst carefully monitoring community feedback to ensure that operations do not exceed community tolerance for noise impacts. This interim approach will also take into account noise abatement processes by operators.

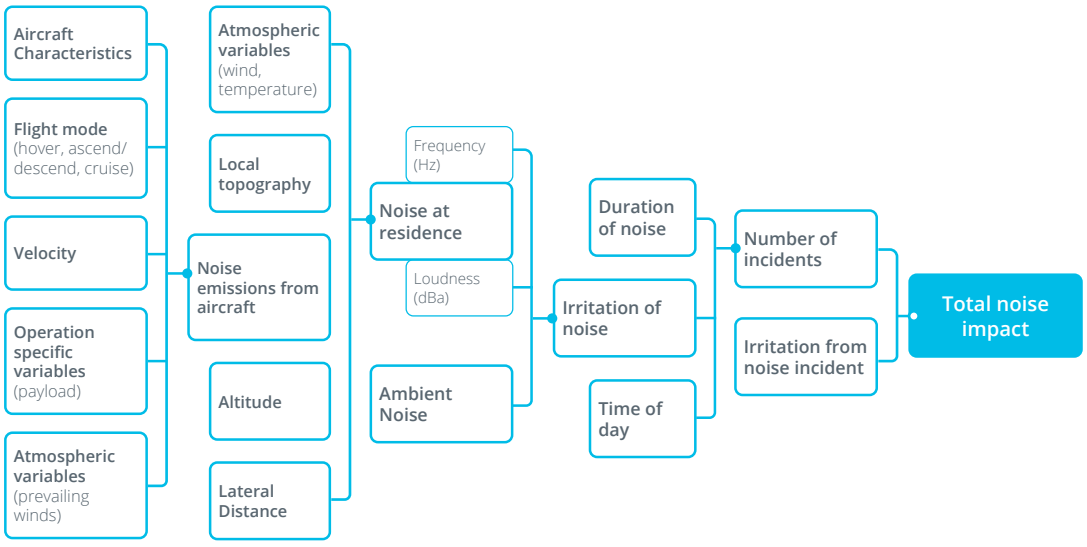
In order to establish a feasible long-term approach to managing drone noise, the Commonwealth in consultation with State/Territory authorities, the industry and the community, will develop a consistent Drone and eVTOL Operations Noise Policy Framework for integrated airspace that encompasses all existing and future commercial drone operations. The national framework could assist in State/Territory planning approval processes related to drone and eVTOL sites.

Noise regulations for drones and eVTOL that meet aircraft noise certification standards (once developed) will be acknowledged under the Noise Regulations. Any approach to noise regulation and noise impact levels will be driven by community acceptance.

Regulating ground based impact of noise versus loudness of drone

A large number of variables determine the noise impact from a drone or eVTOL aircraft.

The following diagram provides an example of how many variables can combine to determine the total noise impact for a particular ground-based location.



Traditional approaches to noise management set limits on the noise emissions from the aircraft or the total number of operations. This approach will not accurately reflect the actual noise impact for drones, leading to an increasing risk of regulations that are either unnecessarily restrictive for operators, or ineffective in ensuring drones operate within community expectations regarding noise impacts.

Localised ground-based noise limits can be set having regard to the surrounding environment and needs. This will serve to set a noise standard at ground level, giving drone operators greater flexibility in how they meet the standard (through aircraft design, routing, operating altitude etc).

Setting baseline noise levels across ground-based locations will provide certainty for both drone operations and the broader community in terms of maintaining appropriate levels of noise impact. Drone operations would be permitted to operate consistent with the various settled ground-based levels, which would encourage and incentivise drone operators to use and develop quieter drones.

Maintaining Commonwealth responsibility for the regulation of drone noise will ensure that a consistent approach is applied across the country, fostering interoperability, enforcement and compliance by industry. State and territory governments and local communities will need to be engaged in local noise considerations and feed into the process of setting appropriate ground-based limits for drone noise, particularly with reference to planning around drone landing sites and facilities.

