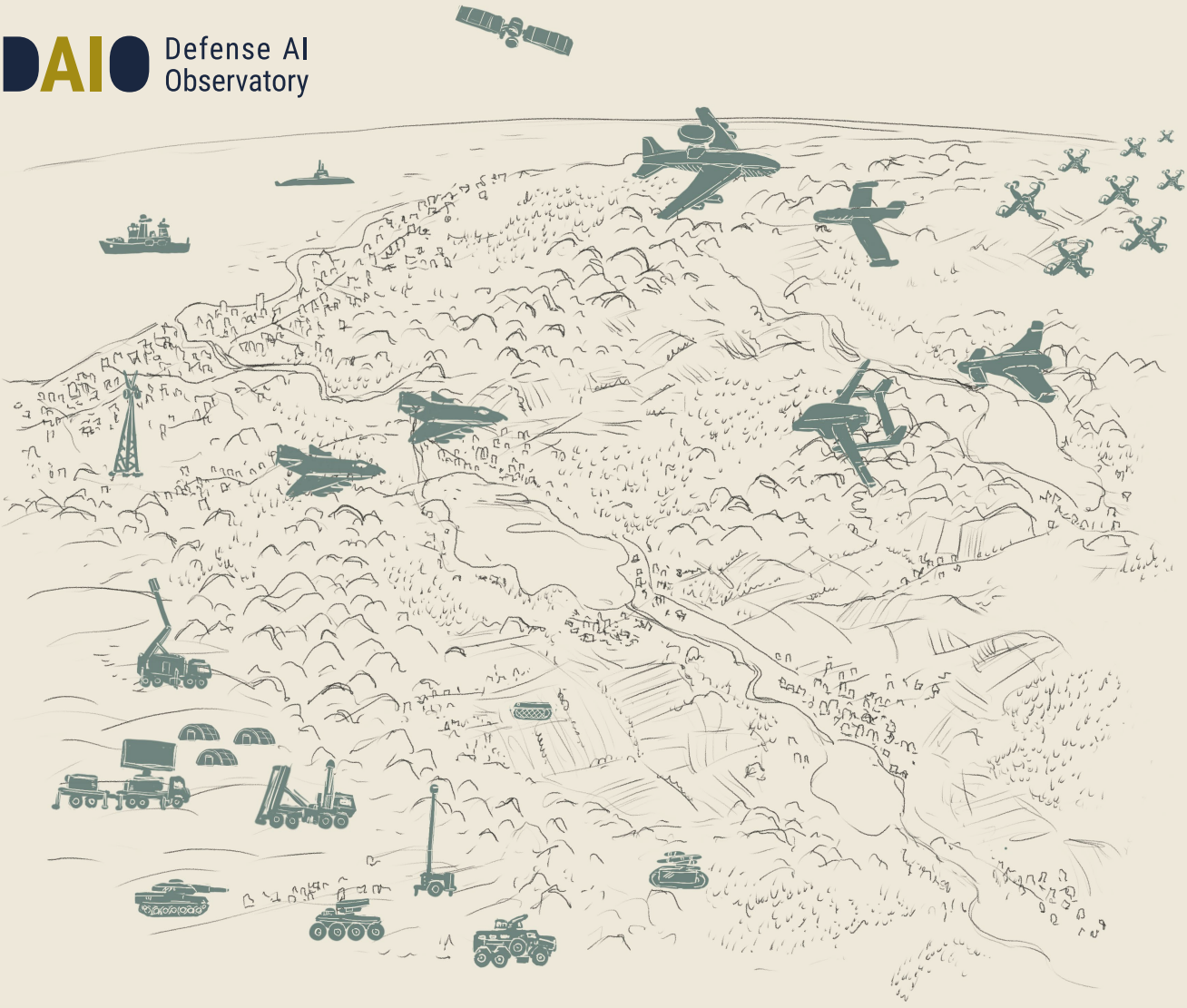
DAIO Defense AI Observatory



Evolution not Revolution

Australia's Defence AI Pathway

Peter Layton

DAIO Study 22|02

Ein Projekt im Rahmen von
dtec.bw
Zentrum für Digitalisierungs- und Technologieforschung der Bundeswehr

