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Legal and Practical Challenges Associated with the use of Unmanned Aerial Vehicles in the Maritime Environment

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Legal and Practical Challenges Associated with the use of UAV in the Maritime Environment

Scott Moloney

Introduction

Unmanned aerial vehicles (UAV) are being developed and used by individuals, organisations and military forces at an ever increasing rate. Although not yet ubiquitous, the use of UAV, and other unmanned systems such as unmanned ground vehicles (UGV), unmanned surface vehicles (USV), and unmanned underwater vehicles (UUV) to enhance military capability, is growing rapidly.

As technological advances occur, increased capability is achieved, cost of production falls and the benefit of unmanned systems becomes more widely known, it is anticipated that the use of these types of systems will increase. Research conducted to date by the Royal Australian Navy (RAN), and counterpart forces in the United States (US) and the United Kingdom (UK), and elsewhere, suggests that UAV can successfully be deployed in a variety of roles to increase capability, including in the maritime domain.

As the use of UAV becomes more widespread, issues have emerged in relation to how the use of UAV by the RAN and the Australian Defence Force (ADF) fits into the extant legal framework governing operations law and domestic regulation. In addition, the use of UAV in a maritime environment raises numerous practical issues, particularly in relation to facilitating their use from a platform such as a warship.

Purpose

The purpose of this paper is to highlight and discuss some of the significant legal and practical challenges associated with the use of UAV in the maritime environment, and to act as a catalyst for the instigation of a wider discussion in relation to the use of UAV and other unmanned systems by the RAN and ADF.

The discussion below draws on the author's research, experience of various personnel interviewed from the ADF, the US and UK military (who are more advanced in their use of UAV than the Australian military), and written publications of various governments, industry commentators and academics. The views expressed in this paper are the author's views and do not represent the views or opinions of the RAN or the ADF. Some of the comments outlined are cautionary in nature, and relate to mistakes made by military forces in relation to procuring various systems without having had due regard to broader issues.

This paper proposes a series of recommendations aimed at assisting the RAN and ADF to identify issues involved in the use of UAV and other unmanned systems in relation to their use and regulation, not only in a military context but also in a civilian context. Given the emerging state of the technology, the RAN and ADF have a real opportunity to contribute to solving some of the problems faced by governments, military forces and civilians who wish to use UAV.

Background

Unmanned aerial vehicles were thought to have first been used in a military context in the Rome Republic War in 1849 in the form of balloons carrying bombs over troops in France. Since then various experimental aircraft have been developed, particularly in the United States following the end of World War II. With increasing advances in technology, UAV became more prevalent in the late 1980s and early 1990s, particularly in relation to complex high-end assets developed for use by the military. Following the 11 September 2001 terrorist attacks in New York and Washington DC, the United States military has facilitated the development of UAV on a larger scale, and the usefulness of the technology has been proven in recent military campaigns including Afghanistan and Iraq. Advances in technology have meant that some UAV have become smaller and cheaper to buy and therefore, more easily accessible by civilians for recreational and commercial use.

Unmanned aerial vehicles can be powered by any means available such as solar-powered, laser-powered, battery-powered, propeller driven or jet-powered and can roughly be categorised according to size as:

- nano - insect or butterfly sized or smaller
- micro - hand-held or small bird sized
- small - capable of being carried by one person
- medium - up to the size of a fighter jet
- large - the size of a commercial airplane such as a Boeing 737
- specialised - unusual shapes such as a parachute glider, balloon or blimp, rockets and space probes.

It is important to note that UAV are not generally classified as either ballistic or semi-ballistic vehicles, cruise missiles or guided weapons.

A more technical classification table (effectively based on weight) is set out in Table 1.

Class	**Category**	**Normal use**	**Normal operating altitude**	**Normal mission radius**	**Civil category (UK CAA)**	**Example platform**
Class I <150kg	Micro <2kg	Tactical platoon, section, individual (single operator)	Up to 200 feet above ground level (AGL)	5km line of sight (LOS)	Weight classification group 1 (WCG) Small unmanned aircraft (<20kg)	Black widow
	Mini 2-20kg	Tactical sub-unit (manual launch)	Up to 3,000 feet AGL	25km LOS		Scan Eagle, Skylark, Raven, DH3
	Small >20kg	Tactical unit (employs launch system)	Up to 5,000 feet AGL	50km LOS	WCG 2 Light UAV (20-150kg)	Luna, Hermes 90
Class II 150-600kg	Tactical	Tactical formation	Up to 10,000 feet AGL	200km LOS	WCG 3 UAV (>150kg)	Serwer, Iview 250, Hermes 450, Aerostar, Watchkeeper
Class III >600kg	Medium altitude, long endurance (MALE)	Operational/Theatre	Up to 45,000 feet AGL	Unlimited, beyond line of sight (BLOS)		Predator A/B, Hermes 900
	High altitude, long endurance (HALE)	Strategic/National	Up to 65,000 feet AGL	Unlimited BLOS		Global Hawk, MC-4Q Triton
	Strike/combat	Strategic/National	Up to 65,000 feet AGL	Unlimited BLOS		

Table 1: Weight-based classification table for unmanned aircraft[1]

An alternate classification table grouping different types of UAV into tiers as used by the United States is set out in Table 2.

Class	**Tiers**	**Typical Terms**	**Examples**	**Typical Physical/Performance Characteristics**			
				MTOW (kg)	**Span (m)**	**Op Alt (ft)**	**Speed (kt)**
Small	Tier I	Micro	AV Wasp	<1	0.3	<500	Ten
		Mini/Small	Skylark Raven	10	1-2	<1000	Tens
Tactical	Tier II	Sub-tactical	Aerosonde Scan Eagle	30-50	>3	<10000	<100
	Tier III	Tactical	Shadow 200 I-View 250	Hundreds	>5-10	<10000	50-100
	Tier IV	MALE	Heron Predator	>1000	>15	<40000	100-200
Theatre	Tier V	HALE/HAE	Global Hawk	>10000	>30	>50000	100-300+
Survivable		UCAV/UR AV	J-UCAS	>10000	>10	Varies	>100

Table 2: Tier based classification table for unmanned aircraft[2]

In a military context, particularly from a maritime perspective, UAV enable a platform such as a ship to obtain information about its surroundings and potential contacts of interest by extending the reach of sensors beyond the organic capability of the platform. For example, a large UAV flying at high level carrying radar, or infrared or optical sensors could be used to scan large sections of the sea to identify potential contacts of interest several hundreds of nautical miles away. Such information could help guide a ship, aircraft or even a smaller UAV, to the appropriate location to conduct further investigations. Similarly, a handheld UAV could be used by a boarding party to hover about a contact of interest to give a bird's eye view of what was happening onboard the vessel as the boarding party approached and boarded the vessel.

In addition to traditional intelligence, surveillance and reconnaissance (ISR) activities, UAV can be used for numerous other military tasks including minefield detection, 'perch and stare' (in which a nano or small UAV attaches to an object and either video-records or voice records data), as a communications relay, to project non-kinetic force, and if weaponised, can be used to deliver lethal force including guided weapons and bombs.

An emerging use for the technology is the 'swarm', in which tens or even hundreds of UAV are programmed to fly together, in much the same way that a swarm of insects or birds fly. It is envisaged that a swarm could be used in a defensive manner, for example, in the same way as a flare countermeasure is used by a fighter aircraft, or could be used offensively by having multiple UAV attack an enemy position simultaneously.

