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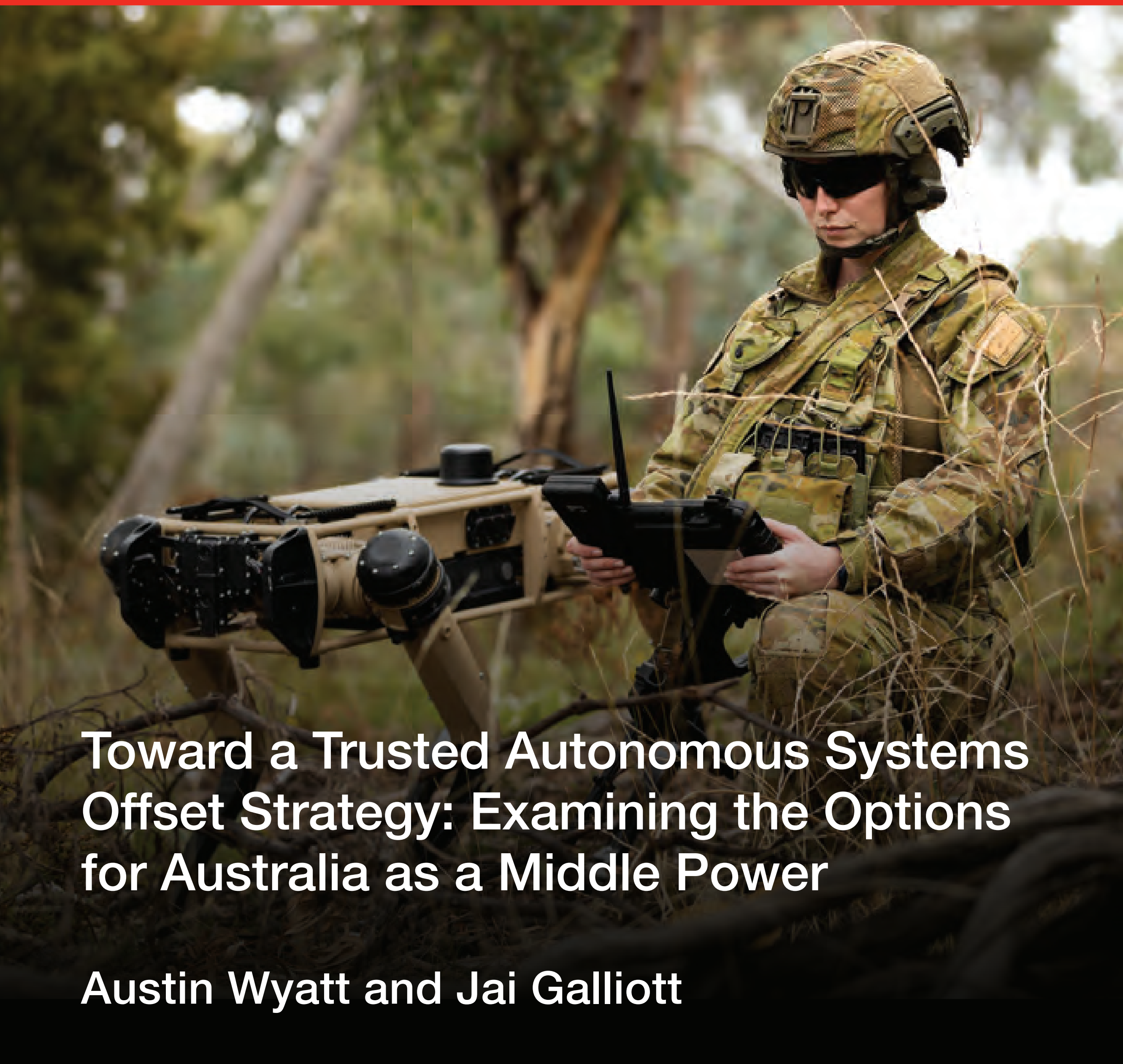

Toward a Trusted Autonomous Systems Offset Strategy: Examining the Options for Australia as a Middle Power

Austin Wyatt and Jai Galliott

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Section One: Introduction

The capacity to generate and project power is central to state relations in what is an inherently anarchic environment. In the absence of a true supranational arbiter, it is the relations of power that establish and influence the normative boundaries that guide state behaviour. At the global and regional levels, states balance against one another to protect and further their own interests, while ensuring their continued survival.

This emphasis on relative power necessarily focuses attention on the actions of superpower and great power actors as they attempt to secure zones of influence and shift the scales of international commerce in their favour. In the post-Cold War era, the implementation of the liberal rules-based international order, chiefly by the United States and its allies, emplaced structures around state interaction and established institutions that have subsequently generated behavioural norms that regulate state behaviour. While competition still occurs, the conventional power dominance of the hegemon acts as a limiting and stabilising force in the anarchic international space, which inspired the much-maligned declaration that we had reached the ‘end of history’.

The resultant balance of power was the foundation of an international relations equilibrium that continues to be particularly valuable for trade-reliant and US-aligned ‘middle power’ states, such as Australia.[1] Within this framework, middle powers have been able to leverage their own power across more limited regional spheres of influence. For smaller states, an established set of behavioural norms generates certainty, and international institutions (backed by the influence of the hegemon) open avenues to protect their interests against intrusion by more militarily powerful states. Overall, therefore, middle powers are incentivised to contribute to maintaining the US-led structure because it offers the protection of a great power, ensures the stability required for global economic activity and allows them to carve out their own niche areas of influence.

As with prior hegemons, however, the rise of a challenger state can threaten to upend this equilibrium. As the challenger grows in influence (chiefly economic), it can begin to chafe against the barriers placed upon it by the current international structure and seek to assert or expand control over what it sees as its sphere of influence. This creates the conditions for great power competition, which can potentially lead to conflict and a transition of hegemonic power.[2] Even though the challenger (in the modern context, China) may be gaining in terms of relative economic and political power, the hegemon typically maintains a strong conventional military edge. However, the emergence of a major military innovation that shifts the paradigm of conflict can act as a sort of circuit breaker, disrupting the hegemon's conventional military superiority.[3]

Generally, but not exclusively, centring on a technological invention, *offset strategies* are effectively a state's attempt to seize on this disruption to *offset* the superiority of a rival actor. Essentially the goal is to change the rules of a future conflict in the adopter's favour and sidestep the often unfeasible task of generating a comparable conventional capability. In the current context, both China and the United States are pursuing artificial intelligence (AI) enabled systems and autonomous platforms to secure dominance in the new conflict paradigm.

Shifting to a middle power perspective, the core purpose of an offset strategy is notably distinct from that of a hegemonic competitor. The return of great power competition and the proliferation of advanced technology will have a destabilising effect, and managing this disruption will stretch the resources of states with global interests but smaller militaries. For these states, the core purpose of an offset strategy is to generate an asymmetry of capability. By maintaining a comparative edge in the emerging military innovation and shifting the way it fights, a smaller military can invalidate the conventional superiority of a rival and compensate for its own weaknesses, thereby creating a strategic advantage that secures its niche over the long term.[4]

This work will evaluate the feasibility of adopting trusted autonomous systems (TAS) as the basis for an offset strategy, which would then integrate into the Australian Army's future force design. Australia has historically been able to maintain an enduring knowledge edge over its neighbours, which it has translated into a deterring capability edge that offsets the comparatively low mass of the Australian Defence Force (ADF). In his 2019 Strategic Guidance, the Chief of Army referred to the Australian Army as an 'Army in Motion' that aims to be 'ready now' and 'future ready' to operate in a shifting operational and geostrategic environment under the emergent conditions of 'Accelerated Warfare'.[5] However, this is a time-sensitive pursuit, with only a limited window to shake off organisational lethargy and proactively take calculated risks. As the pace of technology diffusion quickens (as seen with remote-operated unmanned aerial vehicles (UAVs)) and the adoption capacity of neighbouring states improves, it will become more difficult to maintain a capability edge based on autonomous systems.

Centring the methodology on a qualitative case study (in this case, the Australian Army) is a particularly suitable approach for studying the diffusion of military technology, which is rarely statistically quantifiable while it is occurring.[6] The following analysis draws extensively on data and analysis from defence research bodies, civilian state agencies, and non-government think tanks, alongside traditional academic literature. Additionally, this work draws on published strategic concept documentation from the broader ADF and on related publications which deliver important evidence on the approach of senior military leaders to the utility of autonomous systems to the future force.

Overall this work presents an examination, grounded in theory, of the feasibility of the Australian Army adopting TAS as part of an offset strategy. This is achievable over the medium term; however, the government must invest more deeply in developing the capacity of the domestic arms industry to innovate in identified capability niches. The broader Australian defence community must instigate a meaningful cultural shift to prioritise and support creative risk-taking and innovation. While it is also important to understand lethal autonomous weapon system (LAWS) (defined in detail in section two) proliferation in a broader regional context, it is beyond the conceptual and resource limits of this specific paper; however, this report could serve as a proof of concept for the contention that middle power states can be effective fast-following adopters of TAS.

1.1: Military Innovation and Diffusion Theory

Notwithstanding the popular stereotype that militaries are slow-moving, stagnant organisations that are averse to change and to change-makers (which has admittedly generally proven accurate), there is also a long list of major innovations that started their development with military funding, arguably the most famous being computers and the internet.[7] While military bureaucracy certainly can stifle innovation,[8] the reality is that advanced militaries (for example those of Australia, the United States and Singapore) rely upon their technological superiority to generate an asymmetric advantage over potential rivals that will deter aggression and project stability.

There is a large body of literature available that explores how military innovation occurs; Grissom presents a useful summary of the key theories.[9] Common across these theories is an acknowledgement that an *innovation* consists of an invention and a change to the 'operational praxis'[10]—effectively the process by which a military transforms capability into force. These are commonly referred to as the *hardware* and *software* components of an innovation, respectively. In practice, there is typically a gap between the maturation points of each capability, which can be considered an incubation period. During this period, in a similar manner to disruptive innovations in the civilian sphere,[11] different versions of similar hardware components and operational concepts are experimented with (often in parallel) by 'venturesome innovators'.[12] Once both components have matured, it is only a matter of time before the major military innovation is deployed or acknowledged publicly by a first mover. This is referred to as the demonstration point, after which rival states are faced with the choice of whether to attempt to match the first mover in the early adopter stage.[13]

Historically, becoming an early adopter of an emerging major military innovation has largely remained the domain of major powers, with smaller actors relegated to other response options by high adoption barriers. When an emerging military innovation requires a high level of resources or is reliant upon controllable specialist components, it is unlikely to be adopted by smaller states in the short term.[14] Equally, innovations whose successful integration and deployment are reliant on access to specialist knowledge or require major doctrinal changes are also subject to a slower diffusion curve.[15] A good example of this was nuclear weapons, which, while undeniably influential, were not widely adopted by middle power states.

Contrastingly, innovations with lower adoption barriers offer smaller states the opportunity to adopt in the early post-demonstration point period. Incorporating dual-use technology, utilising existing or low-cost components, and relying on readily available skill sets are all factors that would reduce the required resource intensity and organisational capital capacity. The rapid proliferation of cyberwarfare and espionage tools is a clear example of an innovation with low adoption barriers that has been rapidly adopted by smaller states and non-state actors. The disruptive potential of increasingly autonomous systems stems from the fact that they are clearly within this second camp, with lower adoption and deployment barriers than comparable modern major military innovations. The ability for smaller states with less advanced militaries but rapidly growing resource capacity to acquire weapon systems with varying levels of automation or autonomy will have a notable levelling effect on comparative power between neighbours.

Evaluating whether the Australian Army has the capacity to act as a fast follower in the early adopter stage is one of the chief contributions of this monograph. This evaluation is based on the application of five variables, which are derived from an author-expanded version of adoption-capacity theory.[16] The first is Australia's security threat environment: the influence of traditional and non-traditional security threats on the doctrinal and procurement strategies of the ADF. The second variable is resource capacity, which includes military expenditure, the sophistication of Australia's domestic military industrial base, and foreign arms acquisition capacity. The third is organisational capital capacity, which has three sub-variables: critical task focus, level of investment in experimentation, and organisational age.[17] The final two variables are the receptiveness of the domestic audience to TAS and the ability to develop or emulate a specialised operational praxis for their deployment.

Aside from attempting to establish themselves as early adopters, states are considered to have four broad alternative response options, although these are not mutually exclusive. These alternatives include developing a counter-innovation to diminish first-mover advantage, reasserting neutrality, establishing a balancing alliance against the first mover, or *bandwagoning* with the first mover state. Even if adopting an offset strategy would be the most effective option, it does not preclude other government departments pursuing elements of alternative response options. The following analysis will indicate the feasibility of the Australian Army adopting a TAS-based offset strategy, and will provide a benchmark against which other middle power states could be compared.

1.2: The Third Offset Strategy and Autonomous Systems

The currently published literature focuses heavily on the United States Department of Defense's Third Offset Strategy, which has understandably dominated the discourse on offset strategies and autonomous weapon systems (AWS). However, this is not the first time the United States has reflexively implemented an offset strategy in response to the challenge of a rival military. Prior offset strategies capitalised on major military innovations to disrupt and overcome the conventional (first) and nuclear (second) superiority of the Soviet Union.

Contrastingly, the Third Offset Strategy reflects a concern that losing the race to develop and deploy AWS will allow near-peer militaries to subvert and disrupt its conventional military strengths, undermining the power projection that is essential to maintaining United States hegemony. This approach therefore focuses on encouraging the United States military to innovate rapidly, *failing fast* alongside civilian partners in an effort to innovate, adopt and integrate increasingly autonomous military technologies, with an additional emphasis on cyberwarfare.[18]

Although the Third Offset Strategy was less visible in official documents in the first two years of the Trump presidency, the government confirmed its commitment to securing a lead in AI in July 2018.[19] This commitment was reinforced over the subsequent year by its inclusion in the 2019 National Defense Authorization Act,[20] the signing of an Executive Order,[21] and the release of a Department of Defense Artificial Intelligence Strategy. The latter demonstrated a renewed level of recognition of the dangers of failing to adopt increasingly autonomous systems and ceding initiative in related technologies to rival states, and was clearly influenced by the Third Offset Strategy. It primarily points to the benefits of incorporating AI for reducing risks to soldiers, improving resource efficiencies and shifting human personnel to focus on strategic decision-making rather than dirty, dull or dangerous taskings.[22] More controversially this strategy made the claim that incorporating AI would improve implementation of international humanitarian law and reduce civilian casualties, claims that have been strongly questioned by various scholars and non-government organisations (NGOs), such as Noel Sharkey and the Campaign to Stop Killer Robots.

While the focus on the Third Offset Strategy among policymakers, service members and academia is understandable given the impact that it is having on great powers in our region (particularly China), it must also be noted that an effective Australian offset strategy would be significantly different, and too close a comparison to the Third Offset Strategy would be unhelpful for determining how the Australian Army should approach TAS.

1.3: Distinguishing a Middle Power Offset Strategy

Despite the term's frequent association with the Third Offset Strategy, adopting a major military innovation based offset strategy has a clearly distinct purpose for middle power states. As outlined in the introduction, smaller states look to major military innovations as a method for overcoming their comparative conventional weaknesses to project a credible deterrent against larger, wealthier or more traditionally capable neighbours or rivals. A middle power perspective on major military innovations would justifiably focus on generating technological asymmetry as a way to ensure their security, maintain prestige and preserve their relative position in the regional balance of power, rather than attempting to gain hegemonic status. Consequently, an Australian TAS-based offset strategy should focus on maintaining a credible deterrent capability within a flexible force posture that can respond to the myriad traditional and non-traditional challenges that threaten Australia's security and interests.

Arguably the most common label applied to Australia's status and capability on the international stage is that of a *middle power*, clearly smaller than the great powers and hegemonic competitors but still substantially more influential than minor states. Despite appearing in multiple important government reports, international relations textbooks and ADF strategic doctrine, there are no universally agreed positive criteria for proving that Australia is a middle power.[23] Morgenthau proffered a negative definition that encompasses states that do not fall into the categories of great or minor powers.[24] More recently, Jordaan noted five common characteristics among middle power definitions in the literature,[i] while Carr favoured a

i These characteristics were 'considerations of state capacity, position in the world order, the normative composition of the middle-power state–societal complex, domestic class interests, and the role and influence of foreign policy-makers'—Eduard Jordaan, 'The Concept of a Middle Power in International Relations: Distinguishing between Emerging and Traditional Middle Powers', *Politikon: South African Journal of Political Studies* 30(1) (2003): 165–181.

systemic approach that focused on the 'power to effect change' within the international order.[25] For the purposes of this analysis, Australia's capabilities, its influential role in prior international responses to arms proliferation and its ongoing role in the international legal debate surrounding a potential regulatory response to LAWS are sufficient to support categorising Australia as a middle power.

Even from a purely comparative resource-based perspective, it is immediately clear that the adoption capacity of great powers (such as the United States, China or Russia) would be significantly greater than that of even an advanced middle power like Australia. While substantial for a middle power state, particularly in this subregion, Australia's resource scale pales in comparison to what great power states have devoted to pursuing autonomous systems. For example, in 2019 the United States Department of Defense allocated US$9.6 billion to programs related to unmanned and autonomous systems,[26] which was roughly 446.5 times the Australian Government's investment that year in AI.[27] Based on this capacity gap, it is understandable why the literature has previously focused on great power innovators.

Nevertheless, there are three main problems with focusing on great powers in the incubation and post-demonstration point periods at the expense of minimising or dismissing the role of middle power states. The first is that this approach is predicated upon the false assumption that barriers (chiefly acquisitional, technological and operational) would bar regional middle powers from successfully adopting, integrating and deploying increasingly autonomous weapon systems. However, due to the dual-use nature of enabling technologies and lesser reliance on specialised knowledge, autonomous systems appear to have lower entry-level adoption and emulation barriers than prior major military innovations (such as carrier warfare).