Noise limits

An approach to noise regulation that utilises hard caps on the number of flights will not incentivise operators to use quieter drones or employ noise abatement measures. It also serves to artificially constrain the size of the potential market and have consequences on competition. As work progresses to develop more sophisticated approaches to drone noise management, it is likely that some quantifiable restrictions may be necessary to ensure that early operations remain within community standards. Initial approaches to regulation will seek to minimise the impact of drone noise based on growing evidence of the impact on different areas and communities.

Work will commence to transition to an approach to noise regulation that is sustainable for operators, facilitates industry to innovate and develop, while balancing the needs of the community in respect of noise impacts. It is likely this will be an iterative process that will occur over time.

Noise abatement technology

Due to the projected growth of the commercial drone industry, any manual process to manage and approve aspects related to drone noise will likely become unmanageable within the next few years. A noise management service implemented as part of UTM service delivery will be explored to ensure compliance with maximum ground-based noise levels, including by employing dynamic routing to either spread noise equitably or requiring operators to route drones to a particular vertical or lateral position to achieve an acceptable noise impact on the ground.

A UTM would be able to access and process noise data based on the particular model, flight mode and trajectory of the drone, factoring in environmental variables and noise abatement measures to calculate the noise impact of the ground, and then ensure the route of the drone does not exceed acceptable noise impact limits. This system may also have the potential to manage the noise impacts of eVTOL operations.

Environmental

Drone operations into both urban and non-urban environments can have ecological impacts. These are still being explored to determine the extent that their use benefits, and the extent of any impact on, wildlife behavior and ecological outcomes [48]. The increasing use of drones raises questions over the potential broader environmental impact they may have.

As drones evolve and their use potentially starts to displace existing polluting technology such as petrol vehicles, a reduction in emissions may be possible. A further consideration is the impact of drone use on sensitive cultural areas such as indigenous or memorial sites [49].

Current issues

Any technological intrusion, including drones, into an eco-system will have an impact. The diversity in use and settings generate a large number of variables that make this a difficult area to assess.

Wildlife

The use of drones in conservation and monitoring may have large benefits. The near real time monitoring that drones can deliver as well as their low cost and ease of use make them a useful tool in the ongoing management and protection of vulnerable environments or animal populations [50]. The use of drones also increases the potential for repeatability within any ecological study due to standardisation, as well as providing financial benefits.

The use of drones can deliver substantial economic benefits from the decreased time spent on tasks, increased speed and coverage and reduction in equipment needed. For example, the use of drones in monitoring crocodile nests could replace the need for either helicopter or ground based

surveys [51]. Helicopters are very expensive and ground-based surveys bring significant time costs as well as risks for the people involved.

Drones have been used in the research and ecological arena for some time. Findings from a number of studies on the impact of drones on wildlife indicate that while there were animal reactions to drones, this was often conditioned by factors that related to both attributes of the drone and the animals being studied [52]. Elephants dislike drones that sound like bees while kangaroos note the presence of drones but rarely flee from them [53] [54]. There is evidence that animals adapt to the presence of drones and become habituated to their presence [55].

The use of drones can lead to innovative research that would not otherwise be possible – such as sampling inaccessible wildlife. While the majority of research has focused on the impacts found during targeted research, the impact on wildlife occurring from the more diverse and ubiquitous recreational user is not as well understood [56].

Emissions

Industries around the world are looking at how to manage and minimise their energy use and greenhouse gas emissions. Drones have a potential role to play in the emissions reduction area. However, the diversity of drone types and use, in addition to the broader infrastructure in which they operate will all influence the impact they may have on emissions reduction.

Electric powered drones used for delivery purposes can, in many cases, be more effective in reducing energy and greenhouse gas emissions than a traditional van or truck using petrol or diesel [57]. However, this is partly dependent on the method in which the electricity is generated. It also assumes the van has not transitioned to a less energy intense fuel option. The emissions from a drone also need to account for a more limited range and the potential need for warehouses or recharging pods in order to service a larger area.

Drones used for services where land-based vehicles are unable to access, such as in place of helicopters for search and rescue activities, will have different degrees of benefits.