In a civilian context, hundreds of applications for UAV have been developed including recreational use, scientific research, assisting commercial fishing, disaster response, infrastructure monitoring, bushfire surveys, aerial photography, assisting with law enforcement and cargo delivery to name a few.

The benefits of using UAV in a military context include the fact that they can be lighter and cheaper than manned platforms; their flight endurance can be greater than manned platforms; smaller UAV can be difficult to detect, both visually and electronically; and UAV can provide a capability in an area without risking human lives.

The usefulness of UAV has already been demonstrated to the ADF during recent campaigns in Afghanistan and Iraq. The Army has previously used the ScanEagle, Wasp, Skylark and Shadow UAV. The Royal Australian Air Force (RAAF) has also used the Heron UAV. The RAN, through the Navy Unmanned Aircraft System Unit, is currently trialling the use of the ScanEagle, and has also recently conducted flight demonstrations of the Integrator and S-100 Camcopter. The latter is a vertical take-off and landing platform.

In 2014, the Australian government announced a commitment to purchase the Northrop Grumman MQ-4C Triton UAV in an effort to improve maritime surveillance capabilities, highlighting the Triton's ability to sweep large areas of sea to monitor the naval movements of Australia's regional neighbours, asylum seeker boats and unlawful intrusions. The *2016 Defence White Paper* committed to purchasing seven UAV, to be in service from the early 2020s.[3] They will be based at RAAF Base Edinburgh in South Australia.

A Parliamentary committee was convened in late 2014 to investigate the potential use by the ADF of unmanned air, maritime and land platforms with reference to:

- their role in intelligence, reconnaissance and surveillance operations, including in support of border security, civil emergencies and regional cooperation
- their cost and combat-effectiveness in relation to conventional military platforms
- the government's force structure review and defence capability plan
- challenges, opportunities and risks associated with their deployment
- domestic and international legal, ethical and policy considerations
- research and development capabilities and Australia's industrial expertise
- transport, health and safety implications
- other related matters.

The Committee published its report *Use of unmanned air, maritime and land platforms by the Australian Defence Force* in June 2015.[4] The report noted that the international UAS market for weaponised drones was expected to grow from approximately US$5.2 billion to US$8.35 billion by 2018. The report made several significant recommendations to the Australian government, the ADF, the Civil Air Safety Authority (CASA) and Airservices Australia in relation to the acquisition and use of unmanned assets, namely:

> **Recommendation 1**
>
> The committee recommends that the Department of Defence strengthen its public communications in relation to military unmanned platforms.
>
> **Recommendation 2**
>
> The committee recommends that the Australian Defence Force acquire armed unmanned platforms when the capability requirement exists and the Australian Government make a policy statement regarding their use. This policy statement will:
>
> - affirm that armed unmanned platforms will be used in accordance with international law;
> - commit that armed unmanned platforms will only be operated by the Australian Defence Force personnel; and
> - include appropriate transparency measures governing the use of armed unmanned platforms.

Recommendation 3

The committee recommends that the Australian Defence Force notify the Australian Government of measures taken to address any identified gaps training and dissemination programs regarding the law of armed conflict and international humanitarian law when armed unmanned platforms are acquired.

Recommendation 4

The committee recommends the Australian Government:

- increase funding for innovation in the relation to unmanned platforms; and
- establish a Defence Unmanned Platforms Centre as a cooperative research centre in the area of military unmanned platforms.

Recommendation 5

The committee recommends that strategic engagement with the Australian unmanned platform industry be addressed in the forthcoming Defence Industry Policy Statement.

Recommendation 6

The committee recommends that the Australian Government:

- consider establishing additional support facilities for the Triton in the Northern Territory; and
- review the future deployment and support needs of Australian Defence Force unmanned platforms in the Australia's north.

Recommendation 7

The committee recommends that the Australian Government support international efforts to establish a regulatory regime for autonomous weapons systems, including those associated with unmanned platforms.

Recommendation 8

The committee recommends that following the release of the Defence White Paper 2015 the Australian Defence Force review the adequacy of its existing policies in relation to autonomous weapons systems.

Recommendation 9

The committee recommends that Defence, the Civil Aviation Safety Authority and Airservices Australia increase their cooperation to facilitate the safe use of unmanned platforms in Australian airspace.

It is apparent that UAV are here to stay, both from a civilian perspective as well as a military perspective.

Terminology

Before discussing the various legal and practical challenges that exist in relation to the use of UAV in the maritime environment, it is useful to define some of the lexicon that relates to unmanned systems. This is partly to assist readers in understanding the terminology, but is also partly to highlight the fact that different terms are used in different jurisdictions and there is, as yet, no definitive ‘standard’ in relation to the use of relevant words and phrases.[5]

- Artificial intelligence - a state of sentient awareness reached by a computer system or robot in which the system can learn by itself and make decisions by itself.

- Automated system - an unmanned aerial system (UAS) or remotely piloted aerial system (RPAS) that has one or more functions that are pre-programmed. A human controls some aspects of the system.
- Autonomous system - a UAS that is fully autonomous in the sense of being completely pre-programmed and capable of carrying out a mission with no input from a human being. This kind of system may or may not have artificial intelligence.
- Deterministic autonomy - a phrase to describe a UAS that can operate autonomously within pre-set parameters such as deciding when to conduct aerial refuelling.
- Drone - is the colloquial term for an unmanned aerial vehicle. More commonly used when referring to a remote controlled plane, recreational UAV, or small UAV used by a commercial operator.
- Human-in-the-loop (also known as semi-autonomous weapon system) - a weapon system that, once activated, is intended to only engage individual targets or specific target groups that have been selected by the human operator (examples include 'homing' munitions that, once launched, to a particular target location, search for and attack pre-programmed categories of targets (such as tanks) within the area).[6]
- Human-on-the-loop (also known as supervised autonomous weapon system) - an autonomous weapon system that is designed to provide human operators with the ability to intervene and terminate engagements, including in the event of a weapon system failure, before unacceptable levels of damage occur (examples include defensive weapon systems used to attack incoming missile or rocket attacks).[7] These systems independently select and attack targets according to their pre-programming. However, a human retains supervision of the weapon operation and can override the system if necessary within a limited period.
- Human-out-of-the-loop (also known as autonomous weapon system) - a weapon system that, once activated, can select and engage targets without further intervention by a human operator (examples including 'loitering' munitions that, once launched, search for and attack their intended targets such as radar installations over a specified area and without any further human intervention, or weapon systems that autonomously use electronic jamming to disrupt communications).[8] An autonomous weapon system would be capable of understanding higher level intent and direction, understanding and perceiving its environment and deciding a course of action from a number of alternatives. The overall activity of such a system would be predictable but individual actions may not be. If the autonomous system has artificial intelligence it may be possible for the system to independently determine its own actions, make complex decisions and adapt to its environment in a way that may be less predictable.
- RPA (remotely piloted aircraft) - an acronym that is used, particularly in Europe, to describe a UAV.
- RPAS (remotely piloted aircraft system) - an acronym that is used, particularly in Europe, to described a UAS.
- RPV (remotely piloted vehicle) - a acronym that is used, particularly in Europe, to describe a UAV, USV or UUV.
- UAS (unmanned aerial system) - a phrase that describes all of the components that are involved in the operation of a UAV, including the UAV itself, the command and control centre and ground support equipment.
- UAV (unmanned aerial vehicle) - the flying part of an unmanned aerial system.
- UCAV (unmanned combat air vehicle) - a phrase used to describe a heavily automated or autonomous weaponised UAS.