The second problem is that this approach neglects the fact that AI, the core hardware component underpinning the disruptive element of LAWS (their autonomy), is an enabling invention rather than a distinct, self-contained platform, conceptually closer to the combustion engine than the aircraft carrier.[28] It is, therefore, limiting to demarcate successful adoption solely in relation to whether a military can successfully integrate and deploy LAWS in a direct combat role. Instead, middle power states can progressively integrate limited autonomous capabilities into their platforms over time as the underlying technologies continue to mature, diffuse and normalise.

In this case, states can purchase complete military off the shelf (MOTS) systems or even capitalise on the growing civilian market to fill operational gaps (both responses have already been seen from Israel and the United States). The argument that Australia would be better served by taking this gradual approach rather than attempting a more traditional adoption response is supported by the rapid but consistent diffusion and proliferation of remote-operated unmanned combat vehicles in the region.[29]

Finally, middle power states operate from a different geopolitical perspective to that of the United States or China and would, therefore, prioritise different capabilities when determining how to respond to a demonstration point. While the core purposes of adopting a major military innovation remain to offset either the strength of a rival or an adopter's weakness, middle power states are more concerned with generating asymmetric capabilities as a way to ensure their security and maintain prestige. Furthermore, unlike their larger cousins, middle power states generally know their likely opponent in future conflicts and do not necessarily need to be able to win in a potential war against a hegemonic great power, merely to deter aggression by raising the costs and risks to an attacker. Therefore, middle power militaries focus their efforts on maintaining a credible deterrent capability within a flexible force posture.[30] In effect, their interpretation of the universal state goal of survival places a priority on preserving their position in the regional balance of power, rather than attempting to secure dominance.

Given that Australia is not a great power, one should not view Army's use of increasingly autonomous systems through the lens of first-mover competition. Therefore, this monograph deliberately adopts a middle power approach to major military innovation adoption. Adjusting the scope of a TAS-based offset strategy to suit a middle power military accounts for the distinct task focus of the Australian Army, as well as centring analysis upon capabilities that meet its specific operational needs rather than those of a hegemonic competitor.

Section Two: Development Toward a Trusted Autonomous Systems Demonstration Point

The Australian Army's capacity to become an early adopter is crucial to the success of an offset strategy, whose effectiveness stems from the exclusivity of access. The success of an offset stems from the asymmetry of capability it generates. It is therefore just as necessary that the Army enter this process with a recognition that maintaining an effective offset will require ongoing critical analysis of this emerging innovation to be continually looking to modify its approach where new forms of TAS can reset their capability edge. Maintaining this awareness will require that senior Army, ADF and Department of Defence leaders understand the capabilities and limitations of the enabling technologies. This section outlines the current state of unmanned military technology and the emerging operational concepts for its utilisation. This section also provides necessary definitional clarity to ground its analysis in the context of emerging technology and an unsettled international framework surrounding the legality of its employment.

2.1: Categorising Autonomous Systems

At its simplest, an AWS is a computer that is analysing data input from multiple conventional sensors to inform its actions without direct human involvement. However, because autonomy is not a binary characteristic, much of the existing literature utilises a categorisation system. The most prolific divides weapon systems into semi-autonomous, supervised autonomous, and fully autonomous, based on the level of human involvement in their Observe, Orient, Decide and Act' (OODA) loop, which is the process by which targets are identified and engaged.

2.1.1: Semi-autonomous Platforms

Beginning with the low end of the spectrum, the first category is semi-autonomous weapons. Also known as 'human in the loop', semi-autonomous weapon platforms are human-activated with a limited capacity to autonomously manoeuvre and/or engage designated categories of targets within geographical limitations.[31] The deployment of this variety of autonomous military technology pre-dates the current debate around LAWS and is functionally similar to some forms of civilian platforms that have been tested in public, such as robotic security guards and certain civilian UAVs.

The Mobile Detection Assessment and Response System—External (MDARS-E) is a prime early example of this category. Initially conceptualised in 1993, the MDARS-E passed US Army technical feasibility testing in 2000.[32] The MDARS-E was able to autonomously patrol within an assigned territory (such as a fenced facility).[33] Upon detecting an intruder, it gave an audible warning to turn back. If the intruder did not leave the guarded area, then the MDARS-E had the capability to engage with its pepper-ball gun while calling for assistance from its human supervisors.[34] It also had the ability to launch an onboard UAV to pursue a fleeing intruder.[35] In 2005 the MDARS-E successfully completed a 12-month operations assessment and early user appraisal at Hawthorne Army Depot Nevada, the largest army munitions depot in the world.[36] The MDARS-E was deployed guarding US nuclear facilities in 2010, and an upgraded version is in development.

2.1.2: Supervised Autonomous Platforms

Supervised AWS (human on the loop) are capable of selecting and attacking targets independent of human command, yet include a mechanism that allows a human supervisor to interrupt or terminate the weapon's engagement process within a limited time frame. This is currently the main category of autonomous military technology that is publicly under development.

The most commonly deployed supervised AWS are defensive, such as Close-In Weapon Systems (CIWS), which in automatic mode passively scan for incoming threats to the host vessel. Upon detection of an incoming threat, the human supervisor is alerted, and the weapon system engages the threat. The Russian Uran-9 unmanned ground combat vehicle, which was deployed to Syria in 2018[37] and the Fleet Class unmanned surface vehicle are both further examples of armed supervised weapon systems.

2.1.3: Fully Autonomous Platforms

Finally, there are fully autonomous (human off the loop) systems, which are capable of true autonomous function once activated by a human operator. The definition of 'autonomous' used in the Australian Army Robotics and Autonomous Systems Strategy is based on the capacity to interpret contextual information, proactively set and modify goals, and learn new ways to accomplish objectives.[38]

This definition veers most closely to the definition put forward by the United Kingdom Ministry of Defence, which refers to fully autonomous systems having the capability to understand 'higher-level intent and direction' and to take individual actions that 'may not be' predictable.[39] This is a higher technical bar than that set by United States Department of Defense Directive 3000.09, which considers a weapon system to be autonomous if it 'can select and engage targets without further intervention by a human operator'.[40] However, these are all arguably more realistic than China's definition of a LAWS, which requires 'an absence of human intervention and control' for the 'entire process of executing a task', no method of termination once activated, and the capability to adapt to changing scenarios, conditions and targets independently.[41]

This debate also extends to the rapidly expanding academic literature, where there have been calls to adopt a function-based approach to defining autonomy in weapon systems. Two examples of this are Crootof, who emphasised the weapon's ability to process information to make independent targeting decisions,[ii] and Horowitz who emphasised the ability to select a target that has not been preselected by an operator.[42] In a subsequent article, Horowitz argued that AI is a disruptive enabler akin to the steam engine or electricity, rather than a distinct innovative platform.[43]

ii '[A] weapon system that, based on conclusions derived from gathered information and preprogrammed constraints, is capable of independently selecting and engaging targets.'—R Crootof quoted in Michael C Horowitz, 'Why Words Matter: The Real World Consequences of Defining Autonomous Weapons Systems', *Temple International and Comparative Law Journal* 30 (2016).

In the absence of an internationally agreed definition, this work utilises the following function-based working definition:

> *A fully autonomous LAWS is a weapon delivery platform that is able to independently analyse its environment and make an active decision whether to fire without human supervision or guidance.*[44]

At the time of writing, there have been no publicly acknowledged deployments of fully autonomous weapon systems that would meet this definition. This is largely due to the ongoing legal and definitional uncertainty, as well as the threat of a pre-emptive development ban. There have, however, been deployments of weapon systems that have the capacity to operate in a fully autonomous mode; the DoDAAM Super aEegis II is an example.[45]

2.2: 'Hardware'—Progress Toward Trusted Autonomous Systems

Given the ongoing discussions surrounding potential regulation under international law, it is unsurprising that militaries have proven unwilling to identify systems as LAWS. Therefore, it is necessary to adopt a function-based approach in order to effectively analyse international progress toward a demonstration point for autonomous systems. There are two particularly relevant approaches to measuring the functional autonomy of a platform. The first is the ability of a platform to *sense*, *decide* and *act* independently of a human operator. The second approach considers the extent to which a weapon system has independent control over its 'critical functions', which are the processes used to 'select (i.e. search for or detect, identify, track, select) and attack (i.e. use force against, neutralize, damage or destroy) targets without human intervention'.[46] Both approaches highlight three key areas of technological development that would directly impact whether a weapon system could be effectively deployed into the battlespace. These are movement in the battlespace; target identification and verification; and engagement and assessment. Measuring development progress in these functional areas provides a useful measure of the maturation of the hardware or invention component of LAWS as a major military innovation.

2.2.1: Movement in the Battlespace

Autonomous movement technology is the most advanced of the three key function areas, which is unsurprising given that most in-development ground-based unmanned platforms are utilising software and sensors that are broadly comparable to civilian driverless vehicle technology. Current unmanned platforms process data from a suite of sensors, GPS or other satellite positional navigation,[47] LIDAR[48] and computer vision technology[49] to build an understanding of the environment around them—a mathematical map—which is updated as the device manoeuvres.

'Follow me' platforms are the simplest version and the most common; the MUTT and Alpha Dog platforms designed for the US Marine Corps are both in this category. These platforms use computer vision and lidar to maintain a connection with a nominated leader and autonomously avoid obstacles.[50] However, this is a very low-level autonomous capability, and such systems are generally unable to identify a new leader if the original has been disabled. Despite its limited potential, 'follow me' movement capability is a convenient, effective way to embed heavy firepower in small combat teams, or ferry additional supplies to troops in combat.

Some platforms instead utilise checkpoint navigation, utilising sensor data and GPS to proceed along pre-designated waypoints autonomously.[51] This is complemented by collision-avoidance software to ensure relatively safe autonomous movement,[52] and some of the more advanced platforms are able to independently alter their pre-planned routes to increase efficiency or avoid potential threats.[53] 'Leader' devices within swarming platforms are generally using a combination of these methods to manoeuvre and avoid obstacles. A powerful indicator of the sophistication of this technology is that effective versions are common in affordable civilian hobby UAVs.[54] This is more difficult for ground vehicles because their environment is more actor dense and subject to unexpected change. Furthermore, the potential for cyber attack or degradation, and the need to operate in denied environments, has driven development away from reliance on GPS or active data links, in favour of onboard sensors, although interpreting sensor data in real time places additional processing and power supply demands on the vehicles.

2.2.2: Target Identification and Verification

When a human operator does not independently verify the targets of an AWS, it places immense importance on the development of sensors, AI and advanced image recognition software. However, vehicular and structural targets have proven easier for AI to be taught to reliably recognise, particularly when the platform can verify identification using their electromagnetic or thermal signatures.[55] Loitering munitions such as the Harpy and the CAPTOR encapsulated torpedo passively scan potential targets within their assigned geographical target area. The weapon then engages after it identifies that a target meets its engagement criteria, based on sensor data and an onboard database. Whether this process is truly autonomous or merely automatic is the subject of ongoing scholarly debate.[56]

Reliably identifying human targets has proven beyond the capabilities of current-generation technology. Computer vision sensors and AI are improving rapidly but have significant drawbacks.[57] Beyond simply counting humans in an engagement area, current AWS are unable to identify individuals. Modern systems can identify a human, largely based on their shape, and basic behaviours (e.g. walking). Yet current-generation technology cannot intuitively leap from observing a behaviour (walking, running, putting their hands up) to an inferred intention (fleeing an enemy) or a deduced conclusion (setting up an ambush).[58] This is particularly limiting when one recognises that this means unmanned platforms cannot understand whether an opponent with their hands up is attempting to surrender or committing perfidy.[59]

Despite its prominence in media accounts, using real-time facial recognition has serious reliability problems outside of sterile laboratory conditions.[60] Certain fractal patterns baffle computer vision, and there are even examples of stickers causing computers to read signs completely incorrectly.[61] Furthermore, current-generation machine learning techniques would require that researchers be given access to classified databases of active targets to train AWS prior to deployment.

It is apparent that technology has not developed to the point where it would be feasible to deploy a weapon system with full autonomy over its target identification and selection process into a ground combat role without accepting a high level of risk to non-combatants and friendly personnel.[62]

This position is supported by the fact that the vast majority of unmanned ground combat vehicles and sentry guns currently under development (publicly) retain human oversight.[63] In the absence of sufficiently advanced sensor and processing technology to allow for consistently reliable target identification in complex combat environments, it is vital that human operators/supervisors exercise meaningful control over the critical functions of autonomous systems.

2.2.3: Engagement and Assessment

Once a weapon system has identified a legitimate target, the next step in the 'kill chain' is to select a method of engagement and persecute the target.[64] This is well within the capacity of modern technology. Recall that a LAWS is an advanced *platform*.[65] Hellfire missiles may have attained infamy in US drone strikes, but they have consistently been used in greater numbers by manned attack helicopters. Most unmanned platforms to date have been equipped with pre-existing munitions, which are generally already in service with other well-tested legacy weapon systems.[66] Indeed, allowing AWS to autonomously engage targets designated by human operators, guided by existing computer vision, audio direction finding and precision radar technology, could offer significant advantages in accuracy, reliability and reaction time over human-led engagements.

There are also clear benefits to deploying autonomous systems in dull, dirty and dangerous situations, such as patrolling sparsely inhabited areas of Australia's northern coastline or the immediate surroundings of a patrol base in counterinsurgency operations. TAS, unlike humans, do not become less effective after sustained periods of inactivity. Assuming a constant supply of energy, and barring an effective cyber attack, TAS are more effective at maintaining a constant defence because they do not suffer from fatigue, distraction or boredom. Furthermore, autonomous systems are, by definition, more expendable than human soldiers and do not have a self-preservation instinct; therefore, they are less likely to over-react to a non-lethal threat and better suited for dangerous or predictable patrolling tasks.

2.3: ‘Software’—Exploring Emerging Operational Concepts

2.3.1: Operational Concepts for Enhancing and Augmenting Existing Force Structure

Arguably the most widespread operational concept in terms of concrete development efforts in state military doctrinal documentation is human-machine teaming (HUM-T), which is also referred to as manned-unmanned teaming (MUM-T). The human-centric nature of HUM-T operational concepts has benefits for military leaders in that they present fewer ethical, legal and technological challenges; however, this comes at the cost of willingly sacrificing the disruptive potential of fully autonomous weapon systems. The adoption of HUM-T operational concepts by every state actor known to be pursuing AWS reflects a broad recognition of the applicability of Garry Kasparov’s observation that:

> *Weak human + machine + better process was superior to a strong computer alone and, more remarkably, superior to a strong human + machine + inferior process … Human strategic guidance combined with the tactical acuity of a computer was overwhelming.*[67]

Although Kasparov was referring to a 2005 chess tournament, it is telling that this quote appears in the UK Development, Concepts and Doctrine Centre’s *Joint Concept Note 1/18: Human-Machine Teaming*.[68] At the heart of HUM-T is the recognition that computers, especially those with an autonomous learning capability, are better than humans at certain activities but inferior at others. These superior capabilities, when paired with humans, mean that HUM-T can be used to achieve operational benefits even with today’s technology.

The *ADF Concept for Command and Control of the Future Force*, released in mid-2019, indicated that the existing joint command planners within the ADF were interested in incorporating AI and autonomous systems into their command and control (C2) infrastructure.[69] Essentially the concept paper separated the *command* and *control* functions, moving to a model whereby control over force elements is not necessarily exercised by the commander. Instead agents (whether AI or human) are delegated control over force element ‘nodes’ (the concept paper uses missile defence units as an example), within the parameters set by the human, who retains command.[70] This is an interesting approach to the concept of HUM-T, one that in essence applies the tenets of mission command (which already underpins C2 in most Western militaries) to composite manned-unmanned teams.

The chief objectives of incorporating AI into the C2 apparatus of commanders are to accelerate their OODA processes and ensure cohesion among an increasingly agile force that must operate at a far higher operational tempo. Modern operational headquarters remain static, vulnerable high-value targets, largely due to the number of support personnel who interpret and coordinate incoming data and communications, effectively acting as intelligent filters between the battlespace and the commander. Militaries, including those of China and the United Kingdom, have begun development of small-scale systems to handle components of this process, but the end goal would be developing a 'virtual assistant' AI program that would analyse incoming intelligence data in real time to provide command staff with prioritised information, ideally speeding up their OODA loop. As AI and autonomous systems proliferate, the battlespace is likely to increasingly feature autonomous and automated decision-making. The success of integrating this kind of AI-enabled assistant for intelligence analysis and decision-making support will depend primarily on the capacity of today's Army to invest in building technical literacy, familiarity and trust among the leaders at all levels who will be asked to collaborate with, or even delegate to, these systems.[71] If carefully curated and supported by this preparatory work, bringing 'Lieutenant Siri' into the headquarters (at the strategic, theatre and operational levels) would be an effective response to the increasing tyranny of scale confronting commanders in a data-rich battlespace.

Another HUM-T concept to consider would pair semi-autonomous platforms with human supervisors for logistics both in and out of combat. Taking their lead from civilian organisations, such as mining companies in Australia,[72] army supply convoys can be converted to drive themselves along pre-planned supply routes. While the US Army's version is currently a 'follow-me' system with a manned lead vehicle, they are developing a system for using convoys of autonomous vehicles that could reliably and autonomously respond to obstacles.[73] These obstacles are not always fallen trees or flooded roads; while it does not receive the same level of Hollywood attention, driving supply convoys is dangerous, especially during unconventional conflicts. Harassing enemy supply lines is a tactic as old as organised warfare and remains effective. Eliminating the need for human drivers lowers the risk of casualties among a military logistics train, as well as reducing the resource costs of supplying troops in remote or difficult to access areas (such as northern Australia or Pacific archipelagos).

