Protecting Australia with UAS (Unmanned Aerial Systems)

A Special Report by the Sir Richard Williams Foundation

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Foreword

This report has been prepared in keeping with the Sir Richard Williams Foundation’s (The Foundation’s) objective of promoting constructive debate on issues affecting Australia’s national security and national interests. The Foundation’s board of directors has endorsed the report’s Conclusions and Next Steps.

The report is based on extensive research, interviews and seminars with key stakeholders from politics, defence, civil aviation, border protection, immigration, customs, airworthiness, industry, research and development, unmanned aerial systems (UAS) related associations, academia, the media, ethics and environmental groups, and subject-matter enthusiasts.

The report distils into a concise narrative the major challenges and key issues associated with protecting Australia with UAS capabilities. In doing so, the Foundation has sought to keep the report accessible to a broad range of readers.

Australia’s geography is uniquely well-suited to the use of UAS in a variety of military and civilian missions and roles over water and land. Official action consistent with the report’s Conclusions and Next Steps could allow Australia to take full advantage of this transformative technology.

Adopting these Conclusions and Next Steps, while specifically intended to respond to issues associated with exploiting UAS capabilities in a defence context, could also address a range of challenges that manifest themselves more broadly in the protection of Australian security, particularly in terms of national support operations and air safety.

The board acknowledges the generous and impartial support of the project’s sponsors: Northrop Grumman, Raytheon Australia, Lockheed Martin, General Atomics Aeronautical, Insitu Pacific and Cobham.

Air Marshal Errol McCormack, AO (Retd)
Chairman

February 2014
The capabilities and use of unmanned aerial systems (UAS) has grown rapidly over the last decade or so. Australia’s geography is uniquely well suited to the use of UAS in a variety of military and civilian missions and roles over water and over land.

The Australian Defence Force (ADF), while relatively slow to adopt UAS, has recent successful operational experience with UAS in Iraq and Afghanistan. The ADF plans to build on this experience including through the potential acquisition of new multi-mission UAS with an Intelligence, Surveillance and Reconnaissance (ISR) capability as a complementary capability to the replacement of the AP-3C Orion maritime patrol aircraft with a new manned aircraft (Project Air 7000).

In addition to the ISR role, the introduction of UAS strike capability by Australia appears to be inevitable. A potentially cost-effective way of acquiring armed UAS would be to investigate expanding the scope of Project Air 7000 to include the acquisition of a strike capability for the chosen ISR platform.

Fully exploiting the potential benefits of UAS, however, requires addressing a range of issues. The current debate and analysis on particular manned versus unmanned platforms for specific roles should shift its focus instead identifying the optimum mix of manned and unmanned systems to achieve the desired effect in the most cost effective way.

Policy implications of armed UAS need to be settled in the short term in the context of Australia’s current Rules of Engagement and its obligations under International Laws of Armed Conflict. Australia should consider following the lead of the United Nations (UN) and the United States (US) by adopting a no full autonomy policy for UAS operations.

However, acquiring new unmanned and manned aircraft is only part of the capability requirement. These new technologies will not be properly exploited unless the ADF is able to fully process, exploit and disseminate the gathered imagery and technical information. What is needed is not a separate or new UAS processing, exploitation and dissemination (PED) capability but one integrated PED for all data collection that will be able to cope with future data volumes.

In addition, new UAS technologies will need to be applied to the entire set of ADF core function areas to increase the effectiveness of operations, rather than just plugging UAS into conventional Concept of Operations.

Australia should seek to be an influential UAS buyer as the Defence budget will not afford the scale and diversity of UAS acquisition that can be undertaken by US forces. Next generation UAS preferably should have the flexibility to perform more than just one function through the development of modules so that different mission sets can be accomplished by changing the configuration of the aircraft itself.
Australia should also collaborate with other UAS military users to overcome current UAS limitations particularly their vulnerability in contested and denied air environments, and current data link and bandwidth limitations.

In the specific context of defence, the ADF needs to develop appropriate capabilities to counter potential UAS terrorist acts; an appropriate ADF personnel selection, management and training system to underpin UAS; and a sound understanding of current Australian UAS research and development (R&D) and industry capabilities. In addition, the ADF needs to shape future R&D and industry development to meet expected ADF requirements.

Looking more broadly, UAS will enhance the ADF’s contribution to national support tasks such as civil emergencies and border protection. The persistence and surveillance capabilities of UAS provide new and innovative options for these tasks and will free manned platforms for more complex tasks.

Defence, though, is not the only Australian Government agency acquiring or potentially acquiring UAS. An important issue for Government consideration is whether agencies such as Customs and the Australian Maritime Safety Authority (AMSA) should own their own UAS assets, as is the case for manned assets, or whether they should be in a largely centralised pool owned and operated by the ADF.

With rapid military and civil UAS growth in Australia expected, the civil airspace challenge for the Civil Aviation Safety Authority (CASA) is to ensure the safety of other airspace users as well as the safety of persons and property on the ground. CASA is working closely with the International Civil Aviation Organization (ICAO) and other international bodies to update Australia’s regulatory framework. CASA might like to follow the US precedent by developing a UAS Integration Roadmap and establishing UAS test sites in Australia.
Introduction

This report is a primer and a compendium rather than a deep study. It does not provide technical information on the capabilities or attributes of particular unmanned air systems (UAS) that are weapon systems in their own right.
UAS deliver a multitude of effects and are a complex mix of sub-systems that include the platform, payloads, ground control elements, command network, and launch and recovery elements. Alongside these are data-processing elements, a workforce of intelligence analysts, as well as supporting sub-systems involving training and maintenance. UAS choices require careful analysis, consultation and collaborative effort for effective employment.

The report consolidates ‘where we are now’ and ‘where we are headed’ in an effort to inform the Australian Government and its departments and agencies, as well as to encourage closer collaboration between government bodies (both civil and military), the UAS industry, and the community.

The report is focused on the upsurge in military UAS employment over the last decade that has been the result of increased sophistication of UAS, a technical maturing of their sub-systems, and a growing confidence by the military and governments in UAS capability.

This does not mean that the manned aircraft has been superseded by UAS. Many airborne operations, especially more complex, dynamic and interactive missions, still require the immediate presence of human intelligence and human judgement.

There is, however, a greater recognition of the potential for increased cost-effectiveness of mixed manned and unmanned systems, and the significant advantages and risk reduction achieved by removing personnel from airborne platforms in hostile threat environments.

There is also a greater recognition that UAS bring a new dimension to a theatre – aerial persistence – previously achievable only by recycling multiple manned aircraft through airborne tasks and rapidly running down fleet and crew availability in the process.

Hence, a new paradigm is emerging: one of complementary manned and unmanned aircraft and systems that exploit the advantages of both capabilities. The real issue in the manned/unmanned comparison is determining which is more combat- and/or cost-effective, and in which roles.

The report highlights the potential for military UAS to contribute to national support operations including search and rescue, border control and protection, disaster relief, fisheries surveillance and quarantine.

Importantly, the report also recognises that UAS have limitations such as limited self-defence capabilities and concerns regarding the reliability of their communication links and associated satellite coverage.

The report also highlights a number of issues in the public debate on UAS in Australia and overseas that need to be addressed. These issues include the potential for unethical use of UAS, air safety concerns and uncertainty over fully automated armed UAS.
Definitions and Terminology

Unmanned Aerial Systems (UAS)
UAS consist of an aerial platform without a pilot onboard under the remote control of a pilot on the ground or in another vehicle. The typical launch and recovery method of an unmanned aircraft is by the function of an automatic system or an external operator on the ground.

The basic elements of UAS include:

Platform
Platforms are either fixed-wing or rotary-wing airframes capable of controlled, sustained flight using on-board propulsion and aerodynamic lift. They vary widely in size, weight and sophistication, as well as in means of propulsion.