- UGV (unmanned ground vehicle) - an unmanned vehicle operated on land such as a remote controlled improvised explosive device clearance robot, or a humanoid robot.
- USV (unmanned surface vehicle) - an unmanned vessel that travels on the surface of the water, such as a remote controlled ship.
- UUV (unmanned underwater vehicle) - an unmanned vehicle that operates under the water such as a submarine or underwater research vessel.

For the purposes of this paper, the term UAV will be replaced by UAS to highlight the fact that the UAV component is only one part of the capability.

International Law issues associated with the use of UAV in the maritime environment

Unmanned aerial systems are considered by some states to be aircraft for the purposes of international law. For example, United States doctrine classifies UAV as ‘military aircraft’.[9] This gives US UAS the same protections, and obligations, as regular military aircraft in terms of compliance with international law including sovereign immunity from foreign laws in relation to search and inspection. They should not be boarded, searched or inspected by foreign authorities without permission, and will require diplomatic clearance to enter another nation’s airspace and may have to submit to search as a condition of entry. They will also be required to bear markings indicating both nationality and military status. Only a military aircraft can exercise the combat rights of a belligerent in an armed conflict, a fact that it relevant to weaponised UAS.

The *Convention on International Civil Aviation 1944* classifies military aircraft as state aircraft for the purposes of the convention. As a consequence, military aircraft are exempt from the rules promulgated by the International Civil Aviation Organization (ICAO) in relation to the various flight information regions (FIR) that cover the planet and relate to the coordination and flight management of commercial and civilian aviation. In practice, however, military aircraft often voluntarily adhere to ICAO flight procedures and FIR services when not conducting training or operational flights, including flying with due regard for the safety of navigation of civil aircraft.

There is some debate as to whether a nano or micro UAV would be defined as a ‘military aircraft’ given their small size, limited range, speed and so on. They may more properly be categorised as an organic component of a larger platform (such as a ship). If this is the case the UAV component would not have a distinct legal personality in the same way as a helicopter operating from a warship has sovereign immunity in its own right under the *United Nations Convention on the Law of the Sea 1982* (LOSC) from the laws or assertion of jurisdiction of foreign states. It is suggested that larger UAV may be more easily categorised as ‘military aircraft’ given their ability to fly at reasonably high altitudes at reasonably high speeds covering significant distances for not insignificant periods of time, and their ability to carry visible military markings.[10] The determination of whether a UAV can be classified as a military aircraft will be a question of fact and degree depending on the circumstances of each individual case.

Subject to the right of transit passage over international straits and archipelagic sea lanes, a UAV must not enter another state’s national airspace (such as over land or territorial sea) without consent. Aircraft in ‘distress’ may enter the national airspace of a foreign state if circumstances of aircraft or medical safety require immediate attention, although in such cases the aircraft should seek permission from the foreign state prior to entering its airspace. If the basis of this convention is to protect human life on board manned aircraft, it is questionable whether a UAV could ever avail itself of this right, and whether a foreign state would ever grant permission for a UAV to enter its national airspace in circumstances of distress.

Issues could arise if a UAV were to fly off course into the sovereign airspace of another state, or crash onto land or in the territorial sea, in the same way that could occur if a manned flight did the same. From the perspective of *jus ad bellum*, such an event could be perceived by some foreign states as a sign of aggression or as a threat to the peace and security of the state notwithstanding that there was no *mala fides* on behalf of the RAN.[11] Some commentators have noted that the use of weaponised UAS by the United States Central Intelligence Agency as part of its targeted killing program (described by some as an extra-judicial assassination program and referred to in the media as the use of 'killer drones') has created a negative perception against the technology in the minds of some states, organisations and individuals.[12] This issue, amongst others, has apparently led to some states refusing permission (via diplomatic clearance) for UAS to enter their airspace.

The issue is relevant to the RAN from the perspective of planning for operations involving UAV that have the potential to unintentionally enter into the sovereign airspace of another state. The risk of this event happening may be high depending on the type of UAS being used. For example, some UAV may be susceptible to be blown off course by an extreme weather event. Operators of UAS will need to be conscious of the risk that some UAS may be blown off course by bad weather, or may otherwise have their flying operations impaired in certain circumstances when determining the flight plans and details of operations involving UAS.

One particularly interesting example of the use of UAV technology is in the area of 'hot pursuit'. According to Article 23(1) of the *United Nations Convention of the High Seas 1958*, the hot pursuit of a foreign ship may be undertaken when the competent authorities of the coastal state have good reason to believe that the foreign ship has violated the laws and regulations of that state. Such pursuit must be commenced when the foreign ship or one of its boats is within internal waters, the territorial seas, the contiguous zone or the exclusive economic zone of the pursuing state, and may only be continued outside the territorial seas, the contiguous zone or the exclusive economic zone if the pursuit has not been 'interrupted'. If the foreign ship is within the contiguous zone the pursuit may only be undertaken if there has been a violation of the rights for the protection of which the zone was created (which in the case of Australia will include taking anticipatory action against violations of extant customs, fiscal, immigration and sanitary laws). A foreign ship may violate Australia's rights in the exclusive economic zone by undertaking activities that are inconsistent with Australia's sovereign rights relating to exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of waters superjacent to the seabed and on the seabed and its subsoil, and with regard to other activities of the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds.

Pursuant to LOSC Article 111(4), a hot pursuit can only be commenced after a visual or auditory signal to stop has been given at a distance which enables it to be seen or heard by the foreign ship. Assuming the foreign ship does not stop when directed to do so, the 'pursuit' must then be continuous in that the foreign ship must be tracked continuously either visually or through electronic means.

The benefit of a UAS (or USV or UUV) in this situation is that the asset may be more capable of tracking the offending vessel and providing data to a RAN ship so as to avoid the pursuit being interrupted. To use an extreme example, it may be that a large UAV, such as the Triton, could be used on a rotational basis to continuously track an offending vessel for days, or even weeks, in situations in which the pursuing state ship has not been able to maintain visual or radar link.

Although not strictly within the scope of this paper, it is noted that international legal issues surrounding the use of a USV, or UUV are perhaps more complicated than for a UAV. A USV may not be able to be categorised as a 'warship' for the purposes of LOSC because Article 29 defines a warship to mean:

> a ship belonging to the armed forces of a State bearing the external marks distinguishing such ships of its nationality, under the command of an officer duly commissioned by the government of the State and whose name appears in the appropriate service list of its equivalent, and manned by a crew which is under regular armed forces discipline.

Nevertheless, a USV may be categorised as a government ship operated for non-commercial purposes (auxiliary vessel). If so, a USV will enjoy a right of innocent passage though the territorial sea of a foreign state, subject to the requirement for travelling in a continuous and expeditious manner. Stopping and anchoring is allowed but only insofar as incidental to ordinary navigation, or as rendered necessary by distress or *force majeure* events. Transit passage through international straits and archipelagic sea lanes is also allowed in 'normal mode'. In both cases, the USV will be prohibited from performing any activities that may be considered prejudicial to the peace, good order, or security of the coastal state including threatening or using force against the sovereignty, territorial integrity, or political independence of the coastal state.

A USV might also be considered to be a 'ship' for the definition of some international treaties, such as the *Convention on the International Regulations for Preventing Collisions at Sea 1972*. If so, it will be obliged to comply with the rules governing traffic separation schemes, steering and sailing rules, lighting and sound requirements, and will be required to maintain a proper lookout at all times by sight, hearing and all available means.