About the Defense AI Observatory

The Defense AI Observatory (DAIO) at the Helmut Schmidt University in Hamburg monitors and analyzes the use of artificial intelligence by armed forces. DAIO comprises three interrelated work streams:

- Culture, concept development, and organizational transformation in the context of military innovation
- Current and future conflict pictures, conflict dynamics, and operational experience, especially related to the use of emerging technologies
- Defense industrial dynamics with a particular focus on the impact of emerging technologies on the nature and character of techno-industrial ecosystems

DAIO is an integral element of GhostPlay, a capability and technology development project for concept-driven and AI-enhanced defense decision-making in support of fast-paced defense operations. GhostPlay is funded by the Center for Digital and Technology Research of the German Bundeswehr (dtec.bw).

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Peter Layton, "Fighting Artificial Intelligence Battles: Operational Concepts for Future AI-Enabled Wars," Joint Studies Paper Series, No. 4 (Canberra: Department of Defence, 2021) https://www.defence.gov.au/ADC/Publications/documents/joint_studies/JSPS_4.pdf.

Peter Layton, Algorithmic Warfare: Applying Artificial Intelligence to Warfighting (Canberra: Air Power Development Centre, 26 March 2018) https://airpower.airforce.gov.au/sites/default/files/2021-03/AP33-Algorithmic-Warfare-Applying-Artificial-Intelligence-to-Warfighting.pdf.

Design

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Content

1 Summary

The Australian Defence Force (ADF) defines Artificial Intelligence (AI) as "a collection of interrelated technologies used to solve problems and perform tasks that, when humans do them, requires thinking." AI is mainly envisaged as being used in human-machine teams to improve efficiency, to allow the force structure to be affordably expanded by adding many small AI-enabled systems, to achieve decision superiority by making better decisions and to decrease risk to personnel.

Importantly, these uses suggest AI is understood as a technology to do things better, not to do better things. AI is perceived as a sustaining innovation, not a disruptive one; this narrowness of vision may prove problematic if an adversary thinks differently.

The proliferation of AI means that in future conflicts all involved will probably use AI. Countering hostile state and non-state actor use of AI may be done through perception and control system attacks, information warfare and platform destruction.

The development of defence AI in Australia makes use of a well-defined innovation pathway that runs from initial ideas to in-service use. The Defence Science and Technology Group manages the Next Generation Technologies Fund that funds initial research into innovative technologies and concepts. Successful innovations then pass to the Defence Innovation Hub that funds up to the stage of prototyping, demonstration, and evaluation. Successful prototypes then pass into the defence acquisition system, run by the Capability Acquisition and Sustainment Group, to be turned into an in-service operational capability.

With experience from several years of operation, the pathway's structure has come under criticism. The major critique is that the pathway is fragmented into three major areas each managed by a different organization, each with different responsibilities and ambitions. A more coherent approach is needed where each segment of the innovation chain feeds into, and supports, the others.

The major R&D priorities relevant to AI are agile command and control, remote undersea surveillance, information warfare and managing military platforms through digital lifecycle management. The most active is the command and control priority that seeks both faster and superior decision-making to enable the ADF to deliver synchronized effects across all domains and operational levels.

Three important archetypal research projects are currently underway: the Airpower Teaming System (Ghost Bat aka Loyal Wingman), the M113 Optionally Crewed Combat Vehicle and the Bluebottle Uncrewed Surface Vessel. The three projects are quite different in aims although in each AI and human-machine teaming is at the core of their capabilities.