Pilots and/or trained operators fly platforms either from:

- remote control stations located at sea, on land or in the air, using data links provided through satellite communications; or
- line-of-sight communication links at launch locations.

While the overall system is referred to as a UAS, the air vehicle is referred to as a remotely piloted aircraft (RPA), recognising the critical role of the ‘human in the loop’.

Payload
Payloads are what platforms carry to conduct their roles and missions. In addition to organic avionics and fuel, platforms are designed to carry a variety of sensors and communication devices that send information back to control stations. Sensors can receive and broadcast real-time imagery by day and night, gather technical intelligence and analyse the atmosphere. Payloads can also include armaments (bombs and missiles) and non-kinetic effects such as frequency jamming.

Processing, Exploitation and Dissemination (PED)
PED is the function where, as the name suggests, processing, exploitation and dissemination of information occurs; this is the raison d’être for platforms and payloads. Without PED, output from UAS is limited to real-time operator interpretation of the sensor data. An analogy would be that the payloads are UAS eyeballs, and PED is UAS brains. Typically, PED specialists are co-located in control stations with pilots flying platforms. These personnel collaborate with pilots to employ platforms and payloads to best effect while processing, exploiting and disseminating information to commanders and their staff.
Data Links
Data links are the means for communicating information to and from platforms and sensors. All beyond-line-of-sight platforms and sensors depend on satellite communications for data links that enable pilots to fly platforms remotely and for sensors to send imagery and information to control stations. If data links fail and pilots lose control, RPA are preprogrammed either to self-destruct – immediately or after automatically flying along a route to self-destruct safely – or to fly to a preplanned safe landing location.

Sense-and-Avoid Systems
Many next-generation RPA will be equipped with sense-and-avoid radars, visual/IR systems and datalink systems in order to automatically detect other aircraft in the vicinity and advise the pilot, or, if collision is an imminent risk, take automatic evasive action. This technology is crucial for enabling RPA to share airspace with piloted aircraft.

For further definitions and terminology, see Glossary on page 39.
Myths

A number of myths about UAS could threaten their effective exploitation unless addressed.

The myths about UAS include:

Unmanned aircraft are ‘drones’
The term ‘drone’ has become popular in the media and with the general public and has resulted in an unhelpfully negative view of Remotely Piloted Aircraft (RPA) as sinister, robotic, autonomous but unintelligent platforms. In reality, RPA are responsive, agile, intelligent and effective in a wide range of roles and missions. They perform their tasks with high levels of persistence, precision, fuel efficiency and low carbon emissions. The next generation of RPA will be even faster and more sophisticated, have more stealth, endurance and survival ability in contested airspace and will exhibit a greater level of automation.

‘Drones’ are robots
The use of the term RPA ensures that human control is clear and unambiguous with the essential role of a qualified pilot spelt out in the name. It is erroneous and misleading to describe or infer that robots control unmanned aircraft or that unmanned aircraft are pre-programmed like robots in a way that removes human control during flight and over the use of sensors, information and/or armaments.

‘Drones’ do not need to be flown by qualified pilots
Qualified crews fly RPA but there is a debate about what level of competence is required for effective and safe operation. One school of thought is that pilots qualified on sophisticated aircraft, such as jets, should fly RPA, especially those used for strike operations. Another school of thought advocates that individuals with baseline competence in aviation skills, as well as reasonable physical and mental agility, can be trained to fly RPA. A thorough skilling and training needs analysis would clarify which specific competencies are required in which roles.

‘Drones’ are indiscriminant killers
The decision and command chain regarding the use of lethal and destructive force from the air is the same for both piloted aircraft and RPA; the only difference is the location of the pilot. Those who fly aircraft, whether from the cockpit or remotely from a control station, are equally obligated to make decisions that comply with the Laws of Armed Conflict (LOAC) and Rules of Engagement (ROE). Australian air power has always been applied in this way. The acquisition of UAS will not change this approach.¹

Why do we need UAS?

To decide on the roles UAS can play in Australia’s national security, analysis behind this report has followed the usual top-down derivation of capabilities: that is, starting from Australia’s geo-strategic situation, deciding what broad missions are needed; then breaking those down into the activities or tasks that make up a suitable response. It is then necessary to add a ‘bottom-up’ process by reviewing the full range of possible capabilities, including those offered by UAS, to see how they fulfill the needs identified.

This procedure is long and involved, including contingency planning, risk analysis and operational or mission effectiveness studies. Such a detailed examination need not be included in this report; the fundamental roles have changed little since the Australian defence policy reviews of 1986 and succeeding White Papers.

Suffice to say that the Foundation holds that continuity in the pragmatic self-reliance policies for the defence of Australia and its interests, outlined in the Foundation’s policy document Control and Protect, remains valid. At the next level, UAS can then be usefully tested against the roles that support the campaigns described in this extract from the Williams Operational Scenario (WOS):

> The WOS is part of a series of nested campaigns that together define the overall national campaign. They are: Strategic Shaping Campaign, Intelligence Campaign, Joint Maritime Campaign, Joint Air/Space Campaign, Joint Manoeuvre Campaign (Entry from the Air and Sea), Joint Land Campaign, and Joint Logistics Campaign.

In a classic capability development model, these campaigns are further split into activities, tasks or missions in a selection of likely or seriously damaging situation scenarios, against which capabilities can be tested, acquired or developed.

The Joint Capability Area (JCA) system, recently codified by both the US and Australia to support this approach, comprises nine essential capability areas, including Force Support, Battlespace Awareness, Force Application, Logistics, Command and Control, Net Centric and Partnerships. These capability areas quickly multiply into a myriad of sub-components the further one drills down into the lower tiers of the system. Such detailed analysis is too extensive for this report but the process is sketched out in the following section, to indicate future development.
A look at a few key mission areas will highlight the utility of UAS in a broad range of activities. In some cases, the JCA titles have been modified to allow broader consideration (for example, in-house jargon is avoided by the use of plain English terms for areas like situation awareness and networked systems). Manned systems are of course also relevant in many of these roles and the complex matrix to balance the mix of manned and unmanned solutions is discussed elsewhere.
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<tr>
<th>Capability Area</th>
<th>Near Future</th>
<th>Beyond 2020</th>
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<tr>
<td><strong>Situation Awareness</strong></td>
<td>UAS offer persistence and responsiveness in long- and short-range maritime and land situations. This is a growth area, well suited to UAS sensor suites relaying information to ground stations for analysis and response.</td>
<td>Australia’s vast exclusive economic zone (EEZ) and remote terrain will call for increasingly sophisticated technologies to detect and identify activity, and to report to and assure authorities of ongoing awareness. Maritime reconnaissance and land surveillance will rely on an increasingly integrated mix of interdependent platforms, links, and analysis and response nodes.</td>
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<td><strong>Intelligence processing and dissemination</strong></td>
<td>UAS form a link in the PED chain but much of the work is done in ground facilities.</td>
<td>UAS will not be central to this support process but can assist in communications relay and delivery of intelligence products to forward ships and units. Quick-reaction forward identification using improved electronic warfare and other signature databases should improve focused operational responsiveness to multiple intrusions.</td>
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<td><strong>Force Application</strong></td>
<td>Prevailing peaceful circumstances allow Australia to develop competencies in operating and refining UAS planning for all eventualities on the conflict spectrum.</td>
<td>The ability to deliver kinetic and non-kinetic force (treated as separate JCA sub-tasks) from UAS must be included in future planning to allow the threat or delivery of coercive force against emergent adversaries in our areas of operation. Defensive capabilities must also be developed in case such systems are used against Australia and Australian forces.</td>
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<td><strong>Logistics</strong></td>
<td>Pre-planned repetitive supply missions by UAS have been implemented in some allied countries and this is likely to increase and extend to other countries. No experience in Australia to date.</td>
<td>Potential exists to automate delivery of food water, fuel, munitions and equipment to deployed forces, especially in difficult terrain commonly found in Australia’s north and in regional island partner countries. An example is the support of amphibious deployment to inhospitable littoral regions, including ship-to-objective manoeuvre and force-support operations. The concurrent demands of more than one area of operations or contiguous disaster relief missions could stretch resources such that UAS provide efficient and cost-effective continuity.</td>
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<td><strong>Networked Systems</strong></td>
<td>UAS are already used in the networked system of information gathering for customs, immigration, border protection and safety tasks around Australia’s approaches. Their use is likely to expand due to proven cost-effectiveness.</td>
<td>UAS can be increasingly seen as essential nodes in the seamless network of information flow from remote and deployed sensors, cooperative and collaborative target acquisition, identification and tracking, the extension of radar and visual horizons for naval, air and land assets, communications relay, satellite connectivity and information assurance for deployed forces.</td>
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Table 1 - UAS and Joint Capability Areas
Where Are We Now?