From a tactical perspective, autonomous vehicles could be utilised to ferry supplies and ammunition to soldiers in combat, which would reduce the risk to soldiers and the amount of weight they have to carry into combat. For example, the South Korean K10 ammunition resupply vehicle is an automated armoured ammunition carrier for the K9 self-propelled howitzers. Arming these platforms (which is the case for the MUTT and the Russian Uran-9), would also improve the level of firepower available at the squad and platoon level, and could assist in evacuating casualties under fire.

2.3.2: Replace: Operational Concepts for Deploying Trusted Autonomous Systems

Although pairing autonomous technology with human operators appears to have significant advantages, there are cases where militaries would be incentivised to remove the human from the OODA loop. This is simply because operational AWS would outperform their human-supervised equivalents, at a lower economic and political cost, especially in combat operations with a higher tempo than humans can physically maintain. Morris summarises the issue:

> *When robots with OODA loops of nanoseconds start killing humans with OODA loops of milliseconds, there will be no more debate.*[74]

While current technology does not support deploying AWS into unstructured combat environments with sufficient reliability that they consistently defeat human opponents without harming civilians, this has not stopped scholars and military planners from theorising.

A common theory of operation focuses on pairing AWS with manned platforms that provide guidance but, crucially, not active supervision. This would be more effective in high-tempo combat environments where the human partner cannot spare the mental bandwidth to control their robotic support platform or where a control/data link would critically compromise its effectiveness. Under programs like Loyal Wingman,[75] immediately before an engagement human pilots authorise their autonomous wingmen to employ lethal force, allowing the AWS to participate independently in aerial conflict. It was announced in February 2019 that the Royal Australian Air Force (RAAF) would be partnering with Boeing on the development of an unmanned combat aerial vehicle as part of the aerospace firm's Loyal Wingman initiative.[76]

Any serious deployment of trusted autonomous weapons in an unsupervised combat role, especially in the aerial theatre, would need to be able to operate autonomously: the delay from their reliance on a data link to convey instructions, further delayed by human reaction times, would cause them to be easily destroyed by foes that do not rely on relayed instructions. However, given the ADF's understandable reluctance to delegate full command over the use of lethal force to a machine, further military advantage could be attained from installing autonomous robotic pilots in outdated or optionally manned vehicles.[77] Artificially piloted vehicles could be used for force protection or as perimeter defence. Whether the robots would consistently defeat human pilots is debated,[78] but it is irrelevant given the sheer numbers of relatively effective combat vehicles this approach would allow a state to deploy.

This is related to the conception of 'swarming' unmanned systems, which use their AI to interpret a general objective and respond to a changing operational environment. There is value in deploying a self-guiding swarm of cheap unmanned aircraft to disrupt airfield operations, harass or attack combatant units, destroy material targets or provide near-constant surveillance.[79] Even if unmanned vehicles are not intended to be used for lethal force, we have already seen that individual soldiers are willing to adapt ostensibly non-lethal robotics to fulfil combat requirements, even if that entails duct-taping plastic explosive to the front.[80] Multiple actors are developing autonomous 'motherships' that include the capability to refuel UAVs and even 3D print replacements, increasing the endurance of a deployed swarm.

2.3.3: Influence of Tempo and Security Environment on Operational Concepts

The emergence of multiple operational concepts for the deployment of the disruptive technology is not unusual in major military innovations. While the question of whether Australia has the capacity to adopt autonomous systems is addressed in the following section, it is worth noting the influence of perceived future conflict on how militaries evaluate operational concepts. For Australia, this touches on a longstanding dispute in strategic thinking as to what strategic posture the ADF should adopt.

Australia's strategic approach has historically suffered from a 'tyranny of dissonance', its energy divided between the peacetime Maginot Line style of continental defence and a forward-leaning expeditionary posture reflecting the importance of regional stability and the support of a great power ally.[81] The continental 'Defence of Australia' outlook was popularised by Dibb's seminal defence review in 1986. It assumed a significant notice period of an emerging threat to Australia (originally 10 years) and focused on defending the northern air-sea gap. Contrastingly the expeditionary approach envisaged the ADF participating in selected conflicts to support important allies or reassert regional stability.

Even modern ADF strategic doctrine has vacillated between these domains. The 2000 Defence White Paper has a strong focus on continental defence, albeit extended to include Australia's northern 'direct approaches', with a comparatively minor focus on participating in external efforts to maintain global stability.[82] The subsequent participation in the US-led global war on terror led to criticism of the isolationist focus on Australia's strategic conception, which in turn influenced a conceptual shift back toward the expeditionary viewpoint. During this period another shift occurred with the 2016 Defence White Paper, which reflected a renewed interest in modernisation and started the current fascination with how to prepare the ADF to fight in a technology-enabled future war.[83] However, instead of wholeheartedly adopting unmanned platforms as Singapore and China have, and influenced by its split strategic conception, the ADF invested heavily in resource-intensive manned expeditionary warfighting platforms, including the Canberra Class Landing Helicopter Dock,[84] updated diesel Attack Class submarines and the F-35A Joint Strike Fighter.[85] These choices reflect an institutional concern that the ADF prepares primarily to fight in a future high-intensity conflict, most likely as part of a coalition that it is a junior partner in.[86] It would, therefore, be understandable to focus at least the first tranche of a TAS-based offset strategy on developing, procuring and integrating capabilities that complement Army's capacity to contribute to such a conflict.

However, this focus, as well as the underlying long-term division on overarching strategic direction, is diminishing given that the vast majority of operational needs for the future force (from both a single service and a joint perspective) over the coming decade will be lower-intensity conflicts, operations short of war,[87] and stability operations in support of broader soft-power efforts in South and East Asia.[88] Preparing Army for the return of great power competition and increased regional instability should, therefore, be the primary strategic interest that drives engagement with autonomous systems.

Consequently, this monograph suggests that the ADF's approach to TAS should be guided by which approach would best leverage this innovation to improve Army's capacity to operate in a dispersed, difficult to target and networked manner and to protect its forces in a wide range of operational environments. While it is important that the ADF retain the capacity to contribute to a high-intensity or urban conflict, alone or in coalition, the initial stage of an offset strategy should focus on generating and maintaining an effective asymmetry that allows the ADF to effectively protect Australia's interests in the context of a destabilised and increasingly competitive region.[89]

2.4: Identifying Required Capacity to Adopt Increasingly Autonomous Systems

Prior to evaluating Australia's adoption capacity, it is necessary to identify the level of resource intensity and organisational capital capacity required for successful adoption. Part of the challenge in determining this requirement in the case of AWS is that a demonstration point has not yet occurred, which makes it difficult to completely eliminate uncertainty as to the final parameters of this innovation.[90]

The increasing disparity between the resources required to procure and deploy advanced manned platforms and unmanned systems is one of the most commonly cited arguments in favour of AWS. Consider the often-quoted 'Augustine's Laws'[iii] in light of the continued increases, both in real terms and as a percentage of military spending, of modern manned platforms.[91] For example, the ADF allocated 27.5 per cent of its total capital expenditure in 2018–19 to that year's contribution to the Joint Strike Fighter program.[92] Traditionally proponents have defended these cost increases with the argument that their superior combat, first-strike and

iii 'In the year 2054, the entire defense budget will purchase just one aircraft. This aircraft will have to be shared by the Air Force and Navy 3 1/2 days each per week, except for leap year, when it will be made available to the Marine Corps for the extra day.'—James Fallows, 'Uncle Sam Buys an Airplane', *The Atlantic*, June 2002, at https://www.theatlantic.com/magazine/archive/2002/06/uncle-sam-buys-an-airplane/302509/

survivability capabilities offset the corresponding loss of mass and scale. However, as the pace of technology diffusion quickens, it will become more difficult to maintain an increasingly transient capability edge.

This incentivises militaries to invest in increasingly autonomous, AI-enabled unmanned platforms, which have a lower resource requirement. Without human operators, these platforms do not need the same sophisticated stealth or survivability features, which would reduce the procurement and ongoing operation costs for secondary adopters. Further, unmanned platforms concentrate manpower requirements for militaries that are struggling with recruitment, shifting human soldiers away from routine, dangerous or politically sensitive roles.

Additionally, the enabling technologies for LAWS are largely dual-use in nature and have attracted significant civilian interest, investment and research, the results of which could be transferred to military platforms. Focusing here on the most important enabling technology, AI,[iv] it is apparent that there would be significant overlap between the software used to enable civilian innovation and military application—for example, the AI that allows a UAV to interpret lidar data to search a building independently for survivors following an earthquake could be used to search a building for hostile forces or civilians. There are two important caveats, though. The first is that current machine learning techniques require large and task-specific datasets to 'train' a program. For example, an encapsulated torpedo would have to be programmed with the data of potential enemy vessels prior to a conflict beginning. There is no guarantee that firms (even in the defence industry) would be able to secure this data in sufficient quantities or at the requisite specificity. The second caveat is that military platforms would require a significantly higher level of durability and 'hardening' against electronic warfare than is required in civilian platforms, in order to survive in the modern battlespace. Overall, since the cost per unit is intentionally designed to be lower and there is a greater potential for smaller states to substitute dual-use civilian technologies, the resource capacity required for a secondary adopter to pursue AWS is hypothesised to be low, although it would be medium-high for initial developers.

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iv AI is a broad term. This monograph utilises Horowitz's definition, which describes artificial intelligence as 'the use of computing power, in the form of algorithms, to conduct tasks that previously required human intelligence' (Michael C Horowitz, 'When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability', *Journal of Strategic Studies* 42(6) (2019)).

Horowitz identifies three variables for measuring organisational capital capacity: critical task focus, level of investment in experimentation, and organisational age.[93] The rapid diffusion of remote-operated unmanned vehicles in South-East Asia demonstrated that for secondary adopters the organisational capital requirement is significantly lower for the limited adoption of unmanned platforms than, for example, for carrier or battlefleet warfare.[94] However, when we consider the wide proliferation of drones compared to the limited number of states that have used them in lethal strikes, it becomes clearer that the technology has diffused faster than a supporting normative framework.

Consider the United States military's experience with armed, remotely piloted drones.[95] Firstly, their experience of struggling to build capability literacy and trust in unmanned platforms among soldiers and airmen demonstrated the importance of an adopter possessing sufficient internal capacity to conduct effective training and build trust among end users. It also highlighted how entrenched personnel categories could resist adoption. In this case, traditional pilots were dismissive of drone operators and would rarely volunteer to fly unmanned aircraft, which was viewed as a career dead end.[96] As a result, the US Air Force struggled to fill its drone operator requirements.[97] Singapore's experience demonstrates the importance of a relevant critical task focus. Rather than resource constraints or technological barriers, Singapore's decision not to attempt to procure long-range lethal UAVs appears to have been primarily influenced by the state's concern about antagonising their neighbours and the recognition that the core purpose of the Singapore Armed Forces did not require investment in developing or procuring the capability to launch lethal drone strikes outside their immediate region.[98] Overall, therefore, it is hypothesised that the organisational capital capacity required to emulate elements of a first mover's use of LAWS will be low, but independently innovating in the operational use of LAWS will require a significantly higher level of organisational capital capacity.

Section Three: Evaluating Australia's Adoption Capacity

> *'Our imperative, as a small Army defending a large country with national interests spanning the globe, is to combine superior warfighting concepts, with optimal force structure with the best technology we can afford.'*[99]

The ADF has traditionally aimed to leverage its advanced industry, economic clout and superior training and doctrine to present credible regional deterrence while maintaining the capacity to operate effectively alongside coalition partners in higher-intensity conflicts. An ageing and declining population is imposing additional pressure on the ADF's capacity to recruit and retain sufficient personnel from a population which is already small relative to its neighbours, whose military modernisation efforts, driven by increasing defence spending, are challenging Australia's ability to maintain its capability edge.

While becoming a regionally significant fast-following adopter of unmanned platforms, and autonomous military technology more generally, appears to offer an opportunity to reassert the prior balance of capability, the broader international community remains focused on the role of great powers in its discussion of AWS. There is some merit to this position, as the innovation base and available resources of the United States or China dwarf those of Australia, and the success of an offset strategy turns on the capacity of a state to maintain a comparative capability edge in its use. The implication of this position is that great powers will inevitably become the defining developers of this innovation while smaller states will largely be late secondary adopters merely emulating the larger first movers, which has been the case with prior major military innovations.

The reality, however, is more nuanced in the case of increasingly autonomous systems. This section will demonstrate that Australia possesses the requisite capacity to engage in a limited rapid adoption of autonomous systems to enhance and augment the core elements of a future force that is able to respond to the Australian security environment.

3.1: Security Environment

The Australian security environment is reflected in the strategic objectives outlined in the 2016 Defence White Paper (which should be read in conjunction with the 2017 Foreign Policy White Paper), which are to deter and defend Australia and its national interests, contribute to the broader regional security of our region, and support the broader rules-based liberal global order.[100, 101] Within a ‘more contested and competitive world’[102] the ADF must achieve these objectives within geographical, strategic and resource constraints.[103] As with any major military procurement, Australia’s security environment will influence how policymakers integrate a TAS-based offset strategy into the future force.

Australia’s defence posture has always reflected the geographical reality that traditional military threat is likely to come from its northern approaches. Whether this threat stems from or through a South-East Asian state, it remains crucial to maintain strong bilateral relationships with our neighbours, backed by a strong deterrent capability. The ADF currently maintains a significant capability advantage over its fellow regional middle powers in traditional military terms, which has been reinforced by major recent acquisitions (such as the F-35 Joint Strike Fighter and the Canberra Class Landing Helicopter Dock).[104] The ADF also has regionally superior training, organisation and operational doctrine, backed by a comparatively strong C4ISR[v] capability.[105] The importance of maintaining this significant capability edge is clearly illustrated by the fact that Indonesia, whose army is roughly 10 times the size of the Australian Army,[106] increased its defence spending by 122 per cent between 2008 and 2017.[107]

The Australian Army has recognised that maintaining the capability gap will increasingly rely on the Army being able to ‘outpace, out-manoeuvre and out-think’ threats and rivals,[108] rather than its capacity to outspend

v Command, control, communications, computers, intelligence, surveillance and reconnaissance.

them. Increasingly, autonomous technologies would be a valuable addition to the future force, capitalising on their disruptive potential to continually enhance and augment the survivability, lethality and utility of small, agile warfighting units.[109] The threat of intra-regional conflict or instability would also influence an offset strategy—for example, there would be significant value in incorporating low-cost, low-footprint aerial platforms to expand the awareness of small teams in the battlespace, while network-hardened unmanned ground vehicles (UGVs) would offer direct fire support and assist casualty removal in difficult operating environments. Finally, TAS would need thorough in-country testing and ruggedisation to ensure that they are able to reliably and safely operate in the hostile environment of Australia's northern interior without reliable connectivity or direct human oversight.

Furthermore, Australia's ability to influence its neighbours through the application of soft power is closely linked to its legitimacy as a supportive regional partner. The Australian Army conducts more than 200 collaborative multilateral and bilateral defence activities each year, with a strong emphasis on the Indo-Pacific.[110] In addition to regular training exercises and officer exchanges, the ADF provides specific training, support and platforms to its neighbours in order to build interoperability and mutual trust. In 2018 the Australian Army contributed to the training of over 7,500 allied soldiers in their own countries, while more than 300 foreign military students were educated through Australian defence establishments.[111] Army also contributes to Australia's soft-power generation through active participation in peacekeeping missions and responding to humanitarian crises and natural disasters in the region.

These avenues of soft-power influence throughout the region should be leveraged by the ADF to promote norm diffusion around autonomous systems. In the absence of international legal principles, Army's wide and varied engagements with regional neighbours represent an important avenue for influencing the way autonomous weapons are perceived and used in the region. This can be a powerful tool for limiting the potential for more sophisticated second or third generation autonomous or unmanned weapon platforms being used unethically, against civilian targets, or by violent non-state actors in the region. Given the importance of stable sea lines of communication to Australia's economy, autonomous systems give Army an opportunity to participate meaningfully in developing the attitudes of regional military decision-makers to what is, and what is not, an appropriate use of these capabilities. It will be far more difficult to export Australia's perception of the safe, legal and moral use of autonomous weapons after they begin to proliferate; the ADF must therefore act in advance of the demonstration point.

Autonomous systems could also be incorporated into Army's role in providing surveillance and security of Australia's northern approaches. AI and pattern recognition make autonomous systems offer a more resource-efficient method for active surveillance of multiple targets, while unmanned surface and underwater vehicles offer a significantly cheaper surveillance method for Australia's maritime border regions than the current approach, which relies on patrols by Royal Australian Navy (RAN) frigates and P-8 Poseidon aircraft. From a purely Army perspective, equipping regional force surveillance units with autonomous systems, while currently underexplored in the literature and doctrine, would improve their capacity to provide surveillance. It is also worth noting that, in the event of a high-intensity conflict in Australia's north, autonomous systems would prove invaluable for the small, irregular regional force surveillance units tasked with stay-behind warfare. Examples of how TAS could contribute in this scenario are enabling unmanned supply convoys (potentially via air), emplacing AI-managed and restocked caches across the Top End, providing heavier firepower to the light-vehicle-based units, and enabling high-resilience C2 capability even across distributed forces.

Finally, Army should consider developing autonomous systems as part of a revived, Army-focused version of the Coastwatcher program. By integrating supervised and fully autonomous platforms, as well as an AI-enabled intelligence support system, a single service member could reliably and efficiently provide ongoing surveillance of a wide stretch of Australia's northern approaches. Effectively laid out and supported by well-trained observers, such a system could provide the ADF with a valuable, dispersed and resilient intelligence net for monitoring enemy movements during high-intensity warfighting. This program could also be used to support Australia's non-military interests in the region, such as supporting human, arms and drug trafficking interdiction efforts; protecting merchant shipping; and coordinating regional humanitarian responses.