Pursuant to LOSC, a UUV may be considered to be a 'submarine' as well as a government ship operated for non-commercial purposes (auxiliary vessel). A UUV will be entitled to a right of innocent passage through the territorial sea of a foreign state, but must transit on the surface and show its flag. A UUV will also be entitled to transit passage in international straits and archipelagic sea lanes including submerged.

Unmanned surface vehicles and UUV will enjoy freedom of navigation and UAV the freedom of overflight in the contiguous zones and exclusive economic zones of foreign states and, of course, on the high seas. These freedoms are only limited by the requirement that activities be conducted with due regard for the rights of other states.

As with smaller UAV, there may be instances in which a USV or a UUV will not be considered to be subject to the international treaties and consequent rights and obligations outlined above. If smaller UAV, USV and UUV are not subject to the international treaties themselves, and are therefore considered to be extensions of the organic capability of the warship that is employing them, the 'mother ship' employing them will need to be aware of the rules relating to innocent passage, transit passage and archipelagic sea lanes passage as they relate to the use of these unmanned systems.

The relevance of the issues outlined above are that they will need to be taken into account by the RAN if and when UAV, USV or UUV are sought to be used either on their own, or as part of operations involving all three types of unmanned systems.

Weaponised UAV, UGV, USV and UUV must comply with the law of armed conflict (LOAC) as set out in the Geneva Conventions, Additional Protocols, Hague Conventions and Australia's rules of engagement when used in armed conflict (as opposed to domestic law enforcement activities). Essentially, these rules require that the force used must be necessary to secure the prompt submission of the enemy with a minimum expenditure of life, resources and time. Further, the force used must distinguish between enemy combatants and the civilian population, and military objectives and civilian objectives. Military operations should only be conducted against lawful military objectives, defined by international humanitarian law as:

> those objects which by their nature, location, purpose of use make an effective contribution to military action and whose total or partial destruction, capture or neutralization, in the circumstances ruing at the time, offers a definitive military advantage.[13]

Thirdly, the use of force must be proportional in that it must not cause injury, suffering or destruction to civilians or civilian objects that are excessive in relation to the anticipated military advantage sought to be gained. Collateral damage, including the death of civilians and destruction of civilian property, is allowed but only if the decision-maker complies with the rules outlined above.

Debate is raging at the present time in relation to whether an unmanned system operating on an autonomous basis (such as on a human-off-the-loop basis) could, or should, ever be allowed to use force against an enemy. Technologically, it seems apparent that computer systems and decision-making algorithms have probably reached the point where an unmanned system could be programmed to operate on an autonomous basis to conduct a mission against a defined target or set of targets. In the context of making targeting decisions, there is an argument that a computer can be more effective and efficient in relation to making decisions because it is not affected by fatigue, emotions, medical conditions, or conscious or unconscious bias. Furthermore, the rate of data processing by a computer can be higher than that of a human, which suggests that a computer may be less likely to make mistakes.

Some governments and individuals are opposed to the idea of allowing unmanned systems to operate without a human-in-the-loop or human-on-the-loop because of concerns that an autonomous system may not be 100 per cent safe, and because of the stereo-type of the ‘killer drone’, or ‘killer robot’ evokes such high levels of concern. The concept of autonomous systems operating with artificial intelligence evokes an even stronger reaction, particularly from the perspective that such a system could become ‘uncontrollable’ with the corresponding issue that no one could be held responsible for its actions.

From a LOAC perspective, it is currently unclear as to whether liability for the use of force by an autonomous unmanned system that was in breach of the rules of war may fall upon the commander and/or operator involved in activating the UAS. Depending on the circumstances of the breach, a state, commander, manufacturer or programmer involved with the use of an autonomous system could potentially be held accountable for the unlawful actions of the system under a variety of different regimes including international humanitarian law, international human rights law, international criminal law, domestic criminal law, manufacturers or product liability, and corporate criminal liability.[14] This is an interesting area of domestic and international law that is currently evolving.

To mitigate legal concerns, and perhaps also to help alleviate political and community concerns, some states currently take the view that the higher the amount of force to be used in an operation (and the correlating higher prospect of lethality), the more input is required by a human in relation to targeting and authorising the use of force (the human-in-the-loop or human-on-the-loop requirement). Some states, including the United States and UK have published policies on the use of autonomous weapon systems. The US policy states that:

> autonomous and semi-autonomous weapons systems shall be designed to allow commanders and operators to exercise appropriate levels of human judgment over the use of force.[15]

The UK policy is that the ‘autonomous release of weapons’ will not be permitted and that ‘… operation of weapon systems will always be under human control’.[16]

Interestingly, some commentators have postulated that as members of the military and members of the community become more ‘comfortable’ with the use of unmanned systems in everyday life (assuming the use of such systems is demonstrated to be safe, efficient and cost effective), the prohibition on the requirement for a human-in-the-loop or human-on-the-loop in relation to targeting decisions may begin to wane. The theory is that the successful application of new technologies such as the Google car (a ‘self-driving motor vehicle’ being developed to carry passengers on public streets), the Mercedes-Benz Freightliner (a truck equivalent of the Google car, designed to carry freight from one place to another), and the Amazon drone (a small UAV designed to deliver packages to customers) will begin to demonstrate to the military, and contemporary society at large, that fully automated or autonomous systems are reliable and safe, thereby breaking down some of the current negative attitudes to the use of the technology without human intervention.

Domestic law issues associated with the use of UAV in the maritime environment

There are a number of domestic legal issues that arise in relation to the use of UAS in the maritime environment including from the perspective of:

- privacy
- work health and safety
- insurance
- criminal law
- weapons review
- regulation - both by CASA and military aviation regulations.

The ADF is required to adhere to the provisions of the *Privacy Act 1988* in relation to the collection, use and dissemination of information, particularly personal information. If UAS are going to be used as part of ISR activities, or if information collected by them may ultimately be passed onto other agencies (whether domestic or international) for military, law enforcement, immigration or customs purposes, the RAN should ensure that its policies and procedures comply with extant privacy legislation.

Breaches of the Privacy Act are currently not required to be reported, although if they occur, they are often the subject of complaint initiated by the aggrieved individual to the Office of the Australian Information Commissioner. Remedies for individuals who have been the subject of a privacy breach are currently limited. However, in a recent report by the Parliamentary Joint Committee on Intelligence and Security, it was recommended that a mandatory data breach notification scheme be introduced by the end of 2015.[17] If such a scheme was introduced, and if a recent Australian Law Reform Commission recommendation that the Australian government legislate to create a tort for serious breach of privacy be accepted, the possibility exists that in the future Commonwealth agencies including Defence may one day be liable to pay compensation to individuals whose privacy is breached by the use of UAV or other activities.[18]

That this issue is a topical one is borne out by the fact that the use of ‘drones’, and their ability to obtain visual data on citizens raises privacy concerns, has been specifically dealt with in the United States by way of recent Presidential Memorandum.[19]

The Australia government has also recently examined the issue of the use of UAV and the privacy of Australian citizens. In the July 2014 report *Eyes in the sky - inquiry into drones and the regulation of air safety and privacy* it was noted that the various State and Territory privacy laws provide some protection for citizens in terms of privacy but there were a number of situations in which they may not protect Australians against the invasive use of UAV.[20] Essentially the issue is that laws are not uniform, are outdated in terms of dealing with new technologies such as UAV, and tend to deal with data protection not behavioural privacy protection. Furthermore, although some of the State and Territory privacy legislation contains prohibitions on the use of surveillance devices, not all do, and the terms of the relevant prohibitions are inconsistent. It was noted that the *Surveillance Devices Act 2004* does not contain any prohibitions on the use of surveillance.