Australia

UAS are not new to the ADF. The Air Force Heron, Army ScanEagle and Shadow UAS have formed an essential integrated capability supporting ground operations in Iraq and Afghanistan for well over a decade. The Navy UAS Experimentation Program is also underway assessing UAS technologies and procedures for suitability in the maritime domain.

Heron

The Heron is a large, long-endurance UAS, weighing approximately 1.1 tonnes. It has conducted single missions in excess of 24 hours, with a maximum speed of more than 100 knots (180 km/h) at altitudes of up to 10,000 metres. On average, the Heron flew between 400 to 500 hours of medium-altitude, long-endurance flights during each month of its Afghanistan deployment.

Unlike small UAS, the Heron operated from an airfield runway in conjunction with manned aircraft. To ensure the safe and effective operation of all aircraft, the Royal Australian Air Force used military pilots who had experience with the complex and dynamic airspace to pilot the Heron. The Heron pilot was supported by a Payload (Sensor) Operator who also acted as co-pilot for the Heron.

In addition, up to seven operational staff processed, analysed and disseminated information from the Heron’s sensors. The operational staff included aircrew, intelligence staff, operations officers, engineering staff, administration officers and logisticians.
The Heron capability is also used at Woomera, South Australia, in controlled airspace for training purposes.

The Heron provided high-resolution intelligence, surveillance and reconnaissance (ISR) capability with real-time support to ground commanders to enhance force protection in the Middle East Area of Operations.

Whilst ISR has been an enduring role of Australian air power, the thirst for information has long been tempered by the limited endurance of manned platforms. The Heron overcame some of the traditional limitations to providing persistent ISR, which changed the Air Force approach to ISR. Pattern-of-life surveillance was available through greater persistence; this was the key to tracking and targeting high-value combatants, while contributing to the reduction of collateral damage.

Persistence contributed to the counter improvised explosive device (IED) mission by allowing more sensors on threat areas for longer. The Heron detected changes in roads and tracks, reducing the exposure of ground forces to IED threats.

The Heron provided persistent real-time surveillance to patrols and convoys, alerting them of any detected threats and reducing the response time for support elements. With an increasing awareness of this ever-present eye-in-the-sky, requests from ground forces increased almost exponentially.

However, sensing through optics and radar was only one aspect of the Heron ISR capability. Increased persistence allowed more time to monitor communication and electronic transmissions, thereby increasing the fidelity of intelligence.

Greater persistence also reduced some of the traditional limitations in communications. The Heron could be operated as a communications relay platform, thereby minimising the impact of geography and extending the range of most communication networks that may have relied on line of sight.

Air Force is looking to retain the Heron capability post-Afghanistan. This illustrates the growing Air Force awareness of the significance of UAS and the importance of retaining and growing essential UAS skills and experience.

In the event that retaining the Heron is not cost-effective, an alternative would be for Air Force to procure a replacement UAS with similar capabilities.

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3 ibid
ScanEagle

The ScanEagle is a small, low-cost, long-endurance unmanned aircraft that provided ongoing ISR support to ground elements in Afghanistan from 2007. It made significant contributions to the force protection and situational awareness of the coalition force soldier on the ground, averaging 22 hours of flying time per day.

During five years in operation in Afghanistan, ScanEagles flew about 32,000 hours in more than 6,200 sorties in support of the Reconstruction Task Force, Mentoring and Reconstruction Task Force, Mentoring Task Force, Combined Team – Uruzgan, and the Special Operations Task Group.
2013 Defence White Paper

The 2013 Defence White Paper gives the ADF four tasks:

- **The first two are enduring responsibilities to defend Australian sovereignty and the sea and air approaches to the homeland, and to conduct independent military operations or lead coalitions in order to contribute to the stability and security of the near South Pacific region and Timor Leste.**

- **The ADF is to draw on the capabilities developed for the first two tasks to achieve the second two tasks, namely to contribute to military contingencies in the wider Indo-Asian region and in other parts of the world.**

In the short term, the major threat to Australia’s sovereignty and national interests in the near region is people attempting to enter Australia illegally through northwestern and northeastern Australian waters. The political sensitivity of people smugglers using Australian waters illegally to transport people to Australian territory will endure for the foreseeable future. Current surveillance arrangements in the north struggle to provide sufficient clarity to detect, identify and track all small vessels and groups of people with images that can be submitted as evidence in court.

As well, the development and importance of Australia’s resources industry requires persistent surveillance of vast areas of sea and land in remote northwestern and northeastern Australia. Australia is the third largest liquid natural gas (LNG) producer in the Asia-Pacific region and the fifth largest LNG producer in the world. There are large-scale LNG developments, including coal seam methane to LNG projects, in Queensland and massive projects in northwest Australia and the Timor Sea.

There has been official acknowledgment of the potential for UAS to protect Australia; Australia’s 2013 Defence White Paper contains several generic paragraphs on UAS. It mentions that unmanned systems are less expensive to acquire and have more range, endurance and sensor payload capacity than comparable manned systems, while also mitigating risks to personnel.

The White Paper affirms that UAS technology will enhance the capability and capacity to gather and disseminate technical intelligence. UAS are ideal for assisting ADF commanders and staff, as well as emergency first-responders, to gain and maintain 24/7 situational awareness. Persistent UAS ISR can underpin versatile, responsive and calibrated ADF responses to a range of threats and emergencies.

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Globally and Regionally

Over 80 countries are now developing and employing military and civilian UAS, supported by specialised organisations, infrastructure and workforces.7

The US, Britain and Israel lead the world in employing sophisticated UAS for ISR as well as strike operations for the prosecution of war against terror in Afghanistan and elsewhere. The legal and ethical controversy over the employment of RPA or ‘drones’ to prosecute this campaign has tended to overshadow discussion of the broader applications of UAS to protect sovereignty, respond to natural and man-made disasters, save lives, enforce the law and enhance economic performance and environmental protection, as well as to make other contributions to national wellbeing.

Like Australia, the US and Canada have vast landmasses and thousands of kilometres of borders to protect. The US has been employing UAS to enhance persistent lower-cost surveillance of its borders for nearly a decade. In 2008 Canada entered the market for UAS to monitor its Arctic, Atlantic and Pacific approaches and to seek to neutralise threats to Canadian sovereignty.

Other UAS users include:

- The US Army, which began UAS operations in October 2001 with 54 RPA and currently has over 4,000 UAS in various sizes and capabilities with still more programmed.8
- Indonesia, which has announced plans to mass-produce UAS to better monitor its borders and maritime domain.
- China, which is already producing UAS with “reported” capabilities similar to US UAS.
- South Korea, which is buying the Global Hawk to enhance its strategic ISR capabilities.
- Singapore – has been operating UAS for more than a decade, formed a UAS Command in 2007, has three squadrons with approximately 70 Hermes 450, Heron, Searcher and Scout platforms. The Singaporean Air Force has developed sophisticated operational concepts with UAS in support of their fighter aircraft in ground support operations.