Australia's security environment indicates that it would be unnecessary for the ADF to emulate the United States in pursuing AWS that are aimed at deterring a near-peer great power or fighting in a high-intensity conflict. Of more value are smaller-scale platforms and systems that improve the individual lethality and survivability of Australian Army units, enable greater scalable effects from small combat teams, or cripple the foe's capacity to concentrate force in the battlespace.

3.2: Resource Capacity

The Australian Army is well regarded as one of the most capable in the region, particularly at the small-unit level, and possesses regionally superior intelligence, surveillance and reconnaissance (ISR) capabilities.[112] However, this is not certain to continue in the context of both an increasingly assertive hegemonic challenger and a broader regional military modernisation which threatens Australia's ability to maintain a meaningful capability edge. Fortunately Australia's capacity to build, borrow or buy increasingly autonomous systems is substantially higher than that of its South-East Asian neighbours.[113]

Reflecting Australia's status as a wealthy and advanced middle power, the Australian Government allocated AU$35.5 billion in defence-related spending in its 2019 budget. While still dwarfed by that of China or the United States, Australia's defence expenditure is a comparative outlier among our South-East Asian neighbours. Singapore's defence budget in 2017 was SG$14.8 billion (US$11 billion), the highest among ASEAN member states.[114] In the same year, Indonesia's defence spending reached 108 trillion Indonesian rupiah (US$7.32 billion).[115] From a broader East Asian perspective, the ADF is funded more closely in line with the Republic of Korea (US$39.2 billion) or Japan (US$47.3 billion). Concerningly, available data suggests that ongoing economic growth in South-East Asia, matched by similarly dramatic rises in average defence spending among ASEAN states, means that Australia's spending advantage relative to other actors in the Indo-Pacific will continue to narrow. While the government has confidently stated that defence spending will surpass 2 per cent of GDP by 2021, a recent Australian Strategic Policy Institute (ASPI) report suggests that a gap will soon develop where defence spending rises above 2 per cent of GDP as a result of less than predicted growth in the broader economy.[116]

This surge in resource commitment has been largely channelled toward modernising the capability of the ADF through targeted capital acquisition. The most relevant of these modernisation commitments to this work were significant investments in defence innovation and in research and development (R&D), and the commitment of AU$730 million to 'targeted next-generation technologies' over the decade to 2025–26.[117] Based on the 2018–19 defence budget, the ADF plans to commit AU$11.77 billion to capital acquisitions. Most of this allocation is earmarked for the procurement of new equipment, which accounts for 33.12 per cent of total defence expenditure. At roughly equal to the allocation for personnel costs (34 per cent), the ADF is committing a significantly greater proportion of its expenditure to modernisation and platform acquisition than the average among MIKTA[vi] states.

However, the introduction of this levelling innovation raises the question of whether the western preference for low numbers of increasingly capable advanced platforms is still the most effective use of limited defence dollars. While limiting the human cost of participation in conflict, the cost of acquiring, operating and sustaining major manned platforms has ballooned. In light of this, consider the growing risk that regional actors will gain the ability to counter exquisite manned platforms with modified cheap civilian-model unmanned aircraft. For example, a non-state actor could modify DJI Phantom IV drones to drop hand grenades on soft-skinned vehicles or dismounted troops, or set a swarm of civilian drones with follow-me or basic object recognition capabilities (which are both present on some commercially available models) to interdict military aircraft attempting to take off or land in the battlespace. The Chief of Army's 2019 Strategic Guidance reflects on this risk and states that the Army needs to adopt unmanned platforms in order to build its resistance against this levelling effect.[118]

Overall, therefore, Australia has superior financial resource capacity to that of its regional neighbours and has demonstrated the capacity to purchase advanced foreign systems and platforms that middle powers would not otherwise have access to. However, these resources must be paired with a local defence industry with the capability to meaningfully participate in the development of increasingly autonomous systems for Australia to develop the sovereign capability and high-level input necessary to ensure stable access.

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vi MIKTA is a group of middle powers that share similar-sized economies. The members are Mexico, Indonesia, Republic of Korea, Turkey and Australia.

3.2.1: Domestic Military Industrial Base

The Australian Government has invested a significant percentage of its additional defence spending since 2016 into 'resetting the Defence-industry partnership'.[119] Underpinning this reset was the allocation of approximately AU$195 billion for the development of the future force over the 10 years to 2025–26,[120] divided across six streams including strike and combat air, land combat and amphibious warfare, and operational support and sustainment.[121] Senior military leaders, including the Chief of Army, have subsequently spoken of an intent to work with industry and academia in pursuit of the ADF's capability goals, and defence firms have notably participated in recent multilateral exercises and conferences, including Land Forces 2018 and Autonomous Warrior 2018 (both hosted in Australia), as well as the earlier Unmanned Warrior 2016 (hosted in the United Kingdom).

Though Australia's defence industry is advanced by regional standards, it is notably smaller and has less capacity than comparable advanced states. This is partially due to its structure: the industry is dominated by a small number of large 'prime' firms, while the vast majority of actors are small-to-medium enterprises (SMEs) that carve out a niche production capability, usually within the supply chain of larger firms. For example, while ASC Pty Ltd holds the contract for sustaining the Collins Class submarine, it is supported by a series of SMEs, which produce the flow serve hull valves (Veem), main storage batteries (PMB Defence), components for the diesel engine and periscope assemblies (Levett Engineering).[122] In contrast to the entrenched practice of many of our regional neighbours, Australia's defence industry is heavily globalised,[123] with 27 of the top 40 defence companies[124] either under direct foreign ownership or operating as local subsidiaries of foreign arms firms.[125] This creates both an increased level of path dependency (which is detrimental to pursuing platform innovation) and a greater risk of supply disruption that is outside the ability of government to prevent. Furthermore, this market structure arguably stunts the potential for domestic military industrial expansion by relegating domestic firms to subcontracting elements of projects under the direction of the 'prime' firms.

The Australian Army has worked directly with several 'prime' organisations, including Thales and Boeing, in the post-2016 effort to modernise its ageing major land platforms. Thales Australia has primary responsibility for manufacturing Army's small arms at Lithgow Arms, which it plans to modernise.[126] It also manufactures the Bushmaster medium protected mobility vehicle (PMV) and the lighter Hawkei,[127] which have been adopted by Army and performed well on the export market.[128] Other examples are Army's partnerships with Boeing to upgrade its battlespace communications, and with Harris Communications Australia to upgrade its battlefield command system.[129]

There are also directly relevant SMEs that could contribute to a TAS offset, including Sentient Vision Systems, which specialises in automated video analysis and object detection software,[130] and AOS Group, which is developing the Kelpie UGV in partnership with the RAAF's Plan Jericho. Another is Electro Optic Systems (EOS), which partnered with Army to deploy its remote weapon systems on the Bushmaster PMV and has secured over AU$700 million in export contracts. EOS also recently announced a partnership with the European firm Milrem Robotics whereby its weapon system and optics would be mounted on the THeMIS UGV for export.

While it may be more economically viable, this market structure reinforces an institutional path dependency that lowers the organisational agility of the ADF. Subsidiary firms manufacture under licence from their parent firms, with limited long-term technological spillover even when they contract smaller Australian firms to conduct aspects of production or maintenance.[131] Unlike Indonesia, Australia does not legislatively require defence technology transfer; rather, the 2016 Defence Industry Policy Statement only intends to 'facilitate transfer of technology and access to appropriate intellectual property rights', placing equal importance on requiring tenderers to locate production within Australia to create economic growth.[132] This places a structural limitation on the long-term capacity of Australia's domestic (non-subsidiary) firms to produce advanced warfighting platforms without the support of our allies. This reliance on foreign-owned intellectual property also makes the acquisition of major new platforms brittle and vulnerable to delay even in peacetime, as demonstrated by the Hawkei's delay in 2019, which was due to a foreign subcontractor (Steyr) of the subsidiary prime contractor (Thales) going into receivership while under the management of a Chinese holding company.[133]

Despite its resource commitment, the Australian military industrial base only has a limited indigenous capacity to support the adoption of TAS without relying on support from allied state and external industry actors. While developing a globally competitive defence production capability can give a middle power state a greater level of self-sufficiency, subsidise the resource cost of investing in pursuing military innovations for private defence firms and improve the state's influence over its neighbouring customers, Australia needs to prioritise the development of a greater, yet specifically targeted, sovereign domestic capacity in order to capitalise on the benefits of AWS fully.[134]

Indeed, shifting to focus industry capacity on emerging niche capabilities is among the benefits of adopting an offset strategy for a state like Australia, whose defence industry is reliant on external support and structurally path dependent. By definition the adopter is attempting to develop a disruptive, asymmetric advantage that will offset the conventional superiority of a rival without investing in an attempt to overcome the rival's dominant lead in traditional warfighting platforms. As with civilian disruptive innovation, the pursuit of AWS offers the Australian defence industry and ADF the opportunity to reset its focus, sidestep future path dependency and establish an international niche that can support a domestically superior capacity in an aspect of autonomous systems that will be easier to maintain against potential rivals and more attractive for technology exchange with allies for access to other components. Therefore, it is vital that the government ensure that industry expansion prioritises the capability goals identified by the Army, rather than simply focusing on the domestic economic benefits of increasing global export market share.

3.2.2: Foreign Arms Acquisition

The ADF would not, however, rely solely on the domestic arms industry to provide the initial platforms within a TAS offset strategy. Rather, as per the norm for major capability procurement, the ADF would primarily aim to purchase military off the shelf (MOTS) systems, potentially supplemented by subsystems from commercial providers, which would then need to be modified domestically to better suit their specific operational requirements. While this approach would allow the ADF to leverage its existing civilian and military trade relationships to lower its initial adoption expenses, it would reinforce the ADF's reliance on other states for access to increasingly autonomous systems, at least in the short to medium term, which presents its own suite of reliability, security and procurement stability concerns.

Historically, the ADF has imported the majority of its major capability-enabling equipment and platforms. Between 2012 and 2018 the ADF consistently spent roughly 66 per cent of its acquisition dollars overseas.[135]

This reflects the fact that Australia is a prolific importer of weapon systems, accounting for 4.6 per cent of global arms purchases in the 2014 to 2018 period, ranking it as the fourth-largest global arms importer and the second-largest purchaser of arms from the United States.[136] It is therefore unsurprising that US arms have comprised the majority of recent major capability procurements, although this is skewed by outlying expenditures on the F-35 Joint Strike Fighter and Poseidon anti-submarine aircraft.[137] The ADF is also working with foreign providers to procure more limited (and less resource intensive) capabilities—for example, the Army is considering a limited procurement of computer-aided sights for small arms, developed by the Israeli firm Smart Shooter.[138]

LAND 400 Phase 3 offers an illustration of a current major armament modernisation effort. All four companies that have announced bids to replace the M113 armoured personnel carrier (APC), which has been in Army service for over 50 years,[139] are based overseas. Two are European (Rheinmetall and BAE Systems), one is American (General Dynamics) and one is from the Republic of Korea (Hanwha Group).[140] Compare this to the Hunter armoured fighting vehicle (AFV) (previously referred to as the next-generation armoured fighting vehicle), which Singapore recently announced as the replacement platform for its stock of M113 APCs. While the Hunter incorporates optics and a remote weapon system procured from Israeli firms, the main platform was designed and manufactured domestically by ST Engineering Land Systems and the Defence Science and Technology Agency.[vii] Contrastingly, the Australian Army is essentially purchasing its AFV military off the shelf, albeit with a domestic manufacturing component, a minor level of (essentially temporary) technology transfer, and the assumption that future modifications to suit operational requirements will be completed locally.[viii]

However, this example also illustrates Australia's key advantage over its regional neighbours. All of these firms have previously worked with the ADF and have an active physical presence within Australia. Having domestically situated subsidiaries provides a greater level of Australian access to the

vii Singapore's Defence Science and Technology Agency is roughly comparable to the Australian Defence Technology Group.

viii This is particularly perplexing given that there has been some public evidence that Army is interested in an autonomous protected ground vehicle, including a public demonstration by two modified M113 AS4s that were reportedly conducting fire and manoeuvre demonstrations 'autonomously' (Brian Hartigan, 'Army Tests Autonomous Legged Robot', *Contact Air Land and Sea*, 4 November 2019, at https://www.contactairlandandsea.com/2019/11/04/army-tests-autonomous-legged-robot/).

intellectual property and capabilities of their large transnational parent companies. This is particularly important to this analysis because these firms manufacture advanced unmanned platforms and are actively developing increasingly autonomous systems. For example, Hanwha Land Systems and Rheinmetall build armed UGVs and unmanned weapon stations of varying levels of human control, while BAE Systems and General Dynamics are leading developers of increasingly autonomous combat aircraft. Leveraging these institutional connections could potentially allow Australia, which is one of the few US allies to have been granted approval to import Category 1 UAVs, to access organisational knowledge and intellectual property that would be beyond the reach of its purely domestic firms.

Recommendation

Explore potential avenues for joint investment into autonomous systems, artificial intelligence and remote-operated platforms with friendly states and civilian firms.

3.3: Organisational Capital Capacity

'We cannot rest on the promise that offset technology such as artificial intelligence or autonomous systems will alone deliver decisive advantage. The true potential of these systems will only be unlocked by fully integrating them into operating concepts and force design.'[141]

In isolation, merely possessing adequate resource capacity to build, buy or borrow a disruptive military technology has historically proven insufficient for a state to adopt an emerging major military innovation successfully. Therefore, it is important to evaluate whether the Australian Army has the organisational capital capacity to integrate increasingly autonomous systems into its operational structures.[ix] Drawing on the seminal work of Christensen, Horowitz describes three tests for measuring a state's organisational capital capacity: critical task focus, level of investment in experimentation, and organisational age.[142] While the lower resource requirement of AWS

ix Organisational capital capacity is a measure of the 'intangible change assets needed by organisations to transform in the face of major military innovations' (Michael C Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton: Princeton University Press, 2010)).

makes it possible for middle and smaller states to acquire the underlying enabling technology and even complete unmanned platforms, the adopter must pair these with sufficient organisational flexibility to effectively integrate the innovative technology into a force structure that capitalises on the disruptive potential of the innovation.

3.3.1: Critical Task Focus

The critical task focus of an organisation is the extent to which its identity is bound to a particular mission or goal, which in turn increases its organisational resistance to innovative technologies or operational concepts that challenge the orthodox 'way of doing things'.[143] While a strong critical task focus can be, and often is, damaging to the ability of the military to identify and adopt a revolutionary innovation, it could also focus the military on a given innovation, as is currently occurring with the Singapore Armed Forces. The most common example, which Horowitz references, is that the 'rifleman first, speciality second' mentality of the US Marine Corps made it far less resistant to adapting to a counterinsurgency campaign than the US Army, which since the Vietnam War had prioritised lethality as the measure of success and let that pursuit guide its strategy.[144] Identifying the Australian Army's critical task focus and determining how it would shape the adoption of TAS requires analysis of internally focused operational concept and doctrinal documentation.[145]

The ADF's approach to increasingly autonomous systems and unmanned platforms across all three domains displays a level of incongruity. While recent strategic documentation stresses the importance of improving autonomous capabilities, this has not had a comparable influence on major procurements. In a 2017 speech, the Head of Land Capability for the Australian Army stated that modernisation would prioritise command, control and communications; armoured fighting vehicles; and soldier combat systems.[146] The goal was to rapidly generate a *connected*, *protected* and *empowered* force, which the Chief of Army later referred to as an 'Army in Motion' that is 'ready now and future ready'.[147]

The 2018 Accelerated Warfare Futures Statement incorporated a recognition that the pace of warfare was likely to increase and its character to shift, and that Army needed to develop further its capacity to innovate quickly in order to maintain its capability edge in an increasingly rapidly evolving and congested operating environment.[148] Interestingly, while sufficient methodological detail was not publicly released, the response appears to be built on a similar style of diffusion analysis. In turn, the accelerated warfare concept featured heavily in the Chief of Army's 2019 Strategic Guidance.[149]

In this document, the Chief of Army referred to the need to generate the ability to 'scale' while remaining an agile force across traditional domains, in order to rapidly shift in response to rival innovation or a change to Army's role within the joint ADF. What is most interesting about the Strategic Guidance document is that it explicitly recognises the fallacy of continuing to invest significant resources in expensive manned platforms given the levelling effect of unmanned platforms[x] and indicates that Army would adopt increasingly autonomous unmanned systems, albeit with the caveat that war will always remain a 'human endeavour'.[150] The Chief of Army's Strategic Guidance would indicate that Army is moving toward a future force that prioritises credible deterrence and recognises the need to operate in a persistent manner within constrained conditions.

These statements build on the Australian Army Robotic and Autonomous Systems Strategy (RAS), which outlines Army's approach to increasingly autonomous systems and recognises the ethical risks involved.[151] The RAS further outlines the Army's intention to capitalise on increasingly autonomous systems to enhance and augment the capacity of combat units, alongside more traditional remote-operated platforms. The RAS is quite clear that Army would not want to deploy a fully autonomous LAWS, and provides an implementation plan and potential targeted capacity points. These capacity points are critically evaluated in the following section. Together with the establishment of a Robotic and Autonomous Systems Implementation Coordination Office in March 2020, these documents are a promising sign that Army leadership would support adopting limited autonomous systems and low-cost unmanned platforms, primarily into capability areas where the ADF would benefit from an increased deterrence value.