Further research to understand the impact of drone use in a variety of settings is needed to determine the broad scale impact on emissions.

Cultural sites

Environmental management in Australia needs to consider and respect the Indigenous history and heritage. Many sacred sites are in areas that are open to the public. Others may have restricted access to protect them and maintain their cultural integrity.

There are issues with drones taking footage of sacred sites in jointly managed Commonwealth national parks. The EPBC Regulations allow a Ranger or Warden to request deletion of images of sacred sites. However, legislation does not address the issue of images that are immediately uploaded to the cloud.

The use of drones within a sacred site may be considered disrespectful and intrusive. They can also cause damage to the site. Other cultural sites may also wish to limit drone operations. These could include memorials, places of worship and other sites seen as being unduly disturbed by drone operations.

Current regulation and strategies

There is a mix of responsibility for environmental regulation across Australia. As noted earlier in the noise chapter, the Commonwealth administers EPBC Act while each state and territory administers its own legislation.

State level regulation can have multiple layers within it, for example NSW has the Environmental Planning and Assessment Act 1979 (NSW) and the Protection of the Environment (Operations) Act 1997 (NSW). This state legislation also empowers public authorities, such as local councils, to develop further environmental planning instruments known as local environmental plans.

Managing environmental impacts, covering both wildlife and cultural sites, can take the form of location or event-based regulations. These can be created by both the Australian Government and state and territory governments. However, the triggers for assessments under environmental laws (such as the EPBC Act) is unclear regarding the applicability for drone and eVTOL operations.

Location strategies include the use of Commonwealth and State National Parks across Australia. The presence of a National Park allows for restrictions on the use of drones to be implemented. This is frequently expressed through the need for a permit to operate in certain places and allows the responsible authority to have a degree of vetting on who is using a drone and in what manner. This supports appropriate consideration for managing local wildlife and cultural impacts. Restrictions can be applied for under the legislative authority of the EPBC Act. For example, flying a drone in the Uluru-Kata Tjuta National Park is an offence under the EPBC Act [58].

Restrictions applied for environmental purposes can be complex and differ between jurisdictions. Environmental regulations can be inconsistent with the requirements set out by CASA for safety purposes, as is illustrated in the case of regulations relating to the approach to marine animals [59]. While CASA SOC limit drone operation to below 400ft, the EBPC Act requires a height restriction of 500ft from marine mammals. This means a drone operator will require a permit – either from CASA to operate outside the SOC; or from Department of Environment to operate in close proximity to a whale while in Commonwealth waters. A further complication is that there are inconsistencies in state and territory requirements. For example, in NSW waters the height restriction is 100m, which allows the operation of a drone within the SOC [60].

Proposed policy approach

The Australian Government will lead the development of a consistent, balanced and proportionate approach to manage the impacts on wildlife and the environment, including the enjoyment of nature areas and cultural sites.

The Commonwealth and States/Territories will work together to settle roles and responsibilities, clarify the application of existing environmental regulations to drones and eVTOL operations, and consider further regulations as necessary. This will allow the public to have confidence in the process for determining and managing the level of environmental impact drones may have. This approach will also include the development of rules regarding the use of drones to monitor and protect the environment by government authorities (or contractors), including ensuring interoperability with other rules relating to drone operations, such as safety rules.

Consideration will be given towards working with industry to develop a voluntary code of practice where it is appropriate. Once established, the contents of a code of practice could be managed as part of a UTM and communicated through other drone flight information tools.

Community education programs will encourage compliance with existing regulation and management strategies for minimising the impact of drone operations on the environment. These will raise awareness regarding the need for drone operators to consider specific requirements regarding environmental restrictions and the potential impacts on nature areas and wildlife, irrespective of where drone operations are occurring.

Privacy

The protection of privacy is considered one of the most contentious issues that communities around the world will need to manage as drone use increases[61]. Managing public perceptions of privacy and trust in technology is critical to the ability to embed and harness the benefits of technology and innovation [62].

Privacy is a complex policy area as there is no agreed definition of what is meant by privacy.