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Where Are We Heading?

The Chief of Air Force, Air Marshal Geoff Brown, last year acknowledged the inevitability of the acquisition of UAS to protect Australia and expressed the view that the true value of UAS was not to provide a direct human replacement but rather to extend and complement human capability to deliver these effects. These systems extend air power’s endurance by providing effectively unlimited persistent capabilities without degradation due to human airborne fatigue or inattention.

These effects range from ISR to electronic warfare and potentially into strike. None of the effects are new to Australia, but the means of delivering them is evolving, just as the means to deliver most military effects have evolved over the years.

The air power role most influenced to date through the use of UAS is ISR. This is where the Air Force has started to exploit the benefits of unmanned operations and ISR will be the primary growth area into the future. The introduction of the Heron was a huge step forward for Air Force ISR capabilities. It heralded a transformation in the delivery of Australian air power and was a catalyst for a cultural shift in Air Force’s approach to the delivery of ISR.

The ADF had already recognised the potential for UAS to conduct Broad Area Maritime Surveillance (BAMS) through the establishment of Project Air 7000 Phase 1B that seeks a multi-mission UAS ISR capability as a complementary capability to Phase 2B – that is, the replacement of the AP-3C Orion maritime patrol aircraft with P-8A Poseidon aircraft.


10 ibid
In early 2013, as part of Project Air 7000 Phase 1, the then Defence Minister wrote to the US seeking access to classified technological information about the Northrop Grumman MQ-4C Triton RPA in support of a potential future acquisition. 11

The US Navy’s acquisition of the Triton and the aircraft’s first flight in May 2013 sets the direction for BAMS in the future. 12

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The acquisition of UAS for BAMS could give the ADF the versatility and capacity of larger, higher-altitude RPA that can operate above all other air traffic, generally avoiding problematic winds and weather that frequently trouble lower-altitude RPA. The longer ranges and endurance of larger RPA enable them to patrol vast areas and also revisit areas quickly when other ISR platforms have detected moving targets. Most surface-to-air missiles do not have the range to engage high-altitude RPA.

While it is easy to imagine UAS conducting their airborne tasks, what often receives less emphasis is the back-end of the UAS chain – the processing, exploitation and dissemination of the gathered imagery and technical information. Hence, all discussion of UAS capability development should focus on supporting the Concept of Operations (CONOPS) with UAS rather than just acquiring particular platforms. The ADF Fundamental Inputs to Capability provide a useful framework for maintaining this broader focus.  

13 *Fundamental Inputs to Capability are: Command and Management; Organisation; Major Systems; Personnel; Supplies; Support; Facilities and Collective Training.*
A number of other ADF UAS initiatives are underway or planned:

- **Navy** is looking at the use of vertical take-off and fixed wing RPA as organic air operating from warships and support vessels for persistent surveillance, anti-submarine warfare, mine countermeasures, hydrography, search and rescue, pollution control monitoring, maritime interdiction and general situation awareness. Navy will shortly release an invitation to register interest from Australian industry for ISR RPAs as a precursor for scoping a future Request for Tender for UAS in support of Armidale Class Patrol Boat operations.

- **Army** is developing its UAS capability by employing the Shadow 200 tactical UAS that carries a suite of high-resolution cameras above patrolling troops to provide detailed information about activities on the ground. The air vehicle has approximately eight hours’ endurance, and ground troops are able to receive footage and data from the air vehicle in real-time using ground terminals.

- **Army** is planning to introduce a small single-person launched and operated RPA: the Tactical Unmanned Aircraft System (TUAS). It is intended to provide information to commanders at the Combat Team level and below with enhanced situational awareness through improved reconnaissance and surveillance coverage. It will offer commanders near real-time video and still images with associated metadata by day and night.

- **Army** is also planning to use space and UAS for specialised operations in the developing world; technology and precision munitions will support but not replace close combat.

Looking out 10 years and beyond, expected advances in UAS technology will give the ADF the ability to consider other potential uses. The most fundamental role Air Force undertakes to support national security is control of the air. Currently this is delivered through the classic Hornets and Super Hornets, and in the future by the Joint Strike Fighter (JSF).

Australia has already acquired precision weapons for its manned combat aircraft that greatly increase accuracy and range of delivery, such as the Joint Direct Attack Munition (JDAM) and the Joint Air-to-Surface Standoff Missile (JASSM).

Australia needs to start looking at the future acquisition of long-endurance unmanned combat air vehicles (UCAV) and their ability to deliver strike effects. While technology in the UCAV field is advancing rapidly (e.g. the X-47B has undertaken trials from a US Navy aircraft carrier), there is a long way to go before this experimental platform translates into an operational capability, and even if experimentation is successful, the amount of benefit to be gained from a UCAV is still a point of conjecture.
Taking out the life-support systems and human-machine interface resident in a fighter will save space and weight. But the platform will still need a comprehensive sensor suite, weapons capacity, and at least fifth-generation fighter characteristics to be competitive against modern fighter aircraft. In the age of stealth, shooting first before an adversary can react is the real goal.

If human physiology is the weak link of manned fighters, then communications are the weak link in the UCAV. Unmanned platforms must be able to communicate between each other, to a controlling aircraft or to a ground station. A jammed signal could significantly degrade UCAV combat performance; this is less of an issue for manned fighters because of the skill and judgement resident on board in the aircrew. So while the human element of a fighter aircraft may be able to be stripped away, other areas will need to be enhanced and this will come at a cost.

Nevertheless, UCAV are expected to be sufficiently developed by the late 2020s/early 2030s for them to be considered as replacements for manned combat aircraft including in the long-range air combat and strike role, a capability that the Air Force currently lacks.

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In the shorter term, current UAS technology is sufficient for the Government and Defence to investigate expanding the scope of Project Air 7000 to include the acquisition of a strike capability. This could be a cost-effective way of introducing a UAS strike capability through a proven platform.

Other potential UAS roles include:

- **Logistics support, particularly in very demanding environments such as Antarctica, or in combat, where RPA could be used as emergency first-responders.**
- **Expanded ISR capabilities: flying mini RPA off the Triton where the threat level is high.**

There will not be much UAS airlift activity in the foreseeable future as the Air Force is well served by the C-17A and KC-30A strategic lifters, the C-130J and C-27J for operational and tactical airlift, and the Chinook and MRH-90 for tactical mobility.
Future ADF Challenges

As discussed above, UAS have many potential benefits when employed by the ADF for protecting Australia. Fully exploiting those benefits, however, will require addressing a number of challenges.

1. Policy Implications

The ADF needs to develop a UAS policy and establish a capability authority for UAS. The preferred approach would be for the Vice Chief of Defence Force (VCDF), as the Joint Capability Adviser, to develop a UAS Joint Capability Instruction similar to that for Joint Fires.

The UAS policy will be essential for all forms of UAS, but arguably the most challenging policy issues relating to UAS will be in relation to autonomous operations and the acquisition and employment of UAS in the strike role. In relation to autonomy, the US and the United Nations have adopted a no-full-autonomy policy (except for cyber) that should be considered by Australia for early adoption.