However, despite this promising rhetoric there is a clear disconnect between the statements of senior defence leaders and the actual allocation of modernisation funds in recent tender rounds. Recall that Army is currently in

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x 'Swarming low-cost technologies are increasing the vulnerability of major military systems. Using distributed systems that are smarter and smaller will be essential to survive. Army is an agile force and will adopt these systems quickly to increase resiliency and capacity for offensive action. We must be bold, think differently, and evolve our tactics, techniques and procedures.'— Rick Burr, 'Army in Motion: Chief of Army's Strategic Guidance 2019' (Canberra: Australian Army, 2019) the middle of an AU$20 billion modernisation cycle to replace its inventory of armoured vehicles by 2026. Yet there is no public evidence that Army has required that bidders include any significant autonomous functionality. For example, in the ongoing LAND 400 Phase 3 to replace the M113 AS4 APC, bidders were only required to include remote-operated turrets, despite Army publicly demonstrating optionally crewed testbed versions of the APC they are supposed to replace. As a result, none of the remaining bidders have comparable capabilities to—returning to a prior example—Singapore's Hunter AFV, which fulfils a similar battlefield role. The Hunter includes a digitised command and control module that governs critical functions[152] and, according to industry analysis, can operate autonomously in a 'loyal wingman' role.[153] The fact that autonomous capabilities were not required in either procurement phase of LAND 400, a significant and long-term modernisation effort, is indicative of the disconnect between the commitment expressed in strategic documentation and the reality of the ADF's modernisation effort since 2016.

Recommendation

Formally prioritise autonomous capabilities as an evaluation criterion for future weapon procurement processes.

3.3.2: Level of Investment in Experimentation

The extent to which the ADF has invested in its capacity to experiment and innovate contributes three elements to this analysis. Firstly, it illustrates the level of resourcing available for pursuing this emerging innovation through the comparative lens of other regional actors. This will, in turn, identify whether Army's pursuit of increasingly autonomous systems within an accelerated warfare paradigm is reflected in the prioritisation of related technologies and operational concepts by Australia's national security innovation base. Finally, it is indicative of the broader ADF culture of rapid operational and doctrinal innovation.

Australia has maintained a consistent level of research and development funding commensurate with its status as a middle power that relies on a capability edge yet benefits from the research efforts of allied states. Industry estimates place average R&D spending at between 3 per cent and 4 per cent of the annual defence budget,[154] which roughly translates to AU$1.07 billion to AU$1.42 billion based on 2019 expenditure. As a percentage of total defence spending, Australia is on par with Singapore, and it is likely that military research spending will rise in real terms along with the broader defence budget.

In addition to the R&D funding outlined in annual defence budgets, additional funding was set out in the 2016 Integrated Investment Plan and the 2018 Defence Industrial Capability Plan for projects that build future force capacity. At the broad level, the Integrated Investment Plan allocated around AU$195 billion over the decade to 2026 to 'fund investment in support of the future force'[155] and mandated that 9 per cent of defence funding be set aside for generating new ISR, electronic warfare, space and cyber capabilities for the ADF.[156] Further reflecting the ADF's current focus on developing next-generation capabilities, an additional AU$730 million was allocated over the same period for 'research on next-generation technologies with the potential to deliver game-changing capabilities critical to defence and national security'[157]—in other words, innovations around which the ADF could generate a new offset.

This investment is traditionally coordinated through the Defence Science and Technology Group (DST Group), which is Australia's premier defence research agency. In addition to conducting its own research and providing expert advice to civilian and military planners to future proof, acquisition and platform sustainment, it plays a role in coordinating research partnerships with industry, military and academic partners. DST Group operates with substantial funding, receiving AU$472 million in the 2017–18 defence budget[158] and AU$476 million in 2018–19.[159] Almost all of DST Group's key research areas would impact the adoption of TAS, including the 'autonomous systems', 'weapon systems' and 'operations analysis' streams. DST Group also supports the Defence Cooperative Research Centres program, which aims to improve collaboration between defence, industry and researchers toward militarily significant innovations. The Trusted Autonomous Systems Defence Cooperative Research Centre was established under this program and works closely with DST Group staff.

Civilian research organisations (including universities and relevant corporations) are also active participants in Australian military R&D efforts and have a successful track record of partnering with (or receiving research funding from) defence firms, particularly following the release of the Integrated Investment Plan. An important facilitator of this participation is the Defence Science Institute, run jointly by the University of Melbourne, DST Group and the Victorian Government, which promotes research collaboration among Victorian universities and defence firms through grants and events. Australian examples of university-led research partnerships related to autonomous systems include the Values in Defence and Security Technology group (UNSW);[xi] ICT, Robotics and Reliable Systems (Torch Innovation Precinct, UNSW); and the Cyber-Physical and Autonomous Systems Group (RMIT University). Finally, the ADF has demonstrated a willingness and capacity to partner directly with defence firms for research projects. For example, the ADF recently announced a partnership with Boeing to produce a test vehicle for the Loyal Wingman program,[160] and industry innovation partnerships feature heavily in the RAAF's Plan Jericho, albeit with DST Group support. For Army to succeed in developing the capacity and flexibility to continuously innovate in this space, which will be required for a dual-use derived innovation, military research and development funding requires a greater emphasis on AI and other AWS-enabling technologies as part of a shift in critical task focus toward integrating increasingly autonomous systems.

3.3.3: Organisational Age

The final sub-element in Australia's organisational capital capacity is to determine its organisational age. As organisations age and expand, additional layers of bureaucracy emerge, and interest groups within the organisation resist changes that could undermine their status or resource allocation. This delays, or even derails, efforts to adopt radical innovations.[161] There are two variables for determining organisational age: the time since the military lost or underwent a radically distinct major conflict; and the time elapsed since the last major force renewal.[162]

Among the advantages the Australian Army has over its regional neighbours in adoption capacity is that it has maintained a high operational tempo since the East Timor intervention in 1999. While the ADF has not lost a major conflict in recent decades, it has clearly been influenced by its considerable recent operational experience across a broad range of contexts, undergoing four major reforms in the past 11 years.[163] The Australian Army was deeply involved in both medium-intensity and counterinsurgency operations in Iraq and Afghanistan, by far Australia's longest conflict. The ADF has also

xi Disclosure: the chief investigator of this project is one of the founders of the Values in Defence and Security Technology research group.

been actively training regional military partners, which has the by-product of reinforcing lessons learned in this period of high tempo for the trainers as well as the students. In the same period the Army has assisted in humanitarian work and disaster relief, as well as peacekeeping efforts, particularly within the region.

The Australian Army also recently finalised a major structural reorganisation toward a rotating force generation and certification model. The intent of Plan Beersheba, initially commenced in 2013, was to restructure three brigades within its First Division essentially into similarly sized and equipped battlegroups, which included support personnel and equipment. These groups would then operate on a three-year force generation and recovery cycle in which each multi-role brigade would serve one year at ready status, rest the following year and then prepare for readiness in the third. While this organisational shift is indicative of a capacity to undergo top-down change, the cyclical nature of the resulting model could actually increase Army's effective organisational age by embedding current doctrine and encouraging path dependency through the certification process.

The resulting risk is that the force generation process itself diminishes the willingness of personnel to challenge orthodoxy and to experiment, which are necessary for truly disruptive innovation. While the establishment of the coordinating Robotic and Autonomous Systems Implementation Coordination Office (RICO) is a promising recent development, Army should publicly encourage and promote the efforts of junior soldiers and officers to challenge the orthodoxy not just on how it fights but also on how it operates as an organisation. Some militaries have accomplished this through a RICO-style unit; others have found more success in speculative wargaming and even through encouraging informal discussion and reading groups. In the case of the Australian Army, the most effective solution is likely to be a combination of all three, given the nature of the service and the cross-disciplinary applications of AWS. A further step for limiting the potential dampening impact of this force structure would be for mid-level Army leaders and senior soldiers to take the initiative in establishing and promulgating the innovation and experimentation unit concept in their units.

Finally, the ADF more broadly has also gained recent experience in performing a quasi law enforcement role in its support of civilian agencies through Operation Sovereign Borders, policing the northern air-sea gap for irregular migrants. This expanded role interacts directly with the ADF's broader engagement with military robotics and autonomous systems. For example, in 2018 the Australian Government announced that an agreement had been finalised for the purchase of six Triton UAVs, along with associated infrastructure and maintenance, which would be used for long-range surveillance. As the ADF is expected to continue to provide this support to civilian agencies, it is becoming increasingly important to consider systems and capabilities for an expanded variety of roles beyond the requirements of the joint future force.

Overall, there is a clear link between the Australian Army's recent operational experience and the current focus in strategic documentation on joint ADF interoperability, flexibility and the Army's capacity to scale to meet higher operational requirements. While we have seen interest in procuring and experimenting with remotely operated drones, it remains unclear whether entrenched interests within the ADF and Department of Defence will prove willing to encourage and enable, not just allow, experimentation that genuinely challenges current 'sacred cow' capabilities.

3.4: Receptiveness of Domestic Audience

There is little argument that the legal and ethical operation of the Australian Army is a core component of the ADF's institutional legitimacy and continuing public trust within the Australian democracy. Significant public and political opposition to the development, procurement, adoption or deployment of TAS would severely limit Army's capacity to pursue an offset strategy. It is therefore vital that the ADF's pursuit of increasingly autonomous unmanned systems is conducted with the utmost transparency allowable within operational security requirements and that any TAS offset strategy is presented to the public in the correct manner.

Unfortunately, there is limited published data to construct an understanding of how the Australian public would receive the adoption of TAS. Early studies examining public opinion of LAWS were limited in scope and focused primarily on the United States.[164] From an Australian perspective, the only publicly available studies as of mid-2019 were a pair of global surveys commissioned by the Campaign to Stop Killer Robots.[165] These surveys each included 1,000 Australian respondents and found a 59 per cent opposition rate. However, these were extremely limited surveys: only those who indicated opposition to killer robots were asked the second (of a total of two) questions. This is particularly damaging given Horowitz's findings on the impact of question composition. Therefore, the data from these two surveys is not actually very useful in determining what level of public opposition there would be to the types of autonomous technologies actually being pursued by the ADF.

The ADF should view the absence of sufficient data on public opinion as an opportunity to seize the narrative around TAS and present a compelling case for their ethical utilisation in the future force.[166] An attempt to adopt AWS would attract the ire of the NGOs in this space, who have already demonstrated a capacity to organise large-scale public and academic boycotts.[xii] However, the use of armed drones by the United States Air Force has demonstrated how a dispassionate, carefully curated biopolitical discourse could shape public discussion away from ethical complications toward the operational and resource efficiency benefits. For example, the Australian Army RAS should have included a more substantial engagement with the ethical and practical benefits of increasingly autonomous systems, similar to the one featured in the first section of the identically named US Army strategy.[167] A recent example of direct Army engagement with the press was an article in the *Australian* newspaper in November 2019. Of particular interest in the article is that HUM-T was prominently referenced, while neither 'lethal autonomous weapon system' nor 'killer robot' was used. Instead of focusing on the systems themselves, the article principally focused on efforts to integrate autonomous, digitised or AI-enabled capabilities into the soldier combat system.[168] This is promising given that the limited available data suggests that the public is significantly more willing to accept autonomous systems that are presented as protecting soldiers.[169] The ADF should, therefore, continue to engage in public explanations and demonstrations of TAS and their ethical aspects in order to shape how a future Army TAS offset strategy is discussed, understood and received by the general public.

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xii The proposed partnership between Hanwha Systems and a research laboratory at KAIST triggered calls for an academic boycott in 2018, which resulted in the partnership officially being scrapped.

3.5: Ability to Develop/Adopt a Specialised Operational Praxis

The final variable to consider is whether the ADF has the capability to develop or adopt a specialised operational praxis for the deployment of increasingly autonomous weapon systems. An operational praxis is the process through which a military transforms capability into force and is, therefore, a key factor in determining how a state responds to the emergence of a major military innovation. For example, consider that in the interwar period, distinct operational praxes informed, and were in turn influenced by, tank production and deployment by the United Kingdom, France and Germany. Despite early German tanks being somewhat technologically inferior, the superior German operational praxes in the interwar incubation period led to the installation of radios and the combined arms battlegroup structure, which allowed German armoured units to defeat their counterparts comprehensively.

The modern ADF has demonstrated strong interest in the strategic approach of its more powerful allies. In a similar manner to the third generation of the Singapore Armed Forces, ADF planners seem to have become enamoured of network-centric warfare in the early 2000s. In the same period, when the expeditionary approach was in ascendance due to the global war on terror and the need for interoperability with other members of the US coalition, the Australian Department of Defence released a series of concept papers that basically translated the network-centric warfare concept for an Australian audience, re-branding it as multidimensional manoeuvre warfare.[170] While the importance of maintaining a 'knowledge edge' was embedded into Australian defence planning, this initial interest in the network-centric warfare revolution in military affairs was not effectively pursued as a doctrinal imperative. It did not meaningfully affect procurement, and was eventually rolled into the broader modernisation efforts over the following decade.

It is somewhat concerning that there also appears to already be a level of emulation evident in the Army's approach to increasingly autonomous systems. For example, doctrinal emulation can be seen in the RAS,[171] which draws extensively on *Joint Concept Note 1/18: Human-Machine Teaming*, written by the United Kingdom Ministry of Defence's Development, Concepts and Doctrine Centre,[172] as well as on the United States Army's

Robotic and Autonomous Systems Strategy.[173] A number of the operational concepts identified in the Australian Army's RAS draw on similar approaches being pursued by the United Kingdom and the United States, including the AI-aided battlefield command assistant and the use of follow-me UGVs for casualty evacuation and logistics.[174]

While the importance of interoperability is acknowledged, TAS are not a defined platform that Army can plug into its existing force structure and expect to generate a sufficient asymmetry. This is a capability that will become increasingly prominent over time as the underlying technology diffuses. For it to be effective, the way that Army integrates autonomy into its warfighting must be uniquely reflective of its capacities, objectives, terrain and personnel. Again, there is very little strategic incentive for Australia to adopt a doctrine for autonomous systems that prioritises intercontinental strike capability or envisages the deployment of massed armoured UGVs in pitched battle against other large tank formations. It is just as important that the Army take its strategic objectives and likely operations into account when conceptualising how it can use autonomous systems as it is for Army platforms to be able to operate in the terrain of far northern Australia.

It is vital, therefore, for Army to be careful here that it actively capitalises on the momentum generated by the joint efforts to develop and integrate increasingly autonomous technology across all three service branches in ways that suit Australia's strategic interests. Part of this will require the generation of a stronger culture of innovation and questioning orthodoxy, as well as a conscious recognition and rejection of the ADF's 'cultural fixation on delivering outputs rather than achieving outcomes'.[175] The ADF more broadly must seize this opportunity to challenge its assumptions about Australia's strategic interests and step outside the path dependency of our current supply chain.

The ADF's capacity to develop or adopt a specialised operational praxis that would enable an effective TAS offset strategy is uncertain. Despite the recent operational concept publications and strategic guidance, the lack of evidence that this guidance is impacting procurement decisions highlights the risk of the TAS offset strategy falling by the wayside like multidimensional manoeuvre warfare did a generation earlier. Furthermore, there is a cultural split evident between the service branches' approaches to AWS: while the Army recognises the risk of continuing to rely on extensive but low-mass platforms, the RAAF is quite clearly looking at autonomy within the broader outlines of its development of a fifth-generation Air Force. The latter position has clearly gained support from some academics, with a recent ASPI report calling for the wholehearted use of remote-operated platforms to support a larger combat strike Air Force and an expanded Navy operating at a higher tempo within the region.[176]

> **Recommendation**
>
> Institutionalise the conceptual shift away from low-mass, high-capability platforms toward integrating increasingly autonomous capabilities into high-mass systems that correlate with the accelerated future warfighting environment.

3.6: Summarising Australia's Adoption Capacity

This evaluation indicates that while the Australian Army could draw on a regionally significant adoption capacity, weaknesses remain, including that the ADF's access to sophisticated enabling technologies remains vulnerable to disruption and that efforts to encourage bottom-up innovation around unmanned platforms in the ADF are still emerging. Australia's capacity to direct resources to adopting various increasingly autonomous systems is notably superior to that of our neighbours, reflecting a historically higher defence expenditure than the regional average. Furthermore, the ADF maintains longstanding and close defence trade partnerships with states that are known to be developing autonomous systems and enabling technologies, most prominently the United States. However, this resource capacity is weakened somewhat by the fact that a significant proportion of Australia's military industrial and innovation base remains closely interlinked with and reliant upon foreign firms, creating the possibility of disruption in the event of conflict and reinforcing path dependency.

Unfortunately, while progress has been made and recent strategic guidance is encouraging, the ADF's organisational capital capacity is also limited by path dependency at the strategic level, which has been particularly noticeable in recent procurement decisions. The Australian Government's investments (principally through DST Group) in experimentation with autonomous and remote-operated systems have been promising; however, Army would be well served by a greater emphasis being placed on the core capabilities identified in the RAS in future research funding prioritisation. Finally, the Australian Army's high operational tempo since 1999 indicates that it has a lower organisational age than states in the region that are likely to challenge Australia's ability to maintain a future autonomous systems based offset (such as Singapore or Indonesia). A lower organisational age, and recent signalling of interest in encouraging the participation of lower ranks in the doctrinal innovation process,[177] would suggest that the Australian Army has a higher organisational capital capacity than its regional neighbours.

Overall, therefore, Australia's ability to adopt and maintain an offset strategy based on TAS should be viewed through a regional comparative lens. Australia is unlikely to succeed in an attempt to become the global first mover in AWS; rather, the ADF should pursue a more limited strategy of integrating autonomous capabilities into a smaller series of combat systems that reflect the core service priorities for future joint land combat.

Recommendation

Focus investment on developing and procuring smaller-scale platforms with task-based autonomy for identified capability gaps rather than adopting a more generalised approach.

Section Four: Outlining Options for Integrating Trusted Autonomous Systems into Future Joint Land Combat

> *'I welcome diversity of opinions. No good idea should go unchallenged. Our argument should win on the strength of its logic, not the strength of the advocate.'*[178]

Based on the preceding analysis of Australia's adoption capacity, even a successful attempt by the Australian Army to adopt AWS is likely to be limited. Importantly, this is only partially due to resource constraints. Within Australia's threat environment, there is little incentive for Army to invest its limited time, resources and organisational capital into emulating some of the higher-level platforms that are being pursued under the Third Offset Strategy. This section, therefore, will explore the core capabilities that could feasibly be included in an Australian Army focused offset strategy. In doing so, however, the purpose of this section is not to dictate hard parameters for a future offset strategy; rather, its aim is to prompt deeper discussion and participation at all levels of the ADF, civilian government and academia.