The RAN and the ADF should ensure that policies and procedures relating to the use of UAS and information collected by them comply with extant Commonwealth legislation protecting the rights of individuals, particularly the Privacy Act. Depending on the location of the use of UAS, and the purpose for which information that is collected is going to be used, Defence may also need to review compliance with state and territory based privacy legislation and other legislation that protects the rights of individuals such as the *Human Rights Act 2004 (ACT)*.

Another interesting issue relating to privacy is the fact that with an increase in the use of UAS, the ADF and other military forces can expect a greater degree of scrutiny to be placed on their conduct of operations. For example, a civilian or news reporter may be able to use their own UAS to record the actions of ADF members and equipment on and around the battlefield, in circumstances that have not been possible in the past.

Lastly, noting that Defence is required to store information pursuant to the *Archives Act 1983*, a review of how information collected by UAS is to be stored would also be prudent.

Because some of the roles involved in operating a UAS are different to the well-known categories of naval service, it would be prudent to examine individual roles of people involved in working with unmanned systems from a work, health and safety perspective. For example, because some UAV can stay airborne for significantly longer periods of time than some manned aircraft, a pilot may be required to sit at the controls of a UAS for longer than they are used to depending on the operation being conducted, and availability of relief manning. If there are not many qualified UAS operators at the beginning of the life-cycle of a particular unmanned system this could led to personnel being placed in a position of potentially unsafe work practices.[21]

Furthermore, the nature and repetitiveness of some UAV operations could expose personnel to increased health risks, particularly in relation to mental health risks associated with operations involving the use of force. It is noted that from a workers compensation perspective the *Veterans' Entitlements Act 1986* and the *Military Rehabilitation and Compensation Act 2004* already contain provision for the acceptance of liability for post-traumatic stress disorder suffered by UAS operators in the course of their military service.[22]

Compensation for personal injury or property damage suffered by third parties as a result of the activities of the ADF in non-operational matters may be covered by the Comcover insurance policy.[23] Damage caused by the ADF in the course of operations may be covered by Defence in various ways on a self-funded basis.[24] Both the Comcover policy and extant policies in relation to compensation payable for issues arising on operations should be reviewed to ascertain what risk/s and events arising from the use of UAS will be covered by the Comcover policy, and what risks and events will be covered by Defence on a self-funded basis.

The Australian National University recently made a submission to the Parliamentary committee investigating the use of unmanned systems by the ADF.[25] The authors identified the potential for ADF members involved in the collection of information via UAS to be prosecuted under domestic Australian criminal law in relation to the collection of information that was passed onto coalition partners that was then used by those partners to conduct operations of the kind that would be prohibited by Australian rules of engagement.[26] The authors proposed that this difficult issue be the subject of consideration by various agencies responsible for the relevant policies and legislation with a view to clarifying the potential liability of ADF members.

This issue has recently been the subject of judicial consideration in the UK.[27] In Noor Khan, the UK Court of Appeal held that British courts should not determine the issue of whether members of the British armed forces ought to be held criminally responsible pursuant to British criminal law for passing on intelligence to the United States for use in their drone program, on the basis that the acts of the government of another country are non-justiciable in UK courts. Whether Australian courts will be of the same view is unknown at this point in time.

The ADF requires new weapons to undergo a review pursuant to the terms of Defence Instruction (General) OPS 44-1 *Legal Review of New Weapons*. Depending on the type of UAS (or other unmanned system) that is being contemplated for use by the RAN or ADF, it may meet the definition of 'weapon' for the purposes of the Instruction. If so, a legal review will need to be undertaken by the Directorate of Operations and Security Law within the Defence Legal Division prior to use, to ensure that the UAS will not breach Australia's international obligations in relation to the prohibition on the use of certain types of weapons.

Regulation of UAV from a civil air safety perspective is possibly the most vexed and complex issue in relation to their use. The reason for this is because air safety policies, standards and procedures that have been developed over the past several decades ensure that manned aircraft are operated in an extremely safe fashion. When the regulations were being developed, no-one anticipated that UAS would one day be capable of flying alongside manned aircraft. Safety is achieved by focusing on safety of equipment, safety of personnel and development of safe operating standards and procedures. Each of these areas has minimum levels of safety that must be met, independent of one another. The challenge facing air safety regulators is how to integrate UAS into domestic airspace whilst ensuring the safety of all airspace users as well as the safety of persons and property on the ground.

Aircraft certification standards govern the design, construction, manufacturing, and continued airworthiness of aircraft used in private and commercial operations. These standards were developed with an underlying assumption that a pilot would be onboard the aircraft and manipulating the controls and possessed of the relevant situational awareness required for safe flight. In relation to UAS, aside from the construction of the UAV itself, other components including the software associated with the data link and the launch and recovery mechanisms also need to comply with the relevant standards before a UAS can achieve airworthiness certification.

Safety of personnel involved in operating aircraft (such as pilots, navigators, engineers etc) is achieved through regulations adopted by individual states and associated training requirements, including flying training and technical and theoretical examinations. Conventional theory suggests that the flight crew of UAS operated by the military should be flight crew that have previously flown manned aircraft, or crew that have otherwise received specialist training and are appropriately supervised by flight crew.[28] This premise is based on the fact that flight crew are already trained to a sufficiently high standard to safely operate the UAS, and to deal with typical issues or emergencies that may arise such as dealing with bad weather or coping with some kind of mechanical problem. It is envisaged that military aircrew will be required to undergo platform specific training prior to the use of a UAS, and to maintain the necessary certifications needed to operate it.

In terms of operating standards and procedures, ICAO promotes the safe and orderly development of international civil aviation throughout the world. It sets standards and regulations necessary for aviation safety, security, efficiency, and regularity, as well as aviation environmental protection. As part of its role, ICAO has published guidance material which aims to provide basic guidelines for member states to introduce and integrate UAS into airspace in a consistent manner, to ensure global interoperability and regulatory compatibility.[29] Of significance is the ICAO policy in relation to UAS which states:

> In general, UAS should be operated in accordance with the rule governing the flight of manned aircraft and meet equipment requirements applicable to the class of airspace within which they intend to operate.

Further, the policy explains:

> To safely integrate UAS in non-segregated airspace, the UAS must act and respond as manned aircraft do. Air Traffic, Airspace and Airport standards should not be significantly changed. The UAS must be able to comply with existing provisions to the greatest extent possible.

Due to the nature of UAS operations, specifically the fact that the platform is unmanned and dependent upon a data link for control, there are a number of issues that need to be resolved to achieve successful integration with manned aircraft, including:

- addressing the inability of UAS to comply directly with air traffic control visual clearances or to operate under visual flight rules
- establishing procedures and techniques for safe and secure exchange of voice and data communication between UAS pilots, air traffic controllers, and other domestic airspace users

- establishing wake vortex and turbulence avoidance criteria needed for UAS with unique characteristics.

In recognition of the fact that historically, aviation standards and regulations were developed generically for all (manned) aircraft, and not developed with UAS specifically in mind, the US Federal Aviation Administration (FAA) has been reviewing the use of UAS in domestic airspace for some time. In a comprehensive ‘roadmap’ outlining the various steps that are required to achieve integration, the FAA has identified various policy, guidance and regulatory areas that require research and development prior to achieving aircrew and UAS certification.