In relation to the strike role, it is only a matter of time before the ADF acquires a weaponised or armed UAS/UCAV capability. The combination of precision attack with the inherent persistence of a UAS has opened a new avenue for the application of military power but it brings significant policy implications:

- **Armed UAS come with the attendant disadvantage of being viewed as less constrained and hence a potentially more aggressive capability compared with a force of manned aircraft. Therefore, they may be destabilising rather than enhancing deterrence.**

- **There are profound foreign policy implications in penetrating sovereign airspace without approval and sensitivity to this issue has been heightened by armed UAS operations in Afghanistan, Pakistan and other countries. Most recent military contingencies have been undertaken without the legal cover of a formal declaration of war.**

These policy issues need to be settled in the short term in the context of Australia’s current Rules of Engagement (ROE) and its obligations under International Laws of Armed Conflict (LOAC).

2. Public Perceptions

Public perceptions of UAS are varied, generally based on media reports of armed UAS in Afghanistan and Pakistan, use at sporting events, cheap backyard toys, or proposals by companies such as Amazon to use them for delivery of online orders.
One of the concerns expressed by the general public is the potential for collisions between civilian transport aircraft and ‘drones’.

Australia has a proud air safety record and the public needs to be convinced that this record will not be put at risk by the growth in UAS use for military and civilian purposes. The public will also need to be assured that mechanisms will be put in place to crack down on rogue UAS operators in a manner comparable to responses to rogue manned aircraft operators. Public concern regarding UAS operation in the same airspace as commercial aircraft will be alleviated to at least some extent when the Civil Aviation Safety Authority (CASA) has finalised the rules for integration of UAS into its airspace management. Even then, it will take time for the general public to become comfortable with UAS.

The major area of public concern, however, is likely to be in relation to the use of armed UAS by Australia. While the acquisition of such systems is considered inevitable, some in the community are alarmed at this prospect as it will take ‘humans out of the loop’ and lower the threshold for the ADF to conduct strike missions as aircrew will not be at risk.

In a recent address to a Sir Richard Williams Foundation conference, the Chief of Air Force, Air Marshal Geoff Brown, foreshadowed the possibility of acquiring UAS in a strike capacity.更重要地，他强调说没有什么邪恶的东西要考虑到海军UAS在战斗中的作用，或者任何其他打击飞机在空军的打击中，或者在任何其他武器系统交付的空中，如海军或陆军火炮支援。武装UAS是完全按照规则的交战和武装冲突的法律规定的空中武器系统。

Contrary to some media reports, Air Marshal Brown pointed out that strike UAS did not make their own decisions on target selection and acceptable levels of collateral damage.

These public concerns need to be addressed through an educative process that highlights:

- **Australia’s unwavering commitment to LOAC and legal ROE that will not change through the introduction of armed UAS.**

- **The inconceivability of Australia buying fully automated armed UAS (if and when they become available) given its proud safety record and respect of LOAC, and its commitment to ensuring that highly trained personnel subject to the ADF command-and-control arrangements make any decision to use lethal force to counter a hostile threat.**

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Another public concern is that the Privacy Act currently does not cover most UAS operators as it is not applicable to small business, even though this is the sector of the industry most likely to be subject to privacy complaints.

The inadequacy of current privacy legislation has been a longstanding issue: UAS have merely served as the call to arms and something of a catalyst for privacy law reform.

3. The ‘Unmanned’ versus Manned Debate

Current debate and analysis relating to the acquisition and employment of UAS is often focussed on particular manned versus unmanned platforms for specific roles, e.g. high-altitude long-endurance ISR. Rather, analysis should be based on identifying the optimum mix of manned and unmanned systems to achieve the desired effect in the most cost-effective way.

Next-generation UAS will have the potential for mixed mission packages that can be integrated into the combat force beyond the ISR role. Such packages will provide a force multiplier effect with UAS potentially being used, for example, as weaponised “trucks” with reconfigurable payloads and weapon sensor extensions that could be integrated with the Joint Strike Fighter (JSF), P-8A Poseidon and Airborne Electronic Warfare and Control (AEW&C) aircraft. The UAS could be exposed to higher levels of operational risk that would not be taken with manned JSF and AEW&C.

4. New Concept of Operations (CONOPS)

The conduct of warfare is moving into an information age that is only going to accelerate. Accordingly, conceptions have to change as to how to effectively accomplish security objectives, to adapt them to the flatness of the way information is collected, analysed and distributed. Fully exploiting the potential benefits of UAS will therefore require new thinking and development of new CONOPS.

Currently, 97% of military RPA are used to acquire ISR. They have the advantage of providing persistence in this role and, while the information collected is used in conjunction with other force operations, whether they be surface-based or air-based, there is a long way to go to really achieve seamless integration between UAS and other sources of information.

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16 Lt Gen Dave Deptula USAF (retired), the then First Deputy Chief of Staff for ISR, Headquarters USAF, in an interview with Second Line of Defense, May 2010.

17 ibid
For instance, UAS can be used as a communications relay (airborne node) in a variety of scenarios including civilian emergencies. The thinking has to shift to identifying the value-add that UAS can bring to various scenarios and where existing capabilities are vulnerable.

The ADF will need to apply new UAS technologies to the entire set of ADF core function areas to increase the effectiveness of operations, rather than just plugging UAS into conventional CONOPS.

In addition, Australia’s major allies will expect interoperable UAS. The ADF has yet to produce a joint UAS CONOPS and the ADF Future Joint Operating Concept 2030 does not mention UAS meaningfully. Mindful that it takes years for capability investigations to result in capability acquisition and introduction into service, new CONOPS need to be developed, outside of Urgent Operational Requirements, that list roles and missions for manned/unmanned aircraft, and develop a roadmap on how capabilities fit together and where UAS fit in. This will enable the identification of future UAS requirements.

5. UAS Role Flexibility

In response to resource constraints driving fewer and fewer aircraft types and numbers, the next-generation UAS preferably should have the flexibility to perform more than just one function. This could be achieved by the development of modules so that different mission sets could be accomplished by changing the configuration of the aircraft itself. For example: a common fuselage with the wing structure, empennage or payload structure changeable based on how fast, how survivable or how low observable the aircraft needs to be for a particular threat environment.

6. Survivability

The use of UAS in the war on terror in Afghanistan and Pakistan has been in a permissive air environment and near-perfect operating conditions with clear skies, open terrain and low humidity. Future operations may not be in such favourable conditions. Current-generation UAS are vulnerable in contested and denied air environments and have lower performance in inclement weather than manned platforms. Improved survivability is absolutely vital to the wider employment of next-generation UAS.

7. Processing, Exploitation and Dissemination (PED)

A well-informed choice is needed to select UAS platforms, control systems, payload systems, control and specialised data links that service sophisticated and integrated PED capability. Similarly, a well-informed choice is required to develop well-integrated and connected PED to fully exploit sophisticated UAS capabilities.

UAS data collection must be integrated into data collection more generally and the data exploitation software has to be a priority focus. What is needed is not UAS PED but integrated PED for all data collection that will have cross-system co-ordination functionality and will be able to cope with future data volumes, noting that data availability is growing exponentially and the ADF is already struggling to analyse the data collected now (often less than 30%).
Ideally such PED will be able to exploit whole-of-government sources and provide whole-of-government support, subject to appropriate security and privacy restrictions.

The importance and priority of fully integrated PED is recognised by the Williams Foundation and will be the subject of one of the Foundation’s public seminars in 2014.

8. Data Link and Bandwidth Limitations

Full exploitation of the capabilities of sophisticated UAS requires reliable, secure, broadband data links. For Australia these are not yet in place and must be a focus for Defence investment – not just for UAS but for all future data-intensive systems. Data link interruption in a cyber-war setting and bandwidth requirements are major UAS vulnerabilities that need addressing.

9. Greater Autonomy

A greater degree of autonomous operation – albeit not full autonomous operation – would avoid the vulnerabilities associated with current communications and command-and-control arrangements and would allow the development of new CONOPS where UAS could enhance or extend the influence of all assets that are brought to the fight.