4.1: A Strategic Lens for Identifying which Capabilities Should Be Included in a TAS-Based Offset Strategy

It is worth briefly highlighting that, while identifying and embedding autonomous capabilities into future investment and procurement processes is a crucial first step, care must be taken that any meaningful pursuit of a TAS-based offset strategy is undertaken through the lens of Australia's strategic priorities (particularly those to which a future land force would be the primary contributor), rather than that of technological possibility or entrenched interests. Furthermore, there is also value in mapping the parameters of this lens using the terminology and doctrine already in place in the Army as analytical touchstones.

In constructing this strategic lens, the RAS, as the Australian Army's primary published document in this space, is an effective starting point. The RAS highlights five fields where value could be gained from integrating increasingly autonomous systems to enhance, augment and perhaps replace human soldiers. These fields are maximising soldier performance through reducing their physical and cognitive loads; improving decision-making at all levels; generating mass and scalable effects through human-machine teaming; protecting the force; and improving efficiency. From this we can see that Army is primarily interested in systems that can integrate autonomous capabilities into manned-unmanned teams, with an attendant focus on systems that enhance the capabilities of Army units, improve their survivability and augment their capacity to influence the battlespace, rather than fully autonomous warfighting platforms that would remove humans from the battlespace entirely.

This conclusion is also supported by comparison with the four main lines of effort under the accelerated warfare strategic concept: network, protected manoeuvre, joint fires, and the enabled soldier.[179] These lines of effort further reinforce a conclusion that, at least in the initial stage, Army's engagement with autonomous systems will retain a human somewhere in the battlespace. Finally, recall the lack, at the time of writing, of concrete commitment on the part of the ADF to embedding an autonomous operation or AI requirement in its modernisation, investment and procurement contracts.

Based on the documents published to date, an understandable argument could be made that what the ADF is pursuing in this space is constrained by an organisational requirement to retain a human in the decision-making process. Thus constrained, the ADF is not really pursuing a true *offset* because it is clinging to an existing paradigm of conflict. In effect the ultimate sacred cow here is the presence of a human somewhere in the decision to use force. There is certainly merit to this argument: by focusing on systems that enhance and augment human operators, even if only in the short to medium term, the ADF is willingly giving up the opportunity to bypass its current defence technology entanglements and generate a true asymmetry of capability compared to its neighbours.

While Australia would be justified in pursuing a limited selection of autonomous capabilities, the lesson to draw from this argument is that the selection must be influenced primarily by whether the capability would contribute to Army's capacity to meet Australia's strategic defence goals and, arguably more specifically, to invalidate the conventional superiority of potential rivals. This is why it is important to consider Australia's strategic environment as an adoption capacity variable. While resource and organisational capacity insufficiencies can comparatively delay, or even prevent, states from pursuing an emerging major military innovation, focusing on these factors neglects the influence of a state's strategic goals and threat environment. Where a military has to choose where to spend its limited resources, its perceived threat environment and expected potential future hostilities are an influential factor, which of course lends itself to the maxim that generals are always fighting the last war.

To account for this effect in a future TAS-based offset, it is worth taking a step back to note the ADF's broader strategic defence interests and objectives. The 2016 Defence White Paper identified three strategic defence interests:

> *A secure, resilient Australia, with secure northern approaches and proximate sea lines of communication.*
>
> *A secure nearer region, encompassing maritime South East Asia and the South Pacific.*
>
> *A stable Indo-Pacific region and a rules-based global order.*[180]

To secure these interests the white paper identified three strategic defence objectives for the ADF:

> *Deter, deny and defeat attacks on or threats to Australia and its national interests, and northern approaches.*
>
> *Make effective military contributions to support the security of maritime South East Asia and support the governments of Papua New Guinea, Timor-Leste and of Pacific Island Countries to build and strengthen their security.*
>
> *Contribute military capabilities to coalition operations that support Australia's interests in a rules-based global order.*[181]

Modernising this strategic outlook requires that additional emphasis be placed on securing Australia's relative position and influence in the region during renewed great power competition; the need for the ADF to simultaneously operate in a broad range of operational tempos and paradigms, including operations short of war and humanitarian aid; and the realistic prospect of a rapidly broadening cohort of actors (state and non-state, friendly and oppositional) gaining access to increasingly autonomous systems that will prove a powerful levelling tool for those who want to oppose, surveil or limit an Australian Army operation, even if we assume that the platforms used by these actors will remain objectively inferior.

Therefore, when considered through the lens of Australia's strategic interests, it is clear that a future autonomous system strategy should prioritise capabilities that improve the Army's capacity to identify, deter and defeat future threats to Australia's interests and territory (particularly the northern approaches), and that these capabilities should be interoperable with those of key allies and partners to support coalition operations, particularly in sensor-denied future operating environments. Factoring in the accelerated warfare framework supports the conclusion that these objectives would be best achieved by an agile, survivable, dispersed force that can deter potential aggressors, project power within the region and effectively defend the inhospitable north of Australia.

The most efficient way for Army to achieve this objective is to focus on small, discrete platforms and systems that enhance the capability of its high-quality soldiers. While it may not be as politically attractive, small, independent, mutually supporting units of mechanised infantry with integrated autonomous platforms for resupply and fire support, under the direction of a dispersed, AI-assisted command structure, would be far more effective at defending Australia's northern approaches (either internally or forward deployed) than expensive, exquisite manned platforms that Australia cannot maintain in sufficient numbers to defeat a determined modernised adversary.

Overall, therefore, an Australian Army strategy for developing a TAS-based offset should focus on developing, procuring and integrating autonomous systems at the platoon and company level, where the shift away from low-mass, high-capability platforms and renewed focus on tactical experimentation can occur most effectively in the initial post-adoption period. The remainder of this section will develop a list of suitable target capabilities, focused on sub-unit capabilities of the future force, which are achievable and would contribute to Australia's strategic goals as part of a TAS-based offset strategy within the framework of accelerated warfare.

4.2: Improving Environmental Cognition and Force Element Coordination

Regardless of whether the future Army must participate in high-intensity conflict as part of a coalition, or in urban littoral warfare against an insurgent force, or whether it is even asked to provide assistance after a natural disaster in our near region, it is clear that future operations are likely to be conducted in conditions that compromise or complicate communication, command and control, particularly at the tactical and operational levels. It is, therefore, promising that the *ADF Concept for Command and Control of the Future Force* position paper notes that:

> *Given that the future information environment will be contested, the ADF's future force must be robust enough to sustain operations when command communications cannot be relied upon.*[182]

As the Army transitions toward the dispersed, agile force structure envisaged under the accelerated warfare strategic concept, autonomous systems and task-oriented AI will be a vital aspect of ensuring both the resilience of the future force and the agility of junior leader decision-making.

Autonomous systems could enhance and augment existing units by collating and evaluating intelligence from multiple sources in real time in order to advise soldiers.[183] Essentially this would install a program to sift through incoming intelligence, sensor data and data-link traffic to highlight important information for the commander to review. This is a tactical-level version of the battlefield assistant capability, where instead of managing a large dataset the agent's primary role is to support small-unit leaders by rapid processing, classifying and packaging incoming intelligence into tactically useful packages. This would be particularly valuable for efficiently transferring pertinent information (perhaps with comments attached from the sender) between independently operating small units while filtering out irrelevant data. This could also be achieved by focusing AI-enabled assistants on *edge processing* incoming intelligence gathered by the unit and nearby allied forces, translating the torrent of data from modern information warfare into tactically useful advisories. The chief benefit of using edge AI is that it would reduce the required bandwidth by limiting the amount of non-essential data being presented to the operator or transmitted between units.[184] Incorporating an AI-enabled agent in either of these manners would essentially enable a small-unit leader (perhaps a junior NCO) to have significantly greater situational awareness than their enemy counterpart, while also improving their decision-response period in complex combat environments by tasking an effectively autonomous agent with classifying and transmitting this information without adding to the soldier's cognitive load.

The RAS also raises the prospect of integrating this autonomous assistant into an augmented reality headset, which would provide soldiers with real-time access to intelligence and the capacity to project that data directly onto their perception of the battlefield, highlighting allies and threats. In addition to enhancing small-unit operations by enabling the instant and intuitive sharing of video, audio and signal data, this would allow commanders to designate objectives more quickly and to more efficiently coordinate their soldiers, particularly in dispersed operations where the command post could be actively seeking to avoid being found and fixed in place by an adversary. Furthermore, from an offset perspective, it is immediately apparent that the ability to 'see' allied units and tagged civilians or threats through intervening terrain and 'hear' intercepted enemy signals in real time, guided by high-fidelity intelligence prioritised and presented by an onboard AI assistant, would give multiple small units operating in a dense environment a distinct edge over an adversary. It does raise some risks, however, such as the potential to distract warfighters[185] or that an effective cyber attack would allow an aggressor to track troop movements, siphon tactical information or even feed soldiers inaccurate or misleading information in order to reduce their combat effectiveness, drain resources or draw friendly units into ambushes. Interfering with this sort of battlefield information system (particularly one that uses augmented reality) could also allow an adversary to undertake psychological operations against linked troops.

As technology matures and militaries continue to rely on remote-operated platforms, the risk posed by command and control disruption, whether by effective cyber attack, signal interference or even environmental factors, becomes more severe. The solution proposed by the ADF has been a layered command and control approach where individual units are able to collaborate toward objectives within the commander's intent.[186] Effectively secured and well-trusted autonomous and AI-enabled systems would enable Army units to operate in a dispersed but effective manner in conditions that would otherwise curtail their coordination and sustainment. There is certainly an argument to be made in favour of the future ADF making extensive use of offensive electronic warfare and cyberwarfare tactics to blind and confuse an adversary, confident that future Army units are fully capable of operating in a denied environment, which would in turn generate a significant asymmetric advantage.

4.3: Increasing Mobility

The use of autonomous and unmanned platforms to reduce the physical loads on soldiers is arguably the most common operational praxis among comparable and allied states. Essentially the goal is to reduce the amount of weight each individual soldier is carrying in the battlespace without sacrificing capability. This would lower the impact of fatigue, improve the operational range of dismounted combat units and make small teams more manoeuvrable in an increasingly complex and crowded battlespace. Broadly speaking, it would be more resource efficient and organisationally straightforward for the Australian Army to focus primarily on augmenting units within the current force structure rather than enhancing the individual capabilities of soldiers.

The RAS notes the potential to develop a new kind of load-bearing harness or even a robotic exoskeleton to improve the load-carrying capacity of soldiers and thus reduce the felt impact of their existing equipment.[187] This potential has also been noted by the United States military, which has funded multiple efforts to develop[188] and prototype[189] battery-powered exoskeletons. There are also multiple civilian institutions researching or developing some form of exoskeleton to improve mobility and load capacity. For example, the KAIST Interactive Robotic Systems Lab (in the Republic of Korea) is developing a lightweight exoskeleton to improve the mobility of people with disability.[190] Although the vast majority of these projects are clearly designed for the civilian market, it is promising that the ADF is monitoring these developments through Diggerworks and the Defence Science and Technology Group, which advertised a prototype of its own exoskeleton project (the operational exoskeleton, or OX) in 2015. The Australian Army should continue to monitor these developments carefully with an intention to partner with an effective manufacturer or even to emulate a civilian model.

However, there are problems with pursuing a load-bearing harness as part of a TAS-based offset, beyond the fact that none of the publicly discussed exoskeleton projects have featured autonomous capability. The first is simply that power constraints are likely to limit the use of exoskeletons to logistics roles, at least in the short term. Secondly, exoskeletons reinforce the assumption that humans are expected to remain at the core of combat and logistics taskings, which would effectively dismiss important advantages from passing certain tasks to machines. Even for rear-echelon operations, the benefit to Army of enhancing the capacity of human logistics troops over replacing this role with autonomous systems is unclear. Adopting exoskeletons would not free up uniformed personnel for other roles; soldiers would continue to be exposed to risk of injury (albeit at a reduced rate); and the resupply process would remain essentially at human speed.

Setting aside the technical issues and assuming that a feasible model is available for frontline usage, the Army would be far better served by an autonomous ground vehicle than an exoskeleton, for two key reasons. The first is that this is inherently an unsuitable technology for a military that views robotic and autonomous systems as a way to artificially generate mass and scalability, because exoskeletons enhance the endurance of individual soldiers; they do not bring significant additional capability that a numerically small unit would currently have to rely on supporting elements to provide, such as mortar support, ammunition resupply or casualty evacuation. Secondly, this technology only offers an incremental advantage to the effectiveness of Australian forces, rather than contributing to a shift in the paradigm under which they fight. On the surface, exoskeletons would increase the endurance of infantry patrols; however, they would not eliminate the need for those forces to return for resupply and would enable no significant warfighting capabilities that an infantry section would not already possess. In practice, such systems would be far more valuable for great power militaries that expect to undertake high-intensity, large-scale conflicts with defined supply lines. Simply distributing exoskeletons to soldiers would not significantly improve their capability to operate independently and covertly in battlespaces characterised by inhospitable environments, long distances or effective cyberwarfare, which are likely to be present in the case of an attack on Australia's northern coastline.

Adopting semi-autonomous or supervised autonomous UGVs would be a far more effective method for improving the mobility and endurance of Australian Army units. Attaching an autonomously manoeuvring vehicle would significantly increase the endurance of an infantry unit by reducing the physical load on each soldier while also increasing the unit's overall supply capacity. In terms of developing a capability offset, equipping each section in a rifle company with small MUTT-style UGVs would give that company a significantly greater capacity to operate in difficult to access or denied environments than their regional counterparts. This would also limit the need for special forces units to risk exposure to resupply while forward deployed and would give dismounted units greater access to support weapons and ammunition than they would currently take on patrol, improving their endurance and lethality. These advantages would be particularly noticeable in the event of a conflict in northern Australia or—somewhat more likely—in the event that Australian forces were required to conduct operations short of war in areas of South-East Asia that lack sufficient infrastructure to easily support traditional supply lines. The capacity for these platforms to carry their own armaments, act as mobile cover or extract casualties would be added advantages.

4.4: Command and Control

This leads into utilising AI and autonomous systems to improve the speed and accuracy of human decision-making in the battlespace. This reflects a recognition that, on an increasingly networked and information-based battlefield, there is significant advantage to be gained by reducing the OODA loop of operational commanders and individual soldiers, ensuring that Australian Army units are able to operate effectively at a higher tempo than their adversaries.

In published military literature, including the RAS, a commonly cited goal for the integration of AI-enabled systems is to improve the agility and survivability of forward-deployed unit headquarters groups. This goal is typically associated with developing an AI-enabled agent with the capacity to analyse and prioritise incoming intelligence from a variety of sources and then present prioritised information to the commander to support their decision-making. This operational praxis for AWS is discussed above (section 2.3.1); in summary, it would reduce the OODA loop in force headquarters and reduce the required number of support personnel.

Importantly, 'Lt Siri' would be an augmenting rather than a replacement capability; its implementation would ideally allow for command support elements to be distributed rather than concentrated in a central forward headquarters, without sacrificing capability.[191]

This monograph recommends that, as an extension of AWS as a decision-enabler, the ADF prioritise the development of a modular AI-enabled information management agent for deployment either as part of the Deployable Joint Force Headquarters or at the battlegroup level. The base capability of this agent would be to coordinate intelligence and integrate unit communications, which is a capability that the Australian Army and key allies have identified as crucial in this space. However, where the ADF could establish a real cognitive offset is by pre-emptively developing a series of modules that each correspond with the communications and logistics requirements of the units in the currently deployable combat brigade under the force generation cycle, as well as supporting special forces, RAN, RAAF and civilian agency assets. Ideally, such a system would eventually expand to be interoperable with the expeditionary forces of key allies such as the United States. This would allow the Deployable Joint Force Headquarters to rapidly load a pre-tested agent with the necessary modules to enable it to assist with coordinating the communications, logistics, intelligence and deployment of a rapidly assembled and deployed combat brigade. While developing, integrating and testing this kind of agent could be a comparatively resource-intensive aspect of a TAS-based offset strategy, it would substantively increase the ability of the ADF to respond to an emergent threat with rapid and coordinated force. This capability to agilely project a regionally superior joint force within the Asia-Pacific would also be a powerful deterrent capability for a comparatively small military.

Recommendation

Prioritise the development of a modular AI-enabled communications and information coordination system for battlespace management.

There are, however, both technical and operational barriers to consider. From a technical perspective 'Lt Siri' would require that the ADF significantly improve its battlefield network capability, while the agents themselves would require relevant data about their specific units, objectives and assets (for initial training). Furthermore, the battalion commander would need to be able to trust that the AI-enabled assistant is both reliable and accurate in its recommendations. Building this trust would be further complicated by the 'black box' problem, whereby complex AI-enabled systems generate outputs without the capacity to demonstrate their decision-making process to their operator. As a result, when AI programs fail or act unexpectedly, there is no easy way for the operator to determine the cause. Somewhat confusing and occasionally costly in the civilian space, this becomes a more serious problem when we consider the potential for unexpected engagements by AWS to breach international law, endanger friendly forces and deteriorate trust within human-machine teams.