The Oxford English Dictionary defines 'privacy' as:

"The state or condition of being alone, undisturbed or free from public attention as a matter of choice or right; seclusion; freedom from interference or intrusion" [63]

Australia is a signatory to the International Covenant on Civil and Political Rights. This recognises a right to protection from unlawful or arbitrary interference with privacy. Privacy legislation at the Commonwealth level, and in most States and Territories, supports this right in relation to protecting personal information about individuals. There is no statutory right to sue for serious invasion of privacy in Australia [64], though existing actions such as breach of confidence, trespass or negligence could apply to privacy breaches.

Other regulations that may be seen to support the right to privacy in Australia includes Commonwealth, State and Territory legislation that concerns trespass, nuisance and/or surveillance issues.

Current issues

As small drones are being sighted more frequently in communities, people are becoming sensitive about the potential impact on their privacy.

Drones differ from other forms of new technology that have been introduced to society in recent years, such as engineering robotics or nanotechnology. They are being encountered by people firsthand in a social setting that is atypical for many new technologies [65]. Drones are visible and appear to the public to have unrestricted mobility. They are not bound by the limits that aircraft traditionally have, allowing them to be an anonymous, low-level and continuous presence within any outdoor space [66].

The mobility of a drone, which is in many ways their defining feature, can present privacy concerns in certain situations. A drone can be seen to easily intrude into what is viewed as private space, such as a person's backyard, as well as intrude into personal space, such as when a person is sitting in a public park.

A person's privacy can still be recognised within a public space. The rights to privacy within public spaces are more nuanced, and influenced by the location and activity that a person is engaging in [67]. For example, attending a sporting match that is being filmed and broadcast versus entering a toilet within a public shopping center; both are public spaces, but the expectation of privacy in all forms is different in the setting and context.

Lacking a clear definition, it can be useful to consider two primary forms of privacy invasion [68]. First is the intrusion upon seclusion, such as by physically intruding into a person's private space or by watching, listening to or recording a person's private activities or private affairs. Second is the misuse of private information, such as by collecting or disclosing private information about a person. These two forms can have considerable overlap.

The perceived intrusion onto a person's sense of seclusion can be difficult to quantify and there are questions on how this can be legally enforced [69]. Similarly, with recording information, the ability for a drone to take a photo that includes a person or their home can be viewed as intruding, but may be lawful.

The second issue, relating to the misuse of information, including the collection of information as well as the disclosure of it, is equally complicated. The widespread use of applications such as Google StreetView has sparked conversations regarding an individual right to personal privacy. The collection and publication of material in public spaces is largely indifferent to an individual's personal sensitivity or threshold of privacy.

Drones that are capable of collecting information such as photos, videos or sound recordings that legally operate in public spaces are less of a concern. However, by having the capacity for an aerial view, the potential for people to feel information collection has intruded their privacy grows. For example, the Google StreetView is collected from vehicle height on public roads. A drone operating on the same geographic path will be able to see further into a person's yard circumventing infrastructure, such as fences, that may have been installed to deliver privacy.

Current regulation and strategies

Aside from the Commonwealth Privacy Act 1988, the majority of regulation that is applicable in the privacy area is administered by the state and territory governments. State and territory privacy laws about trespass, nuisance and surveillance are the most likely legislation to apply to drone activities.

The Senate Standing Committee on Rural and Regional Affairs and Transport (2018) report*: Regulatory requirements that impact on the safe use of Remotely Piloted Aircraft Systems, Unmanned Aerial Systems and associated systems and the Australian Government response to the Senate Standing Committee on Rural and Regional Affairs and Transport. Regulatory requirements that impact on the safe use of Remotely Piloted Aircraft Systems, Unmanned Aerial Systems and associated systems* noted that state and territory privacy laws are a matter for state and territory governments, however the Australian Government will engage with state and territory governments to consider national harmonisation of state and territory privacy laws [70].

Regulation is not the only option available to manage public concerns over privacy and drone use. A further option would be to consider the potential for non-binding codes of practice or privacy guidelines applicable to drone operators, and to encourage commercial and community uptake of these when operating a drone.