The aim is to be able to seamlessly integrate UAS with manned aircraft so that unmanned systems can be leveraged to a degree that currently cannot be achieved due to the limitations of current UAS capabilities. This kind of conceptual planning is essential for the introduction and effective integration of future UAS with JSF, AEW&C, P-8A Poseidon and MH-60R Seahawk “Romeo” aircraft.

10. Countering Use of UAS as Terrorist Weapons

IEDs have caused significant casualties in Afghanistan. They are inexpensive to make and can be delivered in a number of ways: by suicide bombers, placement under roadsides or in vehicles.

The proliferation of cheap UAS over the coming decade will give terrorists another potential IED delivery option, with guided accuracy that can bypass access barriers and other forms of physical protection. If Amazon can contemplate delivering books by UAS, so can terrorists contemplate delivering IEDs.
Public concern already evident about the use of UAS will be heightened if or when the first UAS terrorist attack occurs. Such a reaction may be disproportionate to the actual damage but will require defence forces globally to be ready to counter such attacks through intelligence gathering and appropriate response options.

The ADF needs to develop appropriate capabilities to counter potential UAS terrorist acts and integrate them with the capabilities that it has developed to counter other forms of terrorism.

11. Influential Buyer

As previously noted in point 5, future UAS role flexibility will require reconfigurable UAS. This will be particularly important in the case of Australia where budgets will not afford the scale and diversity of UAS acquisition undertaken by US forces. Whilst defence industries will respond to market demands, it is difficult for a country such as Australia, with a relatively small defence market, to influence the production plans of the large manufacturers. Australia may be able to influence such markets and gain the type of UAS optimised to the needs of smaller nations by teaming with like-minded and sized nations (e.g. Canada). Together, a consortium of smaller nations could create a market demand for reconfigurable UAS sufficient to interest the major defence system manufacturers.

12. Workforce Implications of Persistence

Long-endurance UAS overcome one of the long-standing criticisms of air power: the lack of persistence.

UAS flight endurance well beyond 24 hours is common, with technology likely to further advance capacity. Even if manned aircraft were to gain commensurate advances in flight endurance, aircrew fatigue considerations would limit the utility of these gains to a duty cycle of around 15 hours – around 12 hours of flight.

Flight endurance is a poor measure of operational effectiveness as transit flight time is generally operationally ineffective. Effective time-on-station (ETOS) is the key operational performance parameter.15

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The following table illustrates the relationship between distance from base and time-on-station (a 100-knot speed difference has been used to approximate the speed advantage of a manned jet aircraft such as the P-8 over long-range RPA):

<table>
<thead>
<tr>
<th>Distance to on-station</th>
<th>ETOS (hours) Manned</th>
<th>ETOS (hours) UAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Assuming 400 knots transit speed and 12 hours total mission time</strong></td>
<td><strong>Assuming 300 knots transit speed and 24 hours total mission time</strong></td>
</tr>
<tr>
<td>600</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>1200</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>1800</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

*Table 2: Effective Time-on-Station Comparison*

The step-change in time-on-station achieved by UAS, even allowing for its slower transit speed, is apparent. UAS brings persistence to air power and reduces mission rate-of-effort. Instead of having to return to a base and swap the crews – non-productive use of aircraft and crews – ground-based crews can be cycled for the duration of the mission.

As well as avoiding unproductive use of expensive flight personnel, UAS also offer the prospect of using fewer such personnel where, for example, only one aircrew may be required per shift with all other personnel as system operators.

Further, in non-tactical situations, UAS personnel can comprise a mix of uniformed and contractors. Where contractors are used, they must be under ADF command-and-control arrangements and any decision to use lethal force must be made by uniformed personnel.

Experience in Afghanistan indicates that the extra endurance offered by UAS will be used by commanders but comes with a heavy demand in personnel to match the endurance available.

These personnel demands mean that exploiting the capabilities offered by UAS will require an appropriate personnel selection, management and training system to underpin UAS development.

Beyond the direct UAS workforce, training at command and staff courses will need to be updated to include UAS in how to employ various forces to best effect at the strategic, operational and tactical levels.
13. Research and Development (R&D) and Local Industry

Given the expected increase in deployment of UAS by the ADF, complete reliance on imported UAS would limit the ADF’s ability to deliver a self-reliant defence capability. The ADF therefore needs to develop and maintain a sound understanding of current Australian R&D and industry UAS capabilities and to shape their future development to meet expected ADF requirements.

As part of the development of the next Defence White Paper and associated Defence Industry Policy update, consideration should be given to including UAS as a Priority Industry Capability (PIC), noting that PICs identify “elements of broader industry capabilities that confer an essential strategic advantage by being resident in Australia and which, if not available, would undermine defence self-reliance and Australian Defence Force (ADF) operational capability.”
The Use of ADF UAS in National Support Operations

1. Civil Emergencies

ADF UAS will be able to enhance Australia’s civil-military response to emergencies such as cyclones, bushfires and floods. The ADF deploys aircraft, naval vessels and troops during these emergencies when local capabilities are stretched and risks to life and property increase. Such ADF tasking comes at a high cost when highly capable manned ADF assets, structured and trained for combat roles, are diverted to non-combat activities. ADF UAS would provide more layered capabilities that might be more cost-effective than use of manned assets.

It is unlikely that any State or Territory will be able to afford sophisticated UAS to respond to domestic emergencies. In the future, State and Territory authorities could call on ADF UAS before, during and after significant natural and man-made disasters and emergencies that require an urgent, coordinated national response.

2. Border Protection

Border protection operations include search and rescue, border control, fisheries surveillance and quarantine, and can involve the use of ADF personnel and equipment in non-military or non-warlike roles.

UAS will be able to enhance border protection capability in two ways:

- Enhancing surveillance by providing information that is timely and accurate to allow the coordination of response options or to enable command decisions on courses of action in response to threat activities.
- Collecting the broad range of material in a form required by agencies with responsibility for the security and safety of Australia’s maritime domain.

The persistence and surveillance capabilities of UAS provide new and innovative options for national support tasks. UAS capacity would free manned platforms for missions/tasks in complex situations or for response operations. Tests for UAS comparative effectiveness include range, endurance, capacity to fly at low levels in testing weather conditions, daily deployability, flexibility and a system cost no greater than manned aircraft.

3. Ownership Arrangements

An important issue for Government consideration is whether there should be a largely centralised Government UAS pool owned and operated by the ADF or whether individual agencies, such as Customs and the Australian Maritime Safety Authority, should own their UAS assets (as is the case currently for manned assets).

Potential advantages of such a centralised pool include economies of scale, unified command and
control, more ready availability of ADF assets for national support tasks, additional ADF surge capacity, expert capability development and expert through-life sustainment. Such an arrangement would have to be tailored for the operational needs of each agency, noting that the ADF has a broader capability requirement (e.g. mandatory electronic-warfare capability) compared to other agencies (whose needs may be less complex).

In adopting such a centralised approach, however, potential disadvantages must be avoided. These include higher cost of ADF operations compared with civilian/commercial operations, and extremely long acquisition times.

In the short term, the Foundation supports current manned aircraft arrangements with individual agencies owning and operating their own UAS assets, and ADF and Customs operations under a single command structure.

In the longer term, however, the Foundation recommends the Government exploring how UAS ownership and management arrangements can be integrated across governments and industry on a whole-of-nation basis.

4. International Cooperation

Australia has the opportunity engage its neighbours for mutual benefit by employing UAS to enhance each nation’s sovereignty over marine and other natural resources, to monitor the near region environment, and to deter people smuggling, piracy and organised crime, as well as to support responses to natural disasters and other emergencies after mutual agreement. This would augment existing arrangements with manned maritime aircraft.

The cooperative development and collaborative employment of UAS for these purposes would contribute to positive and enduring engagement with neighbours for security, economic wellbeing, law enforcement and environmental protection.