Operational barriers include that senior officers would have to be trained to incorporate this system into their decision-making processes. There is also the ever-present issue of fostering trust in this system and its recommendations long before it can be deployed on an ADF-wide scale in conflict. If officers and soldiers are uncomfortable with, uninformed about or mistrusting of 'Lt Siri', it is likely that they will ignore or minimise their reliance upon it, especially in periods of high-stress and operational tempo (which is exactly where we expect to derive operational advantage from these assistants). Finally, we must consider the risks of incorporating AI into the decision process of commanders. The first of these is that the level of trust is not ideal, resulting in human soldiers either ignoring the system or succumbing to tunnel vision regarding the information presented to them. Secondly, providing the required relevant data to developers and software engineers to train these agents presents a security risk, particularly given the distributed nature of current ADF maintenance and production agreements.[xiii] Adding to these concerns is the risk that an adversary develops the capacity to interfere with, or spoof, such an agent to undermine the accuracy of its recommendation to a commander.

xiii For example, recall the number of firms involved in maintaining the Collins Class submarine.

Overall, however, this will be an important capability for the future Army, creating 'periods of decision advantage' where commanders react and act at a higher tempo than their opponents.[192] Future joint warfare will require that Army headquarters be capable of rapidly and accurately evaluating data and maintaining communications with multiple units across different services or even as part of a multilateral coalition. Developing a network of similar AI-enabled assistants would enable commanders, particularly above the company level, to efficiently process a data-rich battlespace with fewer physical support personnel, allowing the command structure of an Australian Army battlegroup to be far more agile, more responsive and more survivable than the command and control infrastructure of an opposing formation.

4.5: Force Protection

This outcome focuses on the core of the argument in favour of using robotics in warfare: that autonomous systems could replace human soldiers in dangerous, dull or dirty roles. While warfare will remain a human endeavour,[193] using autonomous systems can reduce human exposure to high-risk battlefield roles, thus improving overall force protection.[194] Unlike some of the other operational praxes for the deployment of unmanned systems, there are well-tested examples to draw on when it comes to force protection. For example, remote-operated ordnance disposal UGVs limit soldiers' exposure to unexploded ordnance and IEDs, while the stated purpose of the Super aEgis II supervised turret was to limit the number of Republic of Korea soldiers required to be put at risk guarding the Demilitarised Zone, which remains a dangerous posting.

Looking at autonomous systems from the perspective of generating a capability offset, it is immediately apparent that preserving each soldier and limiting their exposure to dull, dirty or dangerous taskings would be of value to the future Army. For example, integrating semi-autonomous or supervised UGVs into infantry sections would be an effective tool for force protection and preservation in the short to medium term.

This same platform would also be a valuable tool for small units if it were designed to carry additional medical equipment or with an integrated stretcher for evacuating casualties at a faster speed and with less risk to the wounded soldier's comrades. In the longer term, a dispersed and agile future Army would benefit significantly from its frontline medics having greater access to additional or specialised medical equipment in the field. An integrated UGV could even be equipped with a medical interface pre-programmed with advice and guidance for first responders or the capacity to independently measure and administer medication under the medic's supervision.

Furthermore, Army could be expanding its reliance on (currently remote operated) UGVs beyond explosive device disposal to provide a greater level of protection against a variety of unconventional threats. For example, UGVs or small UAVs could be used to integrate a real-time chemical, biological, radiological or nuclear (CRBN) threat detection capability into forward-deployed Army units operating in a battlespace where the use of CRBN is suspected or anticipated,[195] such as special forces detachments in the 2003 invasion of Iraq. Such systems could also be delegated responsibility for intercepting and monitoring electronic transmissions in the battlespace, a particularly important force protection task in counterinsurgency operations. This would reduce the cognitive load on leaders and increase the capacity of the unit to identify and agilely respond to emerging threats.

Moving beyond generating a capability edge, AWS also could be used in more disruptive ways to protect a forward-deployed Army force, while staying within the bounds of feasible technology projection. Presented below are three examples of how autonomous systems could be used for force protection that would require a significant shift in how the Army perceives its role in combat. The first would be to replace humans in forward-deployed surveillance units and frontline land combat platforms. While claims that autonomous systems will somehow lead to 'bloodless wars' are hard to justify, by removing its troops from roles that are known to be high risk, such as clearing houses in an urban combat setting or establishing a beachhead in the event of an amphibious landing, the Army would be able to better preserve its human personnel.

There is also a legitimate question to be asked as to the extent to which 'boots on the ground' would actually be needed in the case of a forward defence scenario. Army could enhance its force protection capability by reducing its deployment of humans in forward defence scenarios, adopting an agile and dispersed force structure that draws on support from its allies as well as unmanned armed platforms and automated supply lines.

Finally, if we accept that high-intensity conflict is the defining tempo autonomous systems should be designed to participate in, this raises the possibility of removing, or at least significantly reducing, the role of dismounted infantry as the core of a deployable Army battlegroup. Underlying Australia's interest in defence technology is the realisation that the ADF is tasked with defending a landmass totally out of proportion to its recruitable population. In the event that the ADF is asked to participate directly in a great power conflict, the quality of its light infantry may not be sufficient in the absence of scale. Autonomous systems open the possibility of a section of mounted infantry managing the equivalent of a company's firepower from the comparative safety of concealment set back from the front line. While this skirts the line of what is currently technologically feasible, the role of autonomous systems in protecting the force touches on a core argument in favour of autonomous systems, and the Army should not disregard the potential to take the final step in the race between weapon system lethality and platform survivability.

4.6: Generating Mass and Scalable Effects

The twin purposes at the centre of a middle power offset strategy are to disrupt the conventional superiority of a potential rival and bolster the capability of one's own forces by leveraging a (usually technology based) capability edge. In a similar manner to the Singapore Armed Forces, the ADF is reliant upon maintaining a distinct capability edge in leading force multipliers in order to maintain a credible deterrence value. Therefore, in the case of the Australian Army, a strategy for developing and integrating TAS must prioritise capabilities that offset its comparatively small size and scale.

Firstly, autonomous systems could be used to directly increase the lethality, endurance and range of small infantry units, essentially reducing the advantage a rival would gain from deploying a more infantry-heavy order of battle. For example, limited AI-enabled or data-driven devices like 'smart scopes' (which adjust their sight picture to account for ballistics and environmental factors)[196] or augmented reality displays (discussed above) would give individual soldiers an edge over their counterparts.

If combined with a more robust battle network capacity, a persistent network of unmanned surveillance vehicles could provide more effective overwatch and more accurately coordinate fire support for small infantry units, even in densely populated or inaccessible areas. For example, the Singapore Armed Forces has expressed interest in acquiring the Stinger Unmanned Aerial Multi-Rotor Gunship,[197] an armed close-range quad-rotor UAV. The Stinger is designed to provide fire support for company-level infantry units.[198] Of particular interest is that the manufacturer is developing an 'assisted threat identification function' whereby 'all a soldier needs to do is to designate the threats that need to be neutralised, and the Stinger will automatically persecute the selected targets'.[199]

Similar platforms could also be used for long-term surveillance in difficult to access or dangerous border regions, to conduct long-term patrols in littoral areas or to monitor the movement of violent non-state actors. Furthermore, unmanned systems could augment unit security either by replacing human sentries[200] or conducting large-scale data analysis to identify enemy troop movements toward friendly assets and advise local commanders in real time.

Furthermore, the Australian Army should prioritise the development of supervised fire support vehicles. Integrating an armed unmanned platform into small infantry units would be a powerful augmentation to their firepower and overall lethality. Integrating an armed UGV would enable an infantry section to organically deploy a wider range of heavier or more specialised armaments than they would otherwise bring on a patrol.

Adopting a similar operational praxis to its allies, Australia could deploy this variety of UGV in support of human soldiers in a supervised or semi-autonomous role; however, it is also worth noting the significant advantage that could be gained from prioritising fully autonomous systems for this role. This advantage would be derived from the fact that supervised and remote-operated platforms require that a rifleman (or even the unit leader) split their attention while engaged. Instead of directing their soldiers or directly engaging the enemy, the operator must devote at least part of their cognitive function to operating or directing an unmanned platform that cannot react independently to changes in the firefight. This would be particularly problematic for small-unit or counterinsurgency operations. While an obvious response would be to increase the size of a unit to include a dedicated operator, this would also require significant retraining to ensure that operators do not neglect their primary role (operating the unmanned platform) in favour of protecting their position and engaging the enemy. Overall, therefore, being equipped with autonomous platforms (or at least platforms that can perform their core function without active direction) would lower the cognitive load on Australian soldiers and give them an advantage over an opposing unit that has to sacrifice a section of its firepower to operating an attached remote-operated UGV.

4.7: Logistics and Force Sustainment

Switching focus from ‘tooth’ to ‘tail’, a TAS-based offset strategy should also include operational praxes that increase the efficiency of logistics and combat sustainment processes, particularly in the tactically challenging and dangerous ‘last mile’. Technological change on the battlefield can be (and often is) transformational; however, at the core of conflict remain human soldiers who need to be fed, armed and supplied to remain combat effective. From an offset perspective, integrating autonomous systems into strategic and tactical logistics would secure Army’s capacity to operate more efficiently in a wider range of environments and with greater structural agility than an opposing force.

The Australian Army has already recognised the suitability of HUM-T for improving the efficiency and reliability of strategic resupply. In addition to replacing or augmenting human drivers with large self-driving supply trucks (discussed above),[201] unmanned ground and aerial vehicles could be used for battlefield resupply at a significantly lower resource cost and with less risk. For example, to a company commander who needs to resupply their first platoon when it is engaged in a running firefight, dispatching a swarm of medium UAVs or a convoy of three armed UGVs would be an attractive alternative to risking another platoon on a predictable resupply route.

The RAS also indicates an interest in leveraging AI to streamline the broader battlefield resupply system. An AI-enabled agent functionally similar to ‘Lt Siri’ could be repurposed to serve as the liaison between forward-deployed units and the central combat service support unit for their formation, limiting the administrative burden on soldiers and reducing the risk of resupply delay. AI also offers the capability to use predictive data analysis to ensure that supplies and spare parts are produced on an ‘as needed rather than just in case basis’,[202] reducing waste and limiting the need for additional stockpiles. Combining AI with rapid prototyping capabilities and unmanned aerial transportation could feasibly enable quartermasters to quickly manufacture and deliver vital small parts (or ammunition) to forward-deployed units with far less risk than manned resupply convoys.

A final efficiency capability that should be incorporated into any TAS-based offset strategy is integrating AI into the maintenance and renewal cycles of the increasingly complex platforms acquired under the Army's current equipment modernisation program. These agents could be focused on improving the efficiency of planned maintenance and resupply by integrating autonomous data-management systems into the military supply chain. Alternatively, however, Army could establish a more distinct resource advantage by instead integrating these agents directly into the platforms themselves—for example, to enable aircraft or PMVs to autonomously conduct diagnostics, coordinate maintenance cycles and predict when future repairs are likely to be necessary.[203] In addition to lowering the resource cost of planned and unplanned maintenance, this capability would also reduce the amount of time for which Army's limited number of combat vehicles are taken out of action by maintenance activities,[204] improving the endurance of mounted Army units.

This section has identified a series of capabilities that would be within Australia's capacity to successfully adopt as a fast follower. The purpose of this section is to provide an outline of capabilities that should be considered as part of Army's effort to integrate a TAS-based offset strategy into future joint land combat. This outline should be viewed as a toolbox of feasible TAS capabilities that could be adopted, discussed or experimented with by the defence community.

Section Five: Recommendations for Developing and Maintaining a TAS-Based Offset Strategy

> *'It is clear that Australia's traditional 'technology edge' within the Asian region is deteriorating—and quickly.'*[205]

Crucially, the effectiveness of any offset strategy would be dependent on the ability of the Australian Army to maintain superior capability in a given innovation compared to other actors in our region, a task that is particularly difficult in the case of autonomous systems because of their reliance on dual-use enabling technologies. It is therefore important to consider how Australia can measure and maintain its initial offset advantage as a fast-follower adopter of TAS. This section presents a series of actions that would assist in maintaining an effective capability offset after autonomous systems mature and begin to diffuse.

The first step in securing a sufficient capability edge to maintain a successful offset strategy is to systematically research and review relevant advancements in our region. The ADF should invest additional resources and personnel into the targeted monitoring of state and non-state developers of key enabling technologies. While it would be tempting to focus on the United States and China, based on Australia's adoption capacity and the Army's critical task focus it would be more effective to use comparable middle power states as the primary benchmark for maintaining an offset. These could be economically similar (such as the other MIKTA states), geographically co-located (such as Singapore or Indonesia), or operating under similar strategic doctrine (such as the United Kingdom or Singapore). However, the dual-use nature of key enabling technologies for increasingly autonomous and AI-enabled systems means that Australia must also consider progress in civilian research and the commercial market. Developing an effective and responsive mechanism for regularly reviewing the progress of key state and non-state actors in our region would improve the Australian Army's capacity to rapidly identify and respond to an attempt to counter its offset, as well as providing a valuable source of opportunities for emulation over time.

Recommendation

Carefully evaluate how fellow middle power states approach key enabling technologies to identify opportunities for collaboration and emulation.

This relates closely to the second action that would assist in maintaining a capability edge in this space, which is focusing innovation efforts on targeted capabilities rather than a general offset. It would be both exceedingly difficult and inefficient for the Australian Army to attempt to maintain a credible capability edge against this benchmark across the totality of warfighting functions. But again, Australia does not have the same security threat environment that drives the Third Offset Strategy to take a broad-brush approach to offset. Instead, the ADF will need to continue to make hard choices beyond the initial offset establishment as to which capabilities it needs to maintain a hard capability edge against the benchmark states.

These choices should continue to be guided by close interaction between senior military decision-makers, prime contractors in the Australian defence industry, other government departments, and scholars. While arguably less reactive than a purely internal defence process, this provides the external perspectives that, alongside support from senior military leadership, will aid in overcoming the organisational inertia and evolutionary thinking that is common among militaries. For example, organisational culture is one of the major remaining restraints on the Chinese military's ability to disruptively innovate,[206] while the Singapore Armed Forces invested almost 1 per cent of its total defence spending in an organisation whose primary purpose is to challenge orthodoxy in the military research, development and procurement process.[207]

Along these lines, the ADF should establish an internal unit to coordinate the ongoing review of benchmarked states, lead the ongoing development of increasingly autonomous systems for land warfare, and promote the internal diffusion of these systems (which would include trust-building and familiarisation). This approach would emulate successful similar organisational units in the United States (Joint Artificial Intelligence Center (JAIC)) and Singapore (Future Systems and Technology Directorate).

Short of establishing a joint ADF unit, the other services could follow the lead of Army, which in March 2020 established the RICO under the command of the Director General Future Land Warfare. It is worth noting that the RAS made reference to the Future Land Warfare Branch acting as a coordinator within this space with an advisory group of stakeholders;[208] however, at the time of writing it is unclear whether RICO will subsequently absorb this advisory group.

While it is promising that the Army took this step as a single-service decision, this is likely to have less impact and does not fully account for the broader centralisation of modernisation within the ADF from a joint-warfare perspective. Observing that both the US and Singapore examples are situated within their respective departments of defence and cover all military branches reinforces that a joint ADF approach would be most effective.

In a similar manner to the JAIC, a key early role of an ADF AI collaboration and integration unit (AICIU) would be to promote an environment of rapid innovation and collaboration at all levels of the service that encourages challenging existing operational praxes. Distributing the innovative workload across its structure and empowering and supporting end users to actively participate in this process would be necessary for the ADF to achieve the necessary level of organisational fluidity to rapidly identify and respond to both problems and opportunities outside of the traditional, and lengthy, organisational change process. Actively drawing on the end users would also enable an AICIU to rapidly prototype evolutionary adjustments to deployed autonomous systems and disseminate effective feedback directly to developers. The establishment of the Innovation & eXperimentation Group (IXG) framework indicates that senior Army leadership has recognised the value of bottom-up approaches to innovation and encouraging self-experimentation at the unit level.[209] Finally, an AICIU could coordinate the engagement and development of uniformed personnel in related specialisations at all levels of the ADF. This further emulates an aspect of the role of the JAIC, which has already declared an interest in recruiting civilian experts to train a defence cadre in AWS-related fields, such as robotics and programming. Adopting a similar approach would build trust and AWS literacy among both officers and enlisted personnel, skills that can be further developed to add to the ADF's internal development capacity.

Recommendation

Establish an internal **ADF AI collaboration and integration unit** to coordinate joint investment and doctrinal development in AI-enabled systems.

Furthermore, the Australian Army should build on its current utilisation and learning from readily available civilian systems and software where feasible. This will firstly allow the Army to issue some form of partially autonomous system to a broad cross-section of its personnel at a fraction of the resource cost of imported military platforms. The Australian Army has already started down this path with the purchase in 2018 of DJI Phantom IV remote-operated aircraft,[210] which have already been used for familiarisation exercises with regular and reservist soldiers, as well as a small selection of units of the Australian Army Cadets[211] (a Defence-supported but civilian-managed youth organisation). Integrating civilian-produced systems would also encourage civilian innovators to approach Army. Lastly, adopting civilian systems as a learning tool builds an organisational recognition of the importance of—admittedly less advanced—increasingly autonomous systems both as a benchmark for maintaining a credible offset and as an important levelling tool for violent non-state actors that will only become more prevalent in future operations.

Recommendation

Further develop familiarisation and trust-building training among Australian Army personnel.

An effective supplementary approach would be for Australia to focus its adoption capacity on overcoming the remaining non-financial barriers to reaching a demonstration point for autonomous systems. In effect, this approach focuses on leveraging existing defence technology relationships with Five Eyes and NATO partners to circumvent the required initial investment in first-generation AWS. Instead of relying on shifting defence investment into the pursuit of a strictly limited list of capabilities, an approach that is complicated by political as well as practical barriers, Australia would contribute value to these partnerships by developing a globally competitive capacity with relevant training data for first-generation AWS and a top-tier STEM workforce.