The Bluebottle is on the cusp of being operational as an Exclusive Economic Zone (EEZ) maritime patrol system while the Ghost Bat is intended to lead directly to an operational air combat capability in the next few years. In contrast, the M113 is an experimental platform for technology and land warfare operational concept development purposes. There are some company crossovers with Boeing Australia behind the Ghost Bat and BAE Systems Australia's AI Vehicle Management System on both Ghost Bat and the M113.

In looking to the future, the Force Structure Plan 2020 covering the next 10-20 years sets out six relevant major equipment acquisition projects, one Navy, one Army, three Air Force and one information and cyber domain. The projects in this decade are Air Force Teaming Air Vehicles (est. cost €6.15bn), Integrated Undersea Surveillance System (est. €4.19bn), Joint Air Battle Management System (est. €1.55bn) and Distributed Ground Station Australia (est. €1.01bn).

The introduction of AI to the Australian Defence Force raises training issues. In the near term, Navy sees the need to start service-wide AI education and training in three streams: specialists, generalists, and integration with industry. Army is similar in envisaging its future workforce being a mix of those with a basic AI understanding, more informed users, and specialists with advanced skills. Over the coming years, at almost every rank level, all personnel will require basic literacy in AI, including knowledge of its application, how to provide a level of assurance and quality control, and how to optimally combine AI with human intelligence.

Training involves more than people. AI systems will also need to be trained in a manner similar to their human operators by exposing them to operationally realistic scenarios so that the AI can develop knowledge bases from the data collected during these events. This training will not just be at the individual AI system level but also at the formation level where multiple AI systems will interact with multiple human-machine teams.

The development of defence AI in Australia may be impacted by the underway independent review of Defence innovation. However, this review is only expected to cause the AI ecosystem to evolve in fairly predictable ways. A revolution seems unlikely but could potentially happen if AI is at some time reconceptualized as a disruptive technology not a sustaining innovation.

2 Thinking About Defence AI

AI is a general-purpose technology that in the last decade has become pervasive across global society. This is principally because contemporary AI is overwhelming a commercial product, predominantly developed in the civil domain, and frequently designed to meet consumer market demands.

AI is now starting to be used for defence purposes, but the military comes late to the game. Defence AI is a case of technology push not technology pull. The result is that defence forces globally, and including Australia, are fundamentally uncertain about AI's place in warfighting. Accordingly, they are now deeply involved in numerous AI experimentation programs. Operational concepts will then be derived from these experiments with the concepts going on to drive future equipment acquisition programs.

While today's AI technology may not be optimized for defence purposes, there are definite upsides. Given mass civilian production, the technology is lower cost than defence-only technology traditionally is. Moreover, much of the personnel, training, logistics, industrial base, and service support foundation such technology needs are already available and spread widely across society.

Middle-power Australia fits within this paradigm. The Australian Department of Defence (Defence) use of AI fits within a broader national picture; it is effectively a subset although adjusted to meet specific defence needs, context, capabilities, and capacities.

Current Defence thinking about AI is nested within the overarching national AI Action Plan which itself is a key artifact within the Australian Government's Digital Economy Strategy. Australia's AI Action Plan sets out the Australian Government's vision for Australia to be a global leader in developing and adopting trusted, secure, and responsible AI.

The plan will be implemented under four primary focus areas, all of which can be imagined within a defence perspective. Focus One is supporting businesses to adopt AI technologies that increase productivity and competitiveness. Focus Two is creating an environment to grow and attract world's best AI talent. Focus Three is using cutting edge AI technologies to solve national challenges; in the defence domain these are identified as developing applications for intelligence mission data together with virtual reality and graphics applications. Focus Four stresses AI usage should reflect Australian values and that ethics are incorporated as the technology develops.[1]

1 Australia's AI Action Plan.

2.1 Conceptualizing AI

Within Defence there has been some uncertainty about what constitutes AI. The as-yet-unpublished Defence AI Strategy uses the definition put forward in the Royal Australian Navy's AI strategy document: "AI is a collection of interrelated technologies used to solve problems and perform tasks that, when humans do them, requires thinking."[2]