Commonwealth legislation

CASA's safety rules limiting the ability for a drone to fly over a person or activity reduces the potential for perceived intrusion. However, a drone operating 30m away from a person may still be seen as intrusive, even if not directly above them.

In terms of specific privacy legislation, the Commonwealth has responsibility for the Privacy Act [71]. This legislation covers the protection of personal information in the Commonwealth public sector and in the private sector for organisations with an annual turnover of $3 million or more, subject to some exceptions [72]. It does not address the collection and use of information by individuals acting in a personal capacity nor does it cover more generally the concept of intrusion upon a person's seclusion. The Privacy Act deals with the protection of personal data and the security of personal information rather than with privacy more generally. The Privacy Act contains 13 Australian Privacy Principles that set out standards for the collection, storage, security, use, disclosure and quality of personal information.

The Privacy Act does not generally apply to state and territory government agencies or contractors to those agencies. They are subject to state and territory privacy legislation in all jurisdictions, except for South Australia and Western Australia, who do not currently have privacy legislation.

Public awareness and expectations of what organisations and actions are covered by the Privacy Act is poor with a majority of Australians believing that the reach was greater and extended to more organisations that it does [73].

State legislation

State and territory governments all have different legislation and approaches to privacy. This reflects the history of each state, the related pieces of state legislation and the community expectations in each jurisdiction. Not all States have privacy legislation. All have some forms of trespass, nuisance and surveillance legislation that may apply to drone activities.

The application of trespass, nuisance and surveillance legislation to drone activities can be complex. The use of nuisance for example may not extend to a drone unless it is interfering with the ordinary usage of a place. Similarly, trespass requires a person to hold a particular title over the land in question and does not apply in public areas [74]. The operation of drones in airspace creates further issues as generally it is viewed that a property owners rights are restricted to the heights that are necessary for the ordinary use and enjoyment of their land [75]. A lack of Australian case law means that there is uncertainty over how trespass legislation is interpreted on some occasions.

Where privacy has been invaded through the use of surveillance devices there may be some remedy under a state or territory's surveillance laws [76]. These laws can include regulations on how a device is used as well as regulating how the information collected from a device is communicated or published. This varies across states and territories. Use of listening devices are generally prohibited without consent. However, optical devices are not as consistently addressed, with a number of states silent on their use [77]. States may have alternative legislation that creates an offense relating to the possession of unlawfully recorded private activities.

Proposed policy approach

The Australian Government will lead the development of a nationally consistent approach for managing privacy concerns that balances the impacts on privacy with the needs of drone and eVTOL operations.

The need for nationally consistent privacy regulation was discussed in a 2008 Australian Law Reform Commission report [78]. While some degree of national consistency has been achieved since then, as the Commonwealth and certain states and territories have amended privacy laws in their own jurisdictions, States and Territories still maintain discretion to ensure that any privacy related legislation responds to local conditions and appropriately interacts with any other state based legislation such as freedom of information or human rights [79]. The Commonwealth will work with States and Territories to consider increased interoperability and application of privacy laws in regards to drones and eVTOL vehicles to provide more clarity and greater consistency in the approach to how the privacy implications of drones are handled.

Non-regulatory approaches will also be considered to educate drone operators and the community to create a respectful operational environment. This could include non-binding codes of practice or privacy guidelines applicable to drone operators, and to encourage commercial and community uptake of these when operating a drone.

The development and introduction of a UTM system will also provide the ability to enable a technology solution to identify and report drones that are potentially infringing privacy.

Privacy impact

Drones will potentially have access to airspace in part determined by the extent of their ability to not unduly intrude upon privacy. Drones without recording devices may have greater freedom to operate over residential areas at lower altitudes than those with high resolution cameras and microphones. This would incentivise, for example, delivery drone manufacturers to develop less intrusive drones for residential deliveries or develop other methods to mitigate privacy concerns where such recording equipment is being used. Drones with high-resolution recording equipment may be limited to higher altitudes or less privacy sensitive areas, such as flying over major road corridors or industrial areas. Similarly, drones flown by trusted operators could have greater access to privacy sensitive areas than those operated by users who have not demonstrated appropriate processes for ensuring privacy in their operations. The Commonwealth will work with States and Territories to develop, as required, a clearer process to handle privacy complaints regarding an inappropriate use of a drone that unduly impacts privacy, causes nuisance or trespasses.