A major non-monetary barrier to producing reliable fully autonomous weapon systems is the difficulty of training, attracting and retaining high-quality researchers, engineers and programmers in the fields required to advance autonomous operation capabilities, such as AI and robotics. Part of the difficulty in pursuing an offset strategy based on a dual-use enabling technology (like various forms of AI) is that militaries must then compete for specialist-qualified talent in an extremely competitive job market. For example, despite arguably being one of the leading investors in AI-enabled systems, China continues to struggle to develop, attract and retain the most skilled and experimental researchers within its restrictive system and is directly investing in hubs of US non-governmental innovation (for example, a 2018 study found evidence of Chinese participation in 16 per cent of all venture capital investments in US-based startups between 2015 and 2017),[212] as well as actively promoting cooperative research with foreign universities[213] and researchers.[214]

Despite starting behind the first movers in this respect, Australia has already identified the need to invest in the education of young Australians in STEM fields. The ADF is already one of the largest STEM employers and released its latest STEM workforce vision in August 2019.[215] The ADF should continue to actively participate in this initiative and insert itself directly into educating the next cohort of STEM graduates, perhaps through the ADF Academy or expanding existing Australian Government scholarship programs. A future offset strategy would be strongly benefitted by early investment in building the talent pipeline that the domestic defence industry will increasingly require in order to effectively compete in the international market, even if it focuses on niche capabilities. Direct ADF participation, particularly in the undergraduate and postgraduate education in related fields, would also have a more subtle benefit, by improving the rate at which these experts are willing to collaborate with or directly work for defence. Without early-career investment, participation and encouragement from the defence community, Australia increasingly runs the risk that key technological components of desired autonomous systems will be delayed or made more expensive by the refusal of experts, researchers and non-defence firms to participate in defence research, a problem that the United States has already encountered.

Recommendation

Invest in developing and recruiting top-level Australian talent in STEM-related fields to improve Australia's internal development capacity for autonomous systems.

The second non-financial barrier which Australia, and the Australian Army specifically, could contribute to overcoming is the requirement for any prospective adopter of AI-enabled systems to be able to generate and maintain sufficient access to the relevant data required by current machine learning techniques. Currently, the significant majority of AI programs must be 'taught', so to speak, by running hundreds of scenarios that the AI software can then learn from, which requires immense volumes of data. Allen highlights that greater access to high-quality, relevant data has historically been a major factor enabling commercial AI firms to build a competitive advantage.[216] For example, the Google AlphaStar AI that defeated StarCraft II professional gamers was, in fact, a series of AI agents, which were initially 'trained' using the data from professional replays before competing in iterative tournaments against each other across the equivalent of up to 200 years of real-time gameplay. In order to continue its training, StarCraft II recently allowed players using its European servers to compete in ranked matches against AlphaStar agents for a limited time on an opt-in basis.[xiv,217]

xiv Interestingly, following this initial opt-in, players would encounter AlphaStar opponents anonymously through the normal matchmaking process. Obscuring their identity from players was intended to ensure that the AI agents were able to train in 'realistic' game conditions.

The crucial qualifier here is 'relevant'; training AI software requires significant amounts of data which is directly applicable to the intended task.[218] Using unrelated or tangentially connected data would be counterproductive for 'teaching' a system; a simple historical example is the ill-fated attempt to utilise dog-mounted anti-tank mines, which failed when the Soviets used Russian tanks to train the dogs. While computer-generated or 'synthetic' data can be used to reduce this requirement,[219] it is only a stopgap and does not fully replace the need for high-quality, relevant data in training AI.

There are two approaches that the Australian Army should adopt in order to build its capacity for viable training data for the first generation of autonomous systems. The first is to design and run specifically designed exercises in realistic combat conditions (either in northern Australia or with allies in the broader Asia-Pacific) to generate the required geospatial, operational and sensor data. For example, a properly recorded and analysed resupply exercise at the Bindoon Defence Training Area would provide valuable data for training unmanned logistics vehicles to safely and reliably traverse hostile environments or changing route conditions.

Recommendation

Participate in targeted exercises alongside partner militaries in the region in order to generate useful data for training AI-enabled systems and acclimatise members to trusted autonomous systems.

Alternatively, or in addition, the Army could co-opt existing military exercises as a source of the necessary data. While this would require greater buy-in from unit leaders and greater up-front expense on developing specialised evaluators and trainers, this approach has the benefit of fitting into the existing ADF training schedule. Taking this a step further, the ADF could gather data from bilateral or multilateral exercises with Five Eyes partners to increase the variety and depth of the data for engineers to draw upon in developing and training Australian autonomous systems.

Recommendation

Develop an analytical model for adapting data from traditional military exercises (including personnel numbers, logistics information, communications protocols, unit equipment lists, and rules of engagement) for use in iterative simulations for training AI-enabled systems.

From a strategic perspective the core benefit of focusing Australia's adoption capacity on overcoming the remaining non-resource barriers to developing autonomous weapons is that, given the comparatively low adoption barriers of unmanned platforms (as demonstrated by the spread of drones), building and maintaining a credible edge on the basis of a consistently higher level of investment in defence modernisation will become both increasingly difficult and less influential as the underlying dual-use technologies diffuse. A better approach may be to instead focus on building an advantage in resources such as top-level expertise and relevant training data, which are already in short supply and cannot be solved by simply committing to higher spending.

This section has focused on the factors that will affect Australia's ability to reach and sustain a TAS-based offset strategy past the initial adoption decision and immediate post-demonstration point diffusion. For an offset strategy to succeed, Army must be able to maintain a meaningful capability edge by regularly making evolutionary developments in both the hardware and the software components. This section argues that the Australian Army, and the broader Defence Force, could improve this capacity through systematic review and selective emulation of comparable middle power states.

Conclusion: Recommendations for Developing a TAS Offset Strategy for the Australian Army

> *'… Army must continue to capitalise on future reform programs including in its most recent initiative, Accelerated Warfare by ensuring that bold opportunity does not give way to modest evolution.'*[220]

The emergence of increasingly autonomous weapon systems will have a significant impact on the paradigm of warfare and is likely to exacerbate the disruptive effect of renewed hegemonic competition on regional stability. As the liberal rules-based order is challenged, and where soft-power outreach has failed, Australia needs to re-learn how to selectively but judiciously project hard power against stubborn competitors or potential threats. Maintaining a credible deterrent capability will require that the future land force be able to leverage a comparative edge in autonomous systems to generate an asymmetry of force that invalidates the conventional strengths of potential rival militaries.

The core contribution of this monograph is a detailed exploration of the factors that would affect the capacity of the Australian Army to successfully adopt an offset strategy (at various levels of the service) based on TAS that would enable it to impose this sort of capability edge under a shifted force paradigm. This evaluation is based on a series of five variables adapted from adoption-capacity theory. The relevant variables are Australia's security threat environment; its capacity to generate and apply resources to the procurement, development or design of novel military innovations; the capacity of the Army to agilely and effectively adapt its organisational structures to identify, experiment with and incorporate autonomous systems in a timely manner; whether public opinion would support or hinder Army efforts to acquire and deploy TAS; and the extent to which the broader ADF could develop or emulate a specialised operational praxis for the effective implementation of autonomous systems acquired.

This analysis has determined that the Australian Army would be able to draw on sufficient adoption capacity to generate an initial comparative advantage in the use of increasingly autonomous and AI-enabled systems across the future joint land combat force. However, this report also makes recommendations for improving this capacity in line with the ADF's identified strategic objectives.

The first recommendation is that the Department of Defence adjust its procurement criteria to formally prioritise platforms that incorporate remote-operated AI-assisted or autonomous subsystems in equipment modernisation efforts. This formal prioritisation would signal the ADF's recognition of the value of TAS and encourage suppliers to experiment with relevant enabling systems, potentially in partnership with smaller enterprises and startups. The ADF's successful adoption of autonomous systems requires a clear integration of TAS into the critical task focus of each service branch and this focus must be reflected in the procurement and investment decisions made by the Department of Defence.

The second recommendation is that the ADF adopt a broader approach of institutionalising the conceptual shift away from low-mass, high-capability platforms (such as the Joint Strike Fighter) toward cheaper high-mass systems that capitalise on autonomous capabilities. While it was promising that the Chief of Army's Strategic Guidance 2019 acknowledged the risk posed by low-cost unmanned systems and the need to shift toward high-mass capabilities in an accelerated warfare environment, this was not reflected in major procurement efforts such as LAND 400 Phase 3.

This requirement leads into the third recommendation, which is that the Department of Defence and ADF target their development and procurement efforts over the short and medium term toward enhancing and augmenting existing combat units with AI-enabled systems while encouraging industry (through a combination of contract requirements and incentives) to focus on developing smaller-scale platforms with task-based autonomy in response to identified capability gaps. Focusing investment in this manner would lower initial development and adoption barriers, while simultaneously building the niche technical expertise that would support future bilateral efforts to develop more advanced AWS, in partnership with allies and civilian firms.

The fourth recommendation is that the ADF invest in developing a modular AI-enabled information management agent for deployment either as part of the Deployable Joint Force Headquarters or at the battlegroup level. The base capability of this agent would be to coordinate intelligence and integrate unit communications, which is a capability that the Australian Army and key allies have identified as crucial in this space. This agent could also inform the development of similar assistants for use at the operational and tactical levels, which in turn could provide a valuable edge processing capability, giving Australian formations a valuable advantage in high-tempo or information-rich operations. While developing, integrating and testing this kind of agent could be a comparatively resource-intensive aspect of a TAS-based offset strategy, it would substantively increase the ability of the ADF to respond to an emergent threat with rapid and coordinated force.

Core recommendations for improving the Australian Army's capacity to a TAS-based offset strategy	
1:	Formally prioritise autonomous capabilities as an evaluation criterion for future weapon procurement processes.
2:	Institutionalise the conceptual shift away from low-mass, high-capability platforms toward integrating increasingly autonomous capabilities into high-mass systems that correlate with the accelerated future warfighting environment.
3:	Focus investment on developing and procuring smaller-scale platforms with task-based autonomy for identified capability gaps rather than adopting a more generalised approach.
4:	Prioritise the development of a modular AI-enabled communications and information coordination system for battlespace management.

Fittingly for a middle power, there are alternatives to attempting to develop an effective offset strategy in the short term, although there are also risks in not pursuing an early adopter advantage. The first alternative response would be for Australia to declare its neutrality and not to attempt to adopt autonomous systems, choosing instead to rely solely on our allies and the international order to secure our interests in the region. Not only would this obstruct any realistic pursuit of a TAS-based offset strategy; it would also negatively impact the ability of the ADF to modernise and would limit

Australia's influence over the development of the nascent international norms around the use of increasingly autonomous weapon systems. It would be far more useful to collaborate with partner states, particularly the United States, to gain access to systems that are outside of Australia's current resource capacity. Collaboration would allow the ADF to spread the resource and training burden among friendly states, while also drawing on relevant military experiences or specialised production capability. Furthermore, the ADF would continue to benefit from superior access to advanced US-manufactured weapon systems and research outputs, bypassing a substantial proportion of the expected initial development costs. Overall, this monograph recommends that Australia pursue a limited offset strategy and continue to leverage its diplomatic resources to lower the initial costs of acquiring TAS.

For an offset strategy to be effective, however, Australia would need to be able to translate the current interest in autonomous systems and initial capacity into a sustained capability to generate, maintain and update a credible capability edge during a time when defence spending on modernisation in South-East Asia is growing[221] and the initial entry costs of emerging military technologies are falling. This monograph therefore makes an additional seven recommendations for improving Australia's capacity to develop a sustainable and deterring advantage through autonomous systems.

The fifth and sixth recommendations focus on carefully and regularly evaluating how peer and neighbouring states are approaching AI and other enabling technologies for TAS, as well as identifying opportunities for joint investment or development collaboration with those states. These steps would improve Australia's ability to forecast and horizon scan, allowing the ADF to compare its capabilities to a realistic and up-to-date benchmark. It would also generate opportunities to demonstrate these capabilities to regional neighbours, improving their deterrent impact.

Seventh, and relatedly, the ADF should prioritise participation in bilateral and multilateral military exercises that include the prominent use of autonomous systems, remote-operated platforms and other related technologies. The eighth recommendation is that this could also be achieved by gathering data from existing exercises and simulations, which could then be analysed and processed into usable training data without the need to organise specific exercises. Participating in these exercises would also generate relevant data for training future generations of autonomous systems, a valuable resource that could be leveraged to gain greater access to collaborative development programs with our more advanced partners. This participation would also provide valuable opportunities for members of the ADF to become familiarised with and acclimatised to these systems, which is a crucial factor in building the trust needed for their effective use in the battlespace.

Fittingly, the ninth recommendation is to invest directly in familiarisation and trust-building training among Australian Army personnel, particularly junior officers and non-commissioned officers. The initial efforts with DJI Phantom and Mavic civilian drones are a fantastic first step; however, as autonomous capabilities and AI-driven functionalities enter the ADF it is vital that the small combat unit leaders be comfortable with those systems. This could be accomplished through the partnered exercises discussed above, or through in-unit training. Where deployable systems are not yet ready for deployment, training could still be undertaken with simulators (such as the Weapon Training Simulation System or a command post wargame with an unseen human simulating an AI-enabled command assistant) or proxies (for example, civilian drones with waypoint navigation functionality).

The tenth recommendation is for Australia to increase its investments in developing and recruiting top-level talent in STEM-related fields among our domestic population. While this would require broader Australian Government participation, its impact would also be felt outside the defence community. Among the core barriers being faced by the United States and China in their efforts to develop AWS is a global shortage of top-tier talent, with recruiting sufficient numbers of AI engineers and programmers proving particularly difficult. As with the United Kingdom, Australia has an opportunity to punch well above its weight by fostering this expertise, either for export or to attract partners. Ideally, the next generation of experts would be funnelled into the ADF or DST Group in order to avoid the problems encountered by the United States in securing civilian participation in military AI projects. However, this would be resource intensive and would need to be targeted initially at the high-school and undergraduate levels. Therefore, this report limits itself to commending the Australian Government's current investment in STEM education and recommends that it be expanded in the short term.

The final recommendation of this report is that the Department of Defence and senior ADF leadership consider establishing an internal ADF AI collaboration and integration unit to coordinate joint investment and doctrinal development efforts across the Defence Force. Such a unit could be modelled on the United States JAIC. Given the importance of a relevant critical task focus for successful adoption, the unit would be a valuable tool for coordinating AI engagement across the service branches of the ADF, where there have been notable differences in the discourse around autonomous systems. For a TAS-based offset strategy to be effective within a joint future warfighting force, the components of that force need to be collaborating at the design stage, especially with AI-enabled systems that will need to be able to communicate in compromised or high-tempo situations.

Recommendations for developing Army's capacity to maintain a sufficient capability edge in trusted autonomous systems to sustain an effective future force asymmetry	
5:	Carefully evaluate how fellow middle power states approach key enabling technologies to identify opportunities for collaboration and emulation.
6:	Explore potential avenues for joint investment in autonomous systems, artificial intelligence and remote-operated platforms with friendly militaries and civilian firms in our region.
7:	Participate in targeted exercises alongside partner militaries in the region in order to generate useful data for training AI-enabled systems and acclimatise members to trusted autonomous systems.
8:	Develop an analytical model for adapting data from traditional military exercises (including personnel numbers, logistics information, communications protocols, unit equipment lists, and rules of engagement) for use in iterative simulations for training AI-enabled systems.
9:	Further develop familiarisation and trust-building training among Australian Army personnel.
10:	Invest in developing and recruiting top-level Australian talent in STEM-related fields to improve Australia's internal development capacity for autonomous systems.
11:	Establish an internal ADF AI collaboration and integration unit to coordinate joint investment and doctrinal development in AI-enabled systems.

In conclusion, this report has argued that, while potentially disruptive to regional stability, the emergence of a realistically adoptable major military innovation also offers the Australian Army an opportunity to maintain its security by offsetting its comparatively low population and military size by improving the utility, survivability and lethality of its Army. However, the Army must actively pursue these capabilities and commit to generating momentum for disruptive change within the ADF. Army leadership has already taken steps to improve the level of engagement and experimentation with autonomous and remote-operated systems at the unit level. Arguably the most important first step is that the ADF's intention to adopt and experiment with increasingly autonomous systems must be explicitly reflected in formal training objectives and transparently factor into investment decisions. This could then be further actioned by company commanders and senior NCOs, who should be encouraging experimentation with these technologies at the unit level. Beyond the question of autonomous systems, however, successfully fostering a stronger culture of questioning doctrinal orthodoxy within all arms of the Australian defence organisation, uniformed and civilian, will be vital for attaining and maintaining any meaningful capability offset into the future.

This is particularly important because the comparatively low barriers to the diffusion of key enabling technologies will make it more difficult for the Australian Army to maintain a significant advantage in core autonomous capabilities for an extended period. In this case, the advantage will come to the military that proves capable of the rapid, effective organisational innovation required to regularly re-set what is an inherently transient capability offset. Without being willing to take risks, challenge existing force structures and resolve the apparent critical task focus disconnect, the Australian Army will remain attached to its existing approach to warfare, limiting the applicability of TAS and undermining the effectiveness of any resulting offset strategy.[222]

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About the Authors

Dr Austin Wyatt is a research associate in the Values in Defence and Security Technology Group at The University of New South Wales at the Australian Defence Force Academy. His research concerns autonomous weapons, with a particular emphasis on their disruptive effects in Southeast Asia.

Dr Jai Galliott is Director of the Values in Defence & Security Technology Group within the University of New South Wales at Australian Defence Force Academy, where he also sits on the Faculty & University Boards. He also holds appointments as a Fellow of the Modern War Institute at the West Point and the Centre for Technology & Global Affairs in the Department of Politics and International Relations at the University of Oxford. He is further a former Royal Australian Navy Officer and has authored/edited the following books: Military Robots: Mapping the Moral Landscape (Routledge 2016), Force Short of War in Modern Conflict (Edinburgh University Press 2019), Big Data and Democracy (Edinburgh University Press 2020) & Lethal Autonomous Weapons: Re-Examining the Law and Ethics of Robotic Warfare (Oxford University Press 2021).