Such definitional precision is at least partly necessary as within Defence over the last five years there has been a conflation of AI and autonomy. Matters concerning AI are then often discussed in terms of autonomy, in some respects confusing a technology with a function and inadvertently creating conceptual difficulties when the two do not overlap. The Army Robotic and Autonomous Systems (RAS) strategy observes:

> Without [AI], RAS will reach autonomous limits quickly; remaining remote controlled and automatic at best. AI tools are also key to the decision support space, with machines able to rapidly analyse huge volumes of data, see patterns and make observations and recommendations.[3]

A second aspect of Defence's conceptualization of AI is noteworthy, although within mainstream thinking: the clear recognition of the centrality of data in supporting AI development. The 2021 Defence Data Strategy argues that maintaining "a capable, agile and potent" Australian Defence Force (ADF) will increasingly rely on AI technologies, and this means that Defence's data holdings must be managed and discoverable in a way that can adequately support AI development.[4] The strategy sets out the vision, pillars, practical initiatives, and priority data areas to elevate Defence's data maturity and become a more data-informed organization.

2.2 Joint and Single Service Thinking

Given the conflation with autonomy noted earlier, the Concept for Robotic and Autonomous Systems published in late 2020 is effectively the ADF's capstone publication informing its adoption of AI technology. In terms of AI, the concept aims to address how Australia's future defence force can best exploit AI to gain

2 RAS-AI Strategy, p. 8.
3 Robotic & Autonomous Systems Strategy, pp. 15-16.
4 Defence Data Strategy 2021–2023, p. 35.

advantages across the conflict spectrum and rather innovatively, how Australia can counter threats posed to the future defence force by AI.[5]

The key exploitation judgements are to use AI in human commanded teams to improve efficiency, increase mass and achieve decision superiority while decreasing risk to personnel. Efficiency involves using AI to perform certain tasks faster and more reliably than human operators, thereby increasing force capacity. In terms of mass, defence force structures can now move away from being a small number of exquisite platforms to instead featuring many, small, lower-cost, AI-enabled systems. In so doing, military forces will have many more battlefield ways possible to generate an advantageous concentration of combat power, disperse the force to enhance survival, and generate deception.[6]

AI use for decision superiority involves assisting making and implementing better and more accurate decisions, while using tempo and leverage to best effect. An important part of this is improving the situational understanding of human or machine decision-makers by improving their awareness, analysis, and comprehension. Lastly, systems employing AI can operate in ways that decreases the risks to defence force personnel during operations; AI systems can be programmed to be as fearless as the decision-makers wish.[7]

The joint service document was shaped by earlier single-service thinking. Equally, more recent single-service thinking is now building on the joint service document, providing additional depth and insights.

The Australian Army provided the initial impetus for the ADF formally thinking about AI. The Army's 2018 Robotic and Autonomous Systems Strategy document asserted such technology could improve decision-making, generate mass and scalable effects, enhance force protection, and improve efficiency. These attributes have some subtle differences to those which the joint service document sets out.

In terms of decision-making, the complicated battlespace of the future is seen as requiring AI processing of vast data troves of information on friendly and adversary forces to adequately support commanders at the operational and tactical levels. Moreover, AI through human-machine teaming could also potentially give a modestly sized army significantly increased combat power and mass through deploying large numbers of AI-enabled systems without the need to expand the human workforce. Likewise, humans might be better protected by transferring many current dangerous battlefield tasks, such as reconnaissance and intelligence

5 Concept for Robotic and Autonomous Systems, p. 22.
6 Concept for Robotic and Autonomous Systems, pp. 36-37.
7 Concept for Robotic and Autonomous Systems, pp. 40-42.