A key challenge in enhanced regional cooperation in the employment of UAS, however, will be developing appropriate information-sharing arrangements. Just as effective PED is essential to exploiting UAS capabilities, some form of PED on a regional basis will be essential for effective regional cooperation in this area.
Developing Regulations for UAS to Fly in Australian Airspace

As a result of the rapid growth in the UAS sector, one of the key civil airspace challenges for the Civil Aviation Safety Authority (CASA) is to ensure the safety of other airspace users as well as the safety of persons and property on the ground.

CASA is required to respond to the rapid, uncontrolled spread of small UAS in Australia. The demand for small UAS flying visual line-of-sight for law enforcement, survey work and aerial photography will continue to grow. Larger and more complex UAS, both civil and military, able to undertake more challenging tasks, will most likely begin to operate in – or at least transit through – controlled airspace where all traffic needs to be known and where Air Traffic Control must provide separation from other traffic.

Progress in Australia

In the keynote address on 25 February 2013 to the annual conference of the Australian Association for Unmanned Systems (AAUS) in Melbourne, the Director of Aviation Safety CASA, Mr John McCormick, identified the rapid growth in the UAS sector as a major challenge for CASA. Civil Aviation Safety Regulations (CASR) 1998 Part 101 is out of date. The challenge for CASA is to promulgate Part 102 that would bring regulations into line with the International Civil Aviation Organization (ICAO), as well as incorporate the emerging work of other leading regulatory bodies like the US Federal Aviation Authority (FAA).

The challenges for regulating UAS include defining technical specifications to support:

- airworthiness;
- command-and-control data links;
- detect-and-avoid technologies;
- automation; and
- other functionalities.

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An UAS airworthiness code, like a manned airworthiness code, will have to include close examination of:

- operational on-board systems;
- level of situational awareness;
- competence of operators;
- history of safe operation;
- remediation of any incidents or accidents;
- use by day and night;
- use in poor weather conditions and cloud/smoke;
- satellite communications interruption;
- bandwidth requirements;
- safety while taxiing;
- air traffic control; and
- airspace management.

Mr McCormick stated that it would be “a lengthy effort” to deliver a complete regulatory framework for UAS in Australia. Detect-and-avoid technology for RPA still has some way to go to enable the safe and seamless integration of UAS into Australian and international airspace.

CASA and the Air Force, supported by Airservices Australia and the current Navy UAS experimentation, are the lead agencies for the introduction, integration and regulation of UAS within Australian airspace.

Navy is already working with CASA on developing the regulations and procedures for maritime tactical UAS operations within and outside controlled airspace.

The potential return of the Heron UAS capability to Australia from Afghanistan in 2014, or their potential replacement with another UAS, is also a driver for change. The Herons or their replacements would be based at RAAF Amberley on the outskirts of Brisbane. The Chief of Air Force would use collaborative arrangements with CASA and Airservices Australia to have regulations in place to permit the Heron or its replacement to operate from Amberley. The regulations for UAS operations at Amberley would set precedents for UAS operations from other Australian airfields noting that Navy has already operated UAS in civil controlled and uncontrolled airspace in Perth, Darwin and Nowra.

Scan Eagle

20 Ibid.
There is no point in CASA writing regulations that cannot be enforced. Therefore CASA is writing only those rules it can control. Pending consultation with industry, CASA is looking at options to re-categorise all UAS into weight classes, to make compliance less onerous for operators but still ensure operation within a safe regulatory environment.

CASA is working closely with ICAO and other international bodies. CASA’s approach for an updated regulatory framework includes maintaining the highest possible uniform level of safety whilst adopting a risk-based approach based on the weight of the UAS.

**US Precedents**

The US has declared UAS integration into the US National Airspace System (NAS) as a national priority, but progress has been slow. In late 2011 the FAA released an order stating, “In no case may any UAS or OPA (Optionally Piloted Aircraft) be operated in the National Airspace System (NAS) as civil registered aircraft unless there is an appropriate and valid airworthiness certificate issued for that UAS or OPA. US registration is a prerequisite for the issuance of a special airworthiness certificate to UAS and OPA.”

In 2012 the FAA released the first list of approved private sector and civil use applicants for a ‘Special Airworthiness Certification’ under ‘Certification for Civil Operated Unmanned Aircraft Systems (UAS) and Optionallly Piloted Aircraft (OPA)’. The FAA’s order 8130.30B outlines the requirements, standards, review and approval processes for private sector and civil deployment of UAS systems to be used in a limited and controlled segregated test scenario.

On 7 November 2013, the FAA released its Roadmap for integrating civil UAS in the NAS. The FAA’s top priority is to accomplish UAS integration without reducing existing capacity, decreasing safety, affecting current operators, or placing other airspace users or persons and property on the ground at increased risk. The Roadmap outlines the actions and considerations needed to enable UAS integration into the NAS. The Roadmap also provides goals, metrics and target dates for the FAA and its government and industry partners to use in planning key activities for UAS integration.

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On 30 December 2013, the FAA announced the selection of six UAS research and test site operators across the US, taking into account geography, climate, location of ground infrastructure, research needs, airspace use, safety, aviation experience and risk. In totality, these six test applications achieve cross-country geographic and climatic diversity and help the FAA meet its UAS research needs.\(^{24}\)

Under the FAA Modernization and Reform Act of 2012, the US Congress has tasked the FAA to integrate UAS into the domestic airspace by September 2015. However, this will be delayed due to their budgetary constraints and debate over privacy issues.\(^{25}\)

Once UAS integration is in place, UAS will share air space with piloted aircraft routinely because aircraft will transmit to each other where they are, instead of aircraft transmitting to a controller, who has to adjudicate aircraft separations.\(^{26}\)

The Foundation would support CASA developing a UAS Integration Roadmap and establishing UAS test sites in Australia based on the US precedent and using experiences gained from the US lead.

\(^{24}\) Federal Aviation Administration, FAA Selects Unmanned Aircraft Systems Research and Test Sites’, 30 December 2013.


\(^{25}\) Terry Farquharson, Civil Aviation Safety Authority, ‘RPAs (drones) in civil airspace and challenges for CASA’. Williams Foundation Seminar: Protecting Australia with Drones: Cheaper, Better, Smarter, Safer? Canberra 3 July 2013

Conclusions

The upsurge in UAS use over the past decade has been the result of their increased sophistication, a technical maturing of their sub-systems and a growing confidence amongst the military and civil community in UAS capabilities.

The character of air power is changing. While for the foreseeable future, Australian aircrew will still drop weapons, some will do so from the cockpit of an aircraft and some perhaps from the confines of a ground station. However, strike missions for UAS will be relatively few compared to the number of ISR tasks. ISR is the growth area for ADF unmanned operations. A cultural shift within the ADF organisation is already taking place and it must be ready to exploit all the opportunities UAS will provide.

The ADF has made a good start to position itself to exploit UAS capabilities, particularly for ISR, but faces significant challenges, such as resolving policy implications (particularly for armed UAS), the need for new Concepts of Operations, requirements for a new integrated approach to the processing, exploitation and dissemination of UAS data, and ADF workforce implications. The ADF also needs to position itself as an informed and influential buyer, particularly to promote the development of multi-role UAS.
Advances in military technology have always sought to maximise operational and tactical advantages. This is why Australia has acquired precision weapons such as JDAM and JASSM that greatly increase accuracy and range of delivering effects from the air. The ADF will always strive to maximise the desired effect while minimising the risk to its forces – that is the nature of Western military operations. That is why it needs to start looking at the future acquisition of long-endurance combat UAS as a potential complement to the JSF.

UAS will also enhance the ADF’s capacity to support civil emergency response, border protection and international collaboration with more cost-effective response options.