Pilot and Crew	**Control Station**	**Data Link**	**Unmanned aircraft**
Policy	Policy	Policy	Policy
Certification requirements	Certification requirements	Certification requirements	Certification requirements
Operational standards	Technical standards	Technical standards	Technical standards
Procedures	Airworthiness standards	Airworthiness standards	Airworthiness standards
Regulations	Regulations	Interoperability requirements	Procedures
Guidance material	Interoperability requirements	Guidance material	Regulations
Training requirements	Guidance material	Coordinated aviation radiofrequency spectrum	Guidance material
Medical standards	Continued airworthiness	Standardised control architectures	Measures of performance
Testing standards	Means of compliance	Measures of performance	Continued airworthiness
		Radio/datalink security requirements	Testing standards
			Means of compliance

Table 3: Issues requiring research and development for aircrew and UAS certification[30]

As can be seen from the Table 3, the amount of effort involved in developing the necessary regulations to integrate UAS into domestic air space is enormous. Other regulatory drivers include developing minimum standards for sense-and-avoid, control and communications, and separation assurance to meet new or existing operational and regulatory requirements for specified airspace. It is noted that the National Aeronautics and Space Administration (NASA), the FAA and General Atomics Aeronautical Systems successfully demonstrated a sense-and-avoid prototype system at the end of 2014 at NASA’s flight research centre in the United States.

In Australia, CASA allows UAS to be operated on a recreational basis as long as they adhere to a number of restrictions including:

- the UAV must only be flown in daylight within the operators line of sight
- the UAV must not be flown within 30m of vehicles, boats, buildings or people
- the UAV must not be flown over any populous area, such as beaches, other people’s backyards, heavily populated areas or sports ovals that are being used for sports
- if in controlled airspace (most Australian cities), the UAV must not be flown higher than 120m

- the UAV cannot be flown within 5.5km of an airfield
- it is illegal to fly a UAS for money or economic reward unless the operator has a UAS Operator's Certificate issued by CASA.

Operators who wish to use UAS for commercial purposes must apply for a licence to do so. There are currently around 250 commercial UAS operators licensed by CASA operating in all Australian states and territories (a number which is growing rapidly). To operate a UAS under 150kg there is no airworthiness requirements but the operator needs an Operator's Certificate, and the UAS must be demonstrated to CASA before it can be listed on the Operator's Certificate. To operate a UAS above 150kg, the operator must have personnel approval and an Operator's Certificate, a certificate of registration, a maintenance program and a certificate of airworthiness (experimental or restricted category).[31]

It is noted that CASA is currently reviewing its policies in relation to the use of UAV in domestic airspace and is expected to release its updated policy in 2016.

The ADF is responsible for the airworthiness and safety of manned military aircraft that it operates. Defence also operates some civil aircraft under CASA registration. The Service chiefs are responsible for management of technical airworthiness of such aircraft in accordance with CASA regulations. The operational airworthiness of any military component of flying conducted by ADF personnel using civil registered aircraft is the responsibility of the relevant operational airworthiness authority, who for the RAN, is the Fleet Commander.

In terms of extant military regulation of UAS, ADF regulatory documents indicate that all UAS owned, leased or chartered, and operated by or on behalf of Defence, must be managed within the Defence Aviation Safety Program.[32] For the purposes of airworthiness management, UAS risk management is achieved through the use of four broad UAS categories. The intended outcome of the Defence military aviation regulations is to assure that Defence-related UAS operations are conducted at an acceptable level of safety to other aircraft, people and property.

Currently ADF UAS categories are:

Category 1 UAS	A system for which the outcome of a catastrophic failure can reasonably be expected to result in death or serious injury, or significant damage to property. Category 1 UAS are characterised by a requirement to operate in any class of airspace, over populated areas.
Category 2 UAS	A system for which the outcome of a catastrophic failure may result in death or serious injury, or significant damage to property. Category 2 UAS are characterised by a requirement to operate in any class of airspace with appropriate operational restriction; including limited flight over populated areas.
Category 3 UAS	A system for which the consequence of a catastrophic failure is unlikely to result in death or serious injury, or significant damage to property. Category 3 UAS are characterised by operations in segregated airspace only, where the UA of the system has a requirement to operate over sparsely populated areas, mission essential personnel and associated property, with appropriate operational restriction.
Category 4 UAS	A system for which the consequence of a catastrophic failure can reasonably be expected not to result in death or serious injury, or significant damage to property.

	Category 4 UAS are characterised by the UA of the system having a collision energy contribution of less than 42 Joules, and operations confined to airspace less than 400 ft AGL and greater than 3nm from an aerodrome.

Table 4: ADF UAS categories

For the RAN, implementation of operational airworthiness requirements for naval aviation is primarily through Australian Book of Reference (ABR) 5150 *Royal Australian Navy Aviation Instructions* and subordinate Squadron orders, instructions and procedures.

Prior to the use of a UAV, the operators must obtain approval from the relevant operational airworthiness authority. This requires undertaking a UAS risk analysis, with inputs derived from the original equipment manufacturer of the UAS, in conjunction with operational requirements and an initial statement of operating intent provided by Defence. The risk analysis includes both technical and operational risks.

When approval is given to operate a UAS and conduct a particular mission, restriction and limitations may be given by way of operational mitigation to ensure the safety of the asset, personnel and property. Examples could include:

- limiting UAV taxi routes on an aerodrome and other steps to remove potential conflict with other ground traffic
- flight over populated areas only be conducted in order to take off and land
- use of UAV flight routes that minimise or avoid tracking over populated areas
- air traffic control services, air battle management be employed to maintain observation of the UAV in relation to other aircraft
- calculate use of minimum transit heights to enable gliding range to a sparsely populated or unpopulated area in the event of engine failure
- ensure the remote pilot has qualifications that ensure in-flight emergency response will be managed in an equivalent manner to manned aircraft
- utilisation of sensor stand-off capability to avoid flight over populated areas
- ensuring the UAV has a system reliability that can help assure that suitability for flight will not be compromised due to failure of the UAV flight control or power systems
- applying the ‘rules of the air’ to the UAV as per manned aircraft
- where possible, maintain UAV operation within controlled airspace or other segregated airspace
- within controlled airspace operate under the same air traffic control standards and procedures applied to manned aircraft, including standard separation standard techniques and use of identification friend or foe transponders.

Flights involving UAS authorised by the ADF in Australia’s domestic airspace to date have either been undertaken in segregated airspace, based on flight paths that have minimal or no potential contact with manned aircraft, or involving shared airspace with manned aircraft in military restricted areas applying international flight rules separation standards. It is apparent that there are still considerable challenges facing both CASA and the ADF in terms of fully assimilating the use of UAS into Australia’s domestic airspace, particularly from the perspective of operating UAS alongside manned civilian aircraft.

The use of UAV by the RAN, particularly in the littoral environment is likely to mean that the impact of issues surrounding domestic regulation is just as keenly felt by the RAN as the Army or

RAAF. Resolving the problem of how to integrate the use of UAS into domestic airspace is an issue that all three Services have an interest in:

- practical challenges associated with the use of UAV in the maritime environment
- various practical challenges have been identified in the course of researching this paper including:
    - policy/concept of operations
    - procurement issues
    - climatic issues
    - using UAS on board a ship
    - command and control and processing, exploitation and dissemination of information
    - development of processes and procedures within a command structure.