collection, to AI systems. Lastly, AI could noticeably enhance efficiency, particularly in the logistics chain. AI systems can bring "aware logistics," creating a "sense and respond" logistic structure that moves from a "just in case" to "as needed" as operations evolve.[8]

The Royal Australian Navy's (RAN) RAS-AI Strategy 2040 published in 2021 describes what the Chief of Navy considers the "five very fundamental effects" such systems will deliver:[9]

1. Force Protection involves protecting people by increasing their situational awareness and providing innovative alternatives to traditional maritime combat approaches, helping keep sailors out of harm's way.
2. Force Projection sees AI allowing the RAN to generate mass and tempo on a scale otherwise unachievable while enabling a presence in Australia's maritime reaches that crewed platforms could not, on their own, achieve.
3. Force Partnerships envisages the navy's AI systems being integrated by design with the overall ADF, and priority being given to interoperability with Australia's strategic partners.
4. Force Potential involves human-machine teaming maximizing human potential by allowing novel ways to conduct and sustain operations, reducing cognitive loads on commanders and enhancing training, simulation, and force level planning.
5. Sovereign Control encompasses two different aspects. Firstly, having a system of control that protects its data and secondly, the navy being able to rapidly task-organize multiple AI assets across air, land, sea, space, and electromagnetic domains. It is hoped new AI systems will be able to 'plug and fight' and be operational within days not years.[10]

The Royal Australian Air Force (RAAF) has not yet published a formal document related to its AI intent. The Chief of Air Force has though recently argued "artificial intelligence and human-machine teaming will play a pivotal role in air and space power into the future."[11] Achieving this seems mainly increasing personnel productivity through using AI to undertake tasks that are predictable, repetitive and which do not require imagination and innovation. AI is not about replacing people but instead allowing employing this "scarce resource" better. The Chief of Air Force's vision is that the RAAF "will be AI-enabled using robotics to augment roles, and humans working with machines, so they get the best out of both. The

8 Robotic & Autonomous Systems Strategy, pp. 9-14.
9 Laird, "The Australian Army, Navy and Air Force Shape a Way Ahead for the Inclusion of Autonomous Systems."
10 RAS-AI Strategy, p.14,
11 Laird, "The Australian Army, Navy and Air Force Shape a Way Ahead for the Inclusion of Autonomous Systems."

days of boring menial tasks will be gone. Our most scarce resource, our people, will focus on higher value and the creative tasks that we need."[12]

2.3 Key Emerging Concern

The joint service document as noted frets about countering hostile states and non-state actors using AI and envisages responding to this challenge using perception and control system attacks, information warfare and platform destruction:

- Perception Attacks aim to disrupt the ability of the AI to properly perceive its environment, possibly by inducing a false understanding of the situation.
- Control Attacks assume future AI systems will still need some human input or direction and that this connection may be purposefully obstructed.
- Information Warfare is a more complicated approach in trying to degrade the quality of the data that the AI system is using, whether when devising its operating algorithms or when using them.
- Platform Destruction is the most traditional in simply aiming to physically destroy the AI system although this is becoming more difficult as such systems may be small and used in mass swarm attacks.

As an important enabling effort to countering AI, Defence is developing the ability to collect technical intelligence on the algorithms and data utilised by adversary AI.[13] This will allow optimised counters to specific AI systems to be devised. However, generic counters will still be necessary given threat intelligence may have some gaps and shortcomings.

12 Laird, "The Australian Army, Navy and Air Force Shape a Way Ahead for the Inclusion of Autonomous Systems."
13 Concept for Robotic and Autonomous Systems, pp. 44-50.

3 Developing Defence AI

3.1 Defence AI Ecosystem

The development of AI for defence purposes, as with the thinking about AI's possible uses, fits within the national development plans and is augmented with the help of defense-specific institutions.

National Framework

As set out in Australia's AI Action Plan, the Australian Government is investing €63.33m over four years to establish a National AI Centre and four subordinate AI Digital Capability Centres (DCC). It is envisaged that this initiative will help drive collaboration between research organizations, businesses and industry and generate a thriving AI ecosystem.