Electric vertical take-off and landing vehicles

Urban air mobility has long existed in many urban areas around the world, however, to date these operations have been undertaken by helicopters. The development and introduction of quieter, cheaper and more efficient eVTOL vehicles will effectively lower the operating price point to enable a viable transport alternative for many people in our cities and regional communities.

The introduction of eVTOL operations at scale will create a new range of challenges, including maintaining the safety of the aviation system, allowing supporting infrastructure, security issues, community engagement and education. There will also need to be consideration of the implications regarding autonomous operations in advance of the introduction of this technology in the future, such as how responsibility and control is ensured with increasing automation as well as the legal responsibility for autonomous operations.

A further challenge for government is to safeguard fairness and equity across the industry by ensuring early adopters of this technology do not unduly restrict the entry of other market operators and existing airspace users. The potential exists for breakthrough companies to create pseudo monopolies simply by being the first to enter the market, if policy and regulations do not support the potential for multiple operators from the outset.

eVTOL operations will also require significant infrastructure, which will require consideration regarding access, competition, oversight, approvals, community impacts and flight corridors. The impact of eVTOL operations in regional areas is expected to be less complex in relation to infrastructure requirements.

Proposed policy approach

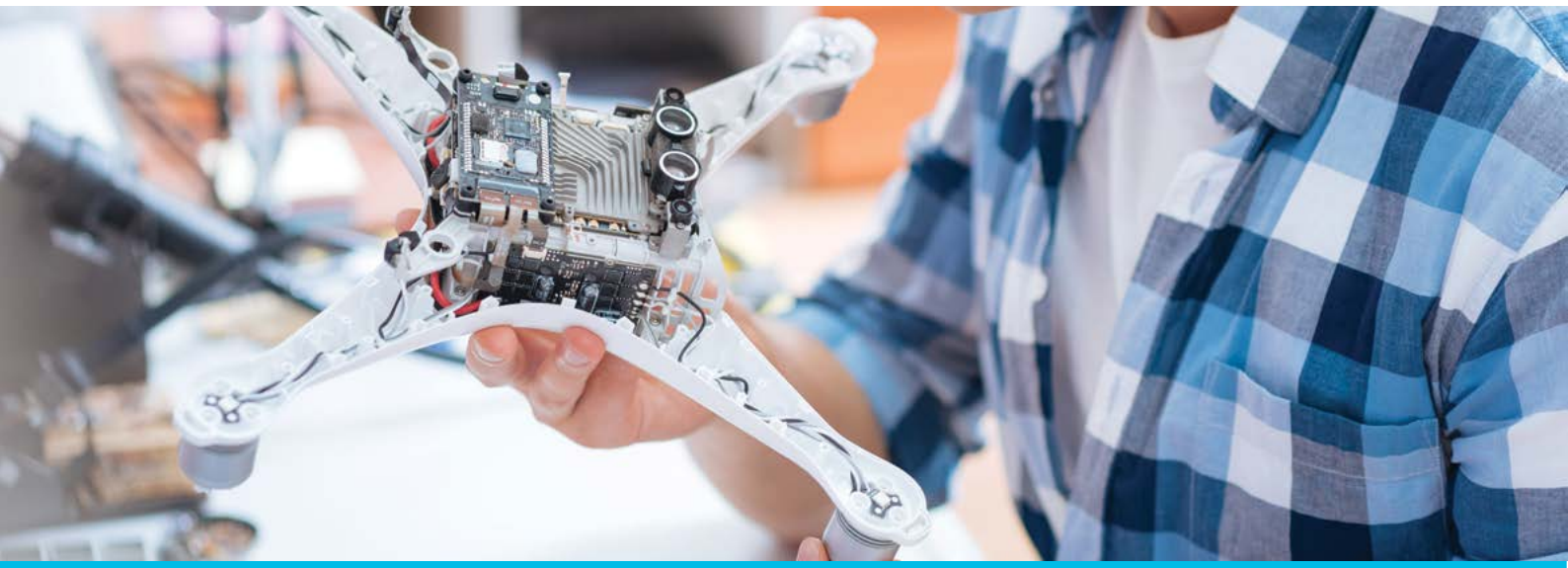
The Australian Government will work with all relevant stakeholders to develop measures for safe, efficient, considerate and reliable eVTOL operations in a competitive market that supports safe, efficient and equitable access for all airspace users.