Policy/concept of operations. The emergence of new technology, and how the RAN and ADF intends on using such technology for specific operations, requires a review of extant policy and concept of operations, and the development of new policies and concepts that enable the technology to be integrated into relevant ADF functional areas. Commentators have raised the issue that it may take several years for capability investigations to result in acquisition of new UAS and introduction into service.[33] Their suggestion is for the ADF to commence thinking about developing policies and concepts based around the use of unmanned systems now so as to better enable the identification of future UAS requirements and to facilitate their introduction and use into ADF operations. It would make sense that debate and discussion about UAS specific policies and concepts be undertaken on a tri-Service basis.

Procurement issues. The procurement of UAS and other unmanned systems is fraught with issues. First, given the cost of purchasing larger UAS, it would seem prudent to undertake appropriate scoping and due diligence processes prior to purchase. It is understood that the ADF has previously had an unhappy experience with the attempted acquisition of a tactical UAS for the Army several years ago, known as project JP129. The contract for the purchase of the UAS under JP129 was ultimately terminated (although the Shadow UAV was subsequently purchased by Army under JP129 phase 2), and lessons learned resolved around a number of issues including continued uncertainty about the role and level of capability of the UAS, an institutional unfamiliarity with UAS, a lack of mature ADF doctrine on which to inform and base the requirement for a tactical UAS, and an inability to confidently assess what might realistically be delivered by the manufacturer and contractors.[34]

Another cautionary tale revolving around the issue of not undertaking appropriate scoping and due diligence relates to the purchase of equipment quickly for use in operations under the operational requirement rules. Purchasing equipment in a fast moving area of technological development carries a risk that the platform, including necessary through-life support, may be very expensive, may not integrate with any other equipment properly, and may become obsolete shortly after it enters use.

The risk of purchasing equipment that was not configured to operate with Australia’s allies was raised as an issue, particularly from the perspective of undertaking joint operations, although the risk of this occurring may be mitigated by purchasing technology that has been developed by an ally such as the United States or UK.

There is also an issue of adopting a ‘smart buyer’ approach, in which foreign states spend money on the development and testing of different UAS. Once the technology matures and becomes ‘proven’, Australia may then seek to purchase the equipment. Risks associated with this approach include the foreign state refusing to sell the technology, or not providing improvements or upgrades in a timely fashion.

The issue of interoperability between unmanned systems and current RAN and ADF equipment is a significant one. There is no point purchasing a new ISR capability if the information cannot be received and utilised by other platforms. Some interviewees thought it would be desirable to have modular payloads with standard interfaces so that cameras, radar and other sensors could be easily switched from different types of unmanned systems as required. Whether this would be possible to achieve in practice given the variety of different manufacturers is unknown, although more and more manufacturers are known to be using NATO Standardization Agreements for common military and technical procedures and equipment to achieve standard inputs and outputs.

Another interoperability issue relates to the use of UAV with other unmanned systems such as UGV, USV and UUV. Assuming the RAN determines that USV and UUV technology would also be useful, it is suggested that the perfect 'end-state' in terms of capability would be that information collected by one or other of the unmanned systems could be relayed to, and used, by other unmanned systems on a real-time basis. To use an example, a large UAV, such as the MQ-4C Triton, flying at 65,000 feet detects a contact of interest in the Indian Ocean. This information is relayed to a warship in the region. The warship launches a ScanEagle UAV to have a closer look at the contact, and is guided to the location of the contact by the Triton. The ScanEagle has difficulty tracking the object due to the weather conditions. The warship directs a UUV to the location of the contact with assistance from the Triton to continue tracking the contact underwater until the weather clears. At night time the warship launches a USV equipped with infrared and night-vision optical technology to take a closer look at the contact and obtain information about the vessel and its crew. By working with the Triton the warship is able to obtain information about the contact of interest without disclosing its presence thereby giving the commanding officer useful intelligence to inform future decisions.

Effect of climate. Discussions with operators of UAV in the maritime environment have identified that some platforms can be adversely affected by the weather. For example, the performance of small UAV can be adversely by inclement weather and may not be able to launched or retrieved in high sea states. In addition, small UAV that are controlled by line of sight communications may be blown off course resulting in a loss of control. Some UAV can also be adversely affected by extremes of temperature and humidity in relation to control and performance issues.

Using UAS onboard a ship. For those UAV that will be launched from a ship, the issue of space in relation to storing the necessary components onboard arises. For example, the ScanEagle UAV is launched by a compressed air catapult and retrieved via a vertical line recovery system. Assuming the launcher and retrieval system need to be stored until being rolled onto the flight deck for use, and then stored away again, the questions arises is there enough space on board the ship to accommodate the equipment. Can modifications be made to a ship to save space? For example, a warship creates compressed air - can the UAV launcher be affixed to a part of the ship that can access compressed air? Similarly, can the retrieval system be affixed to a part of the ship so that it is out of the way and can be easily and safely deployed when needed? In terms of command and control, can the operations room or alternate compartment accommodate the control station, and can the ship itself accommodate the additional personnel required to operate each UAV?

Perhaps counter-intuitively, the use of an 'unmanned system' may actually require more personnel than that of a manned system. In the case of a UAS, where the UAV component can stay aloft for 24 to 48 hours (or more) there will be a requirement for numerous pilots and sensor operators to be available during the operation of the aircraft. Furthermore, expended periods in the air may require more intensive maintenance and engineering to be carried out on the platform between missions. The heavy reliance on electronic sensors and systems that form part of a UAS may also require more technicians to be available to fix any issues that arise during flight.

Command and control and information use issues. Because UAV are controlled by radio-frequency for radio line of sight operations and for beyond radio line of sight (via satellite), there is a risk that these types of communications systems could be jammed or hijacked by third parties.

Consideration should be given to the level of security of command and control systems as well as redundancy plans should control of a UAV be lost or hijacked.

The issue of information processing, exploitation and dissemination needs to be considered. What sensors will be carried on board the UAV and how will the information be interrogated and used by the platform? It may be that for the larger UAS with multiple sensors, one or more personnel will be required to operate the sensors. These sensor operators are often co-located with the pilot of the UAS.

There is an also an issue of maintaining safe control of two (or more) UAS being operated by one ship. For those UAV being operated by radio-frequency via line of sight effective control of each UAV can be achieved by appropriate frequency de-confliction, or via digital data links with multiple unique nodes on the same frequency. Perhaps more problematic is the issue of maintaining appropriate separation protocols for each UAV while the ship is manoeuvring and underway to avoid the prospect of collision. Similarly, for those UAS that are predominantly operated from land, issues can arise in relation to calculating positions and distances relative to the 'ground station'. On land the coordinates of the ground station does not change, whereas for those UAV that are being controlled from a ship, the location of the ground station will be changing constantly when the ship is underway. Modern UAS systems have both a ground control station global positioning system in addition to a UAV global positioning system so that system always knows where the ship and air vehicle are in relation to each other.

UAS command structure. Standing up a new command, such as an unmanned patrol squadron, brings unique challenges including the need to develop new policies and operating procedures to deal with a range of issues. For commands operating large UAS such as the MQ-4C Triton, with personnel stationed around the globe in different time zones, the issue of effectively dealing with personnel issue such as work rosters, morale and discipline was identified.

Further personnel issues included a perceived stigma felt by some who argued that amongst their peers and the community they were not 'real pilots' if they were operating a UAS. In this regard it was suggested that those people who were genuinely interested in being involved in the use of UAV in the military would 'self-select' and this was a better option than forcing someone who was not interested to be part of the project. Associated with this issue was a concern that personnel involved in the use of UAS may lose their certification in relation to flying other platforms if they were not given the opportunity to keep up their hours in manned aircraft.