The National AI Centre is intended to drive business adoption of AI technologies by coordinating Australia's AI activity, expertise and capabilities in a manner that improves national productivity and competitiveness. The centre will focus on key central themes including responsible AI, AI for diversity and inclusion, and AI at scale while becoming a focal point for international partnerships. The National AI Centre is organizationally located within Data61, the data and digital specialist arm of Australia's national science agency, the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

The four, lower-level DCCs are being established through an open competitive process that will see each funded for up to €7.43m to focus on a specific application of AI, such as robotics or AI-assisted manufacturing. The centres are principally aimed at supporting the commercialization of Australia's AI expertise and capabilities which often resides at the small and medium enterprise level.[14]

Internal Defence AI Ecosystem

In the defence domain, an AI ecosystem is also steadily being established and in being hierarchically lower is more complicated organizationally than the national level. The Australian Department of Defence has two main parts, one commanded by the Chief of the Defence Force (CDF) and the other managed by the Secretary of the Department of Defence. Each is responsible for different parts of the overall defence AI ecosystem.

14 "National Artificial Intelligence Centre."

The military CDF commands several entities including the Joint Capabilities Group that is responsible for progressing specific leading-edge capabilities such as AI for the military services. The Group has recently set up the Defence Artificial Intelligence Centre (DAIC) designed to build the capability foundations and accelerate the understanding and implementation of AI across Defence.[15] During the pandemic the DAIC developed data visualization and analytical tools for use by the Australian Defence Force COVID-19 Taskforce in its support of state and territory governments.[16]

As part of the DAIC initiative, the Joint Capabilities Group partnered with others to establish the Defence Technology Acceleration Collaboration Laboratory to better connect Defence with industry and university AI expertise. Through harnessing a multi-cloud environment that crosses various security domains, the laboratory can test prototypes that address capability challenges and guide the development of future capabilities.[17] The laboratory's initial studies involved Intelligence Mission Data, Virtual Reality and Graphics Applications.[18]

The largest portion of the Defence AI ecosystem falls under the civilian Secretary of the Department of Defence management. There are two major sections: the Defence Innovation Hub and the Defence Science and Technology Group (DSTG).

The Defence Innovation Hub, located within the Defence Industry Policy Division, is a flagship program funded at some €540m to function for ten years ending in mid-2030.[19] The Hub funds proposals that are ready to enter the engineering and development stages of the innovation process from concept exploration and technology demonstration, through to prototyping and integrated capability demonstration and evaluation (Technology Readiness Level, TRL 6-8).[20] Submissions are comprehensively assessed through a two-stage procurement process, in consultation with relevant military and civilian capability managers, and the DSTG. Independent technical and financial assessments are included as part of the evaluation process before use of the funding is finally endorsed by the Minister for Defence.[21]

The DSTG provides scientific advice to Defence and, in certain circumstances, devises innovative technological solutions to national defence and security needs. DSTG's latest strategic plan sees a continuing shift towards playing a stronger role in coordinating support to Defence from the national S&T enterprise that en-

15 Defence Data Strategy 2021–2023, p. 35.
16 Defence Annual Report 2019–20, p. 74.
17 Defence Data Strategy 2021–2023, p. 35.
18 "Special Notice: Artificial Intelligence Applications in Defence."
19 "Innovation opportunities and priorities."
20 "Defence Innovation Programs."
21 Patrick, "Question Details."

compasses other publicly funded research agencies, universities, and commercial enterprises, whether large or small.[22]

In terms of AI, a major entity within DSTG is the Trusted Autonomous Systems (TAS) defence cooperative research centre. TAS is funded through the Next Generation Technologies Fund that invested €34m over seven years, with further supplementation by other governmental funding when necessary. TAS facilitates emerging defence technology projects through coordinating, and at times collaborating with, other interested government, commercial and academic entities. Most projects are industry-led but TAS is also undertaking two common-good activities: Ethics and Law of Autonomous Systems, and Assurance of Autonomy.[23]