The Australian Government is already working with state and territory governments, eVTOL operators and developers and infrastructure owners to prepare for the planned introduction of urban and regional eVTOL operations, and to understand the various horizons of future operations. Key areas of focus include community engagement, vehicle certification and testing pathways, competition and equitable access, infrastructure planning, and airspace routes and design.

Introduction of eVTOL operations will require states and territories to assess the community needs in relation to transport and development priorities. This could be incorporated in the master plans for cities and regions and financial mechanisms determined. This may include the job creation opportunities for the local community.[80]

Considerate operations, acceptance and education is a key priority that must be addressed. Understanding community sentiment and generating social acceptance of this new technology will be central to the successful large-scale roll out of eVTOL operations.

A core component will be ensuring multiple operators can conduct concurrent operations safely in the same airspace and considering the needs of all airspace users when undertaking infrastructure and town planning. As with broader drone operations, a well-planned UTM will be particularly vital for ensuring the long-term success of eVTOL operations.



Infrastructure

Infrastructure will be required to support the continued uptake and application of drones and eVTOL within Australia. The type of infrastructure may differ depending on the future evolution but is likely to include some form of warehouse or site management where drones can return for charging, loading and maintenance. Most current thinking prefers a hub and spoke style model of drone and eVTOL deployment, but that is not yet certain. There will also need to be a range of new infrastructure developments to accommodate eVTOL operations, including integration with existing transport and community hubs.

The infrastructure needs will be further influenced by the capability and size of the drone/aircraft, network planning, integration with ground-based transport modes or depots, air routes and air traffic management. The options are many and will need to be closely monitored to ensure that once a technology path is more certain, investment and planning can occur in a timely manner.

The future growth of drone operations and eVTOL may affect the use of existing or newly planned infrastructure. For example, the growth in drone delivery operations may reduce the reliance of vehicles on the ground, thereby reducing congestion. Infrastructure design and planning may also need to change to accommodate eVTOL operations, such as strengthened rooftops for landing pads or vertiports. Further studies and consideration will be required to understand the long-term impacts of the changing use of transport resulting from a greater reliance of drones, and how that will inform planning and funding for future infrastructure projects.

Communication, navigation and surveillance systems

The wireless communications links used by drones rely on access to radiofrequency spectrum, which is regulated by the ACMA under the Radiocommunications Act 1992. Spectrum management in general, and targeted spectrum reforms for drones in particular, will play a key role in enabling the social and economic benefits that drones are expected to facilitate. Over time, it is likely that any one drone will rely on multiple communications systems, and some drones will be integrated into broader communications systems and networks. Airspace integration and safety outcomes will also rely on access to, and management of, spectrum.

Spectrum management will be an enabler of safe, secure and efficient integration of drones into controlled airspace. [81] These applications and their users will require greater assurances in the quality and reliability of spectrum access arrangements than is currently provided, necessitating a mix of new and existing approaches to radiocommunications licensing and spectrum management.

Proposed policy approach

The Australian Government will lead the development of a coordinated and informed approach to infrastructure planning, investment, requirements and approvals.

Commonwealth and State/Territory Governments will jointly undertake work with industry to better understand the impact of drone and eVTOL operations on infrastructure and will continue to work with planning agencies and local government to support the evolving requirements, including pathways for approval. Consideration and planning around such infrastructure will also need to factor in the perspective of the community and the operators that utilise such infrastructure.