An issue relating to continued eligibility to receive a flying allowance was also raised given that some military forces have stated an intention not to pay personnel involved in UAS operations flying allowance because they are not participating in manned flight.[35]

Another issue relates to the development of tactical plans for use in operations. This type of planning was anticipated to take up a large amount of time especially if the UAS had not been used before and its capabilities were still being tested and understood. Contrast this to the position of many manned types of aircraft which have been used for many years and which have undertaken the same, or similar, types of operations in specific areas for decades or more.

The issue of providing proper training was raised, particularly for 'new' systems that were still being developed or trialled by the manufacturer. It was thought that the use of a training simulator would provide an option for personnel to undertake training, but this was thought to be sub-optimal compared to the use of the UAS in real-time.

Recommendations

The following ideas are put forward as recommendations to assist the RAN and ADF realise the potential of UAS technology:

- The RAN (and Army and RAAF) undertake further research into the various legal issues involved in the use of UAS, particularly from the perspective of assimilating the use of UAS into the domestic aviation regulatory framework. This may be the kind of project that the Military Law Centre can undertake.

- A ‘UAS centre of excellence’ be established with representatives from industry, academia, each of the Services, CASA and other interested agencies and individuals to debate and discuss legal and regulatory issues surrounding the use of UAV in both the civilian and military context. It is noted that Northrop Grumman recently partnered with the Royal Melbourne Institute of Technology to study airworthiness requirements for the use of UAV in Australia. This kind of collaborative approach should be encouraged.
- One or more, dedicated UAS ‘test sites’ be established to allow for the testing and use of UAV over land and water. Consideration should be given to similar test sites for USV and UUV.
- If it does not already exist, the RAN and ADF develop a formal program for identifying and reviewing available UAS (and possibly UGV/USV/UUV) technology, including future trends. One way to obtain more information may be to invite industry to participate in ‘field days’ at one or more of the test sites discussed above.
- An inter-governmental committee be established with representatives from the ADF (possibly from extant ADF committees looking into the use of UAS, namely, the 1* UAS steering group, the O6 UAS working group and the operator level UAS user group), together with other interested agencies such as CASA, Australian Federal Police, Department of Immigration and Border Protection, Australian Maritime Safety Authority, Airservices Australia, Attorney-General’s Department, Australian Security Intelligence Organisation and the DDepartment of Foreign Affairs and Trade to discuss issues associated with the use of UAV from a whole of government perspective, including how to counter the use of UAV acting against Australia’s interests both from a military and national security perspective.
- The RAN (and ADF) continue to engage with allies such as the United States and UK in relation to their experiences in using UAS technology.

Conclusion

The RAN, ADF, and indeed the wider Australian community, have already begun to experience the usefulness of unmanned systems, particularly UAV.

As with any emerging technology, the full extent of capability is yet to be determined. Similarly, as with any emerging technology, a challenge exists in relation to assimilating the technology into the existing norms of military operations and international and domestic regulatory frameworks.

One benefit of participating in the development of UAV technology is the opportunity for the RAN and the ADF to lead the way in the context of identifying issues with the use of UAV, and other unmanned systems, and proposing solutions.

To that end, this paper has identified some, but not all, challenges relating to the use of UAV in the maritime environment. This paper has also made some recommendations with a view to stimulating further discussion and proposing a way forward in terms of assisting the RAN and wider ADF to become a significant stakeholder in the debate, and a key influencer in the development and use of this technology on a national, regional and global basis.

[1] Ministry of Defence, *Unmanned Aircraft Systems: Terminology, Definitions and Classifications*, Joint Doctrine Note 3/10, www.gov.uk/government/uploads/system/uploads/attachment_data/file/432646/20150427-DCDC_JDN_3_10_Archived.pdf. Note UK doctrine has been updated, see Ministry of Defence, *The UK Approach to Unmanned Aircraft Systems*, Joint Doctrine Note 2/11, www.gov.uk/government/uploads/system/uploads/attachment_data/file/33711/20110505JDN_211_UAS_v2U.pdf.

[2] Adopted from internal Department of Defence documents.

[3] Department of Defence, *Defence White Paper 2016*, Canberra, 2016, pp. 87, 94, www.defence.gov.au/WhitePaper/Docs/2016-Defence-White-Paper.pdf.

[4] Foreign Affairs, Defence and Trade References Committee, *Use of unmanned air, maritime and land platforms by the Australian Defence Force*, Parliament of Australia, Canberra, 2015, www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/Defence_Unmanned_Platform.

[5] The International Civil Aviation Organization (ICAO) has endorsed the following acronyms: UAS - unmanned aircraft system consisting of remotely piloted aircraft (RPA) + remote pilot station (RPS) + command, control and communications (C3) link. A remotely piloted aircraft system (RPAS) is a subset of UAS and comprises RPA + RPS + command and control (C2).

[6] Department of Defense, *Autonomy in Weapon Systems*, Directive 3000.09, 21 November 2012, Glossary, Part II Definitions, www.dtic.mil/whs/directives/corres/pdf/300009p.pdf.

[7] Department of Defense, *Autonomy in Weapon Systems*, Glossary, Part II Definitions.

[8] Department of Defense, *Autonomy in Weapon Systems*, Glossary, Part II Definitions.

[9] Department of the Navy and Department of Homeland Security, *The Commander's Handbook on the Law of Naval Operations*, 2007, www.jag.navy.mil/documents/NWP_1-14M_Commanders_Handbook.pdf.

[10] Although note the Harvard Program on Humanitarian Policy and Conflict Research *Manual on International Law Applicable to Air and Missile Warfare* defines a 'military aircraft' as an aircraft that is (i) operated by the armed force of a state, (ii) bearing military markings of that state, (iii) commanded by a member of the armed forces, and (iv) controlled, manned or pre-programmed by a crew subject to regular armed forces discipline. See http://ihlresearch.org/amw/HPCR%20Manual.pdf.

[11] Criteria used to determine whether engaging in war is permissible from an international legal perspective.

[12] See, for example, the report of United Nations Special Rapporteur, Ben Emmerson, *On the promotion and protection of human rights and fundamental freedoms while countering terrorism*, dated 28 February 2014, and the report of United Nations Special Rapporteur, Christof Heyns, *On extrajudicial, summary or arbitrary executions*, dated 13 September 2013, www.ohchr.org/EN/HRBodies/HRC/RegularSessions/Session25/Pages/ListReports.aspx.

[13] Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflict (Additional Protocol I).

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[23] Comcover is the Australian government self-managed insurance fund, www.finance.gov.au/comcover/.

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[25] Rob McLaughlin, David Letts and Hitoshi Nasu, *Submission to the Standing Committee on Foreign Affairs, Defence and Trade on Use of Unmanned Platforms by the ADF*, Centre for Military and Security Law, The Australian National University, Canberra, 2 February 2015, www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/Defence_Unmanned_Platform/Submissions.
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The Sea Power Centre - Australia was established to undertake activities to promote the study, discussion and awareness of naval strategy, doctrine, history and maritime issues within the Royal Australian Navy, the Department of Defence and the wider community. Its mission is:

- to promote understanding of sea power and its application to the security of Australia's national interests
- to manage the development of RAN doctrine and facilitate its incorporation into ADF doctrine
- to contribute to regional engagement
- to contribute to the development of maritime strategic concepts, and strategic and operational level doctrine, and facilitate informed force structure decisions
- to preserve, develop and promote Australian naval history.

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