But current UAS limitations, including lack of survivability in contested and denied airspace and the lack of assuredness of communication links and satellite coverage, need to be addressed before their potential can be fully realised.
Next Steps

This report identifies a number of key opportunities that UAS offer but also a number of challenges and issues that need to be addressed by Defence and/or Government before potential benefits can be exploited. Next steps required to fully exploit UAS benefits include the following.

Defence – Short Term

- Develop a maritime tactical UAS capability to support the broad range of maritime tasks from Patrol Boats to the Landing Helicopter Dock.
- Retain and develop the Heron capability or procure a replacement with similar capabilities to ensure that the experience of operations in Afghanistan is built upon and not merely consigned to the annals of the period.
- Consider expanding the scope of Project Air 7000 to include the acquisition of a strike capability for the chosen UAS platform.
- Ensure UAS capabilities – including PED and communication requirements – are suitably addressed in the upcoming Defence White Paper and associated Defence Capability Plan.
- Develop and promulgate ADF UAS policy (e.g. through a UAS Joint Capability Instruction).
- Establish a single coordinating capability authority for UAS.
- Develop and promulgate new CONOPS to incorporate new UAS technologies into the entire set of ADF core function areas.
- Develop and promulgate a roadmap on how current and future UAS capabilities will be progressively integrated into ADF core function areas.
- Develop appropriate capabilities to counter potential UAS terrorist acts.
- Develop PED capability to meet future data volumes, including those generated from UAS. In developing PED capability, consideration must be given to a whole-of-government approach to information PED and also to how and to what extent this can be shared on a regional basis.
- Develop UAS workforce policy that identifies an appropriate personnel selection, management and training system.
- Identify Australian industry R&D capabilities relevant to ADF future UAS technology requirements and overcoming current UAS limitations. Ideally UAS technologies should be identified as a PIC as part of the new Defence Industry Policy.
- Develop a Government media strategy that dispels UAS myths and educates the Australian public about the rigorous ROE and legal obligations under the LOAC that require ‘human in the loop’ in the use of UAS, including UCAV.
Protecting Australia with UAS

Government – Short Term

- Through CASA, develop and implement an updated regulatory framework for UAS in Australia.
- Through CASA, develop a UAS Integration Roadmap and establish UAS test sites in Australia based on the US precedent and using experiences gained from the US lead.
- Determine UAS ownership and management arrangements across the Australian Government.
- Issue a policy statement that outlines Government policy and position on the use of UAS by Defence and other agencies, and on the work of CASA to develop an appropriate regulatory framework. Investigate recognising UAS as a PIC as a key component of Australia’s self-reliant defence capability.

Defence – Long Term

- Work with allies and industry to develop new technologies that overcome UAS vulnerabilities in contested and denied air environments and their weaknesses in communications and data link reliability.
- Collaborate with other users to shape international market demand for the development of multi-role and more adaptable (modular) UAS.
- Include in future capability plans the option of UCAV and other potential UAS roles such as emergency first-response.

Government – Long Term

- Explore how UAS ownership and management arrangements can be integrated across Governments and industry on a whole-of-nation basis.
**Glossary**

**Concept of Operations (CONOPS)** is a verbal or graphic statement that clearly and concisely expresses what a military commander intends to accomplish and how it will be done using available resources. The concept is designed to give an overall picture of the operation.

**Electronic Warfare** refers to any action involving the use of the electromagnetic (EM) spectrum or directed energy to control the spectrum, attack an enemy, or impede enemy assaults via the spectrum. The purpose of electronic warfare is to deny the opponent the advantage of, and ensure friendly unimpeded access to, the EM spectrum. EW can be applied from air, sea, land, and space by manned and unmanned systems, and can target humans, communications, radar or other assets.

**Human-in-the-loop** means that autonomous and semi-autonomous weapon systems are designed to allow commanders and operators to exercise appropriate levels of human judgment and intervention over the use of force. Humans still must play an oversight role, with the ability to activate or deactivate system functions should the need arise.

**Line of sight** is an imaginary line from the eye to a perceived object.

**Improvised explosive device** (IED) is a homemade bomb constructed and deployed in ways other than in conventional military action. It may be constructed of conventional military explosives, such as an artillery round, attached to a detonating mechanism. Roadside bombs are a common use of IEDs.

**The Law of Armed Conflict** (LOAC) encompasses all international law with respect to the conduct of armed conflict and is based on the three principles of military necessity, avoidance of unnecessary suffering and proportionality. The provisions of LOAC are binding on Australia and individual members of the ADF.

**Intelligence, surveillance and reconnaissance** (ISR) is the integration and synchronisation of all battlefield operating systems to collect and process information about the enemy and environment that produces relevant information to facilitate decision making.

**The Joint Direct Attack Munition** (JDAM) is a guidance kit that converts unguided bombs into all-weather smart bombs.

**The Joint Air-to-Surface Standoff Missile** (JASSM) is an autonomous, long-range, precision missile designed to destroy high-value, well-defended, fixed and relocatable targets. Its significant standoff range keeps aircrew well out of danger from hostile air defence systems.

**Kinetic warfare** refers to weapon systems that use velocity and mass, generally initiated/propelled/energised by explosives, to incapacitate the target. **Non-kinetic warfare** refers to anything non-lethal that hurts the enemy’s ability to wage warfare (e.g. jamming communications).

**No-full-autonomy** retains human intervention and judgement in the use of force.
Optionally piloted aircraft (OPA) is a hybrid between a conventional aircraft and a remotely piloted aircraft. It is able to fly with or without a human crew on board.

Processing, exploitation and dissemination (PED) is a function that facilitates the allocation of military assets to support intelligence operations. Under the PED concept, planners examine all collection assets and then determine if the allocation of additional personnel and systems is required to support the exploitation of the collected information. PED enablers are the specialised intelligence and communication systems, advanced technologies and the associated personnel that conduct intelligence processing. PED activities are prioritised and focused on intelligence processing, analysis, and assessment to quickly support specific intelligence collection requirements and facilitate improved intelligence operations. PED began as a processing and analytical support structure for unique systems and capabilities like full-motion video from unmanned aerial systems.

Priority Industry Capability (PIC) identify elements of broader industry capabilities that confer an essential strategic advantage by being resident in Australia and which, if not available, would undermine defence self reliance and Australian Defence Force (ADF) operational capability. PICs are defined in terms of industrial capabilities rather than specific companies and, ideally, healthy PICs should function without any special form of Government subsidy or intervention in the market. Under this policy an international company can establish a local workforce, infrastructure and intellectual property in Australia to develop or support a capability in a specific PIC area.

Project Air 7000 Phase 1B is intended to consider and further develop options leading to the acquisition of a high altitude long endurance unmanned aerial system that can perform all-weather, long endurance surveillance and reconnaissance tasks over maritime and land environments. Phase 2B will acquire a manned Maritime Patrol Aircraft system capable of performing maritime patrol and response tasks. Phase 2B is being driven by the Life-of-type of the AP-3C aircraft.

Rules of engagement (ROE) provide authoritative guidance on the use of military force by the ADF. They outline and emphasise the critical aspects of the laws of war relevant to a specific mission, and proscribe additional policy and command constraints on the use of military power. ROE do not form part of the law but it is important to clarify their relationship with the law. LOAC determines which actions are lawful and are therefore permissible. Government then places further limitations upon the ADF (for operational, political, diplomatic and legal reasons) and does so by the use of ROE.

Strike capability is an attack by lethal force to damage or destroy a military objective or capability.

Time-on-station is the amount of time that an aircraft can perform its allocated task. It is determined by the endurance of the aircraft and its crew (in the case of manned aircraft), the time taken to transit to and from the aircraft’s operating base and its refueling capabilities if available.