Taking a coordinated approach to infrastructure planning, including clear guidelines and processes for infrastructure approvals, will ensure infrastructure developments are compatible with the scale of future drones and eVTOL operations and that Australia continues to generate interest from international investors.

Technology trials

It will be important for governments to collaborate with industry to learn about and facilitate the use of new technologies that will foster growth of the drone industry and assist drone operators to deliver the range of expected regulatory, commercial and societal benefits. This may require governments to consider bespoke control arrangements for trials or undertake joint trials with industry players to enable the development of an evidence base from testing new technologies and operating environments.

Such technologies may also be of benefit to government regulators, and could play a role in regulatory enforcement, such as maintaining secure and safe operations.

Sandboxes – areas for innovation

Safety is a hallmark of the aviation industry. This needs to, and can, be maintained without stifling innovation. One way in which a wide range of drone related innovations can be advanced without compromising public safety is the use of controlled 'sandbox' spaces for conducting trials. These spaces are designed to allow activity that may be difficult to integrate into existing regulatory processes. They allow for controlled operations that might not otherwise be possible or permissible without compromising safety. Regulatory processes regarding the safety requirements exist to support implementation of these spaces, and a number of drone test areas have already been established in Australia.

Some state governments are looking to support drone operations including the development of spaces where airspace integration trials, including UTM systems and other drone technology, can be conducted [82]. Trials are showing that there is potential for positive collaboration and engagement with all levels of government and industry [83]. Utilising the opportunities of vast uninhabited areas

in regional Australia to conduct trials could result in potential benefits for drone operators and stimulate new investments in regional Australia.

With many aircraft developers and manufacturers looking to test their new aircraft prototypes, there is an opportunity for Australia to facilitate flight-testing in a quick and reliable manner, and realise the economic development and investment opportunities that would follow. Australia is blessed with significant open space to test such aircraft, good weather and low sovereign risk. To attract these opportunities, it will be important to signal a willingness to work with manufacturers, regulators and local stakeholders.

Proposed policy approach

The Australian Government will develop an approach that fosters partnerships between government and industry to promote shared outcomes and learning with the goal to support the commencement of future commercial operations.

Appropriate sandbox areas for trials will need to be developed by governments in collaboration with a range of partners including industry, developers of drone technology, and local communities to facilitate flight-testing of new technology. Establishing these arrangements will involve collaboration between manufacturers, regulators, planning authorities and local stakeholders. Appropriate regulatory approaches will be required in order to enable testing and trials of new operational and vehicle concepts.

Governance and central coordination of future work

There are many players involved in the drone field and the authority for many aspects of policy, regulation and responsibility is shared across a range of different Commonwealth and State/Territory agencies. Coordination of information and the sharing of learning and international engagement that occurs in a fragmented and ad-hoc way, can reduce potential efficiencies and synergies that could otherwise eventuate.

As new challenges arise and responses are required, it will be essential that responses are coordinated and consistent across Commonwealth and State/Territory governments, which includes the ability to respond to community concerns and complaints.

The Department of Infrastructure, Transport, Regional Development and Communications will coordinate and manage ongoing policy work regarding the management of emerging aviation, including drones and eVTOL operations. This will involve coordinating engagement and cooperation with Commonwealth agencies through regular inter-departmental forums, with each agency being responsible for developing their own coordinated whole-of-agency positions and contributions.

A Commonwealth and State/Territory forum will also allow governments to facilitate the ongoing management of drones and will assist in managing a nationally consistent and coordinated approach moving forward, facilitating industry compliance and interoperability.

Processes will be settled to provide clear, transparent and proportionate avenues to address community concerns, such as those relating to safety, privacy and noise. Such processes will also provide an opportunity to develop an understanding to enable suitable mechanisms to be developed and implemented to mitigate community impacts of drone operations moving forward.

Proposed policy approach

The Department of Infrastructure, Transport, Regional Development and Communications will coordinate an ongoing whole-of-government policy approach to manage future challenges associated with emerging aviation technologies to ensure a consistent and coordinated approach to regulation across issues and jurisdictions.

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80 Headway Urban Air Mobility Policy Recommendations for the Next 5 Years.

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