DSTG also works closely with universities including setting up the Defence AI Research Network (DAIRNet). This aims to establish and sustain a community of AI researchers who work together in an environment that stimulates new ideas and knowledge and which supports AI system evaluation, testing, and integration. DAIRNet is another initiative under the Next Generation Technologies Fund. There is also the more general Australian Defence Science and Universities Network (ADSUN) that connects DSTG into state-based research and innovation networks. DSTG has a senior Defence scientist, an Associate Director, embedded in each of the state-based networks to promote cooperation useful to Defence.[24]

Beyond national defence, DSTG also manages the National Security Science and Technology Centre (NSSTC) concerned with domestic and transnational security matters. The Centre is involved in advancing relevant AI, machine learning and data science capabilities.[25]

External Industry-Academia Defence AI Ecosystem

Small and medium enterprises (SME), which include start-ups, comprise some 90% of Australia's defence industry sector. Of the remaining 10%, there are a few medium-sized companies and several large foreign-owned businesses. Of the latter, BAE Systems Australia has been involved in AI developments for more than a decade. Boeing Australia has become active in AI over the last five years, while the Australian subsidiaries of Lockheed Martin and Northrup Grumman have recently become interested in AI in command and control systems. Within this ecosystem BAE Systems has done considerable work in-house whereas the

22 More, Together: Defence Science And Technology Strategy 2030, p. 2.
23 "Trusted Autonomous Systems".
24 "Australian Defence Science and Universities Network ADSUN."
25 "National Security Science and Technology Centre."

American companies have purchased relevant Australian SMEs or formed business relationships with them.

Australian SMEs are proving innovative in devising AI solutions. However, the SME dominance of the defence industry sector, combined with few adjacent relevant industries such as telecommunications and personal electronics, means there is a shortage of investment capital that limits SME growth possibilities. Given this, there are uncertainties over whether Australian SME AI innovations can transition to become a sustainable operational capability; for such a transition, larger sovereign Australian enterprises or consortia are considered necessary.[26]

The issue gains additional importance as AI, seen as encompassing algorithms, machine learning and deep learning, has been designated as a Sovereign Industrial Capability Priority. Accordingly, Australia "must have" access to, or control over, the skills, technology, intellectual property, financial resources, and infrastructure necessary for long-term defence capability support.[27] Given these requirements, the investment capital issue needs addressing to allow constructing Australian sovereign supply chains resilient to shocks and outside interference.

There are proposals to overcome the capital shortfall problem through shaping existing Government investment to generate enduring sovereign infrastructure that fosters SME growth. Significant capital and schedule efficiencies might be achieved through cost reduction of business and technical processes by creating a 'scaffolding' for re-use and leveraging of existing investments. Embracing enterprise collaboration may avoid wasteful duplication of effort, provide substantial efficiencies, and enable capital pooling that delivers outcomes unrealizable by individual enterprises.[28]

Supporting SMEs and the wider defence industry sector there is a new initiative, the Trailblazer Universities Program, intended to drive the commercialization of academic and industry research. Under this, the Concept to Sovereign Capability (CSC) project that encompasses defence AI will involve the University of Adelaide and the University of New South Wales working with industry to rapidly secure capital for both collaborative research projects and the commercialization of defence and dual-use technology successes. Over 80% of industry commitments to the CSC are from Australia-based SMEs.[29]

26 Robotics Roadmap for Australia 2022, p. 144.
27 Sovereign Industrial Capability Priorities, p. 1, 4.
28 Robotics Roadmap for Australia 2022, pp. 144-145.
29 Savage, "Universities blaze a trail to commercialise defence research."

International Cooperation

DSTG is involved in defense AI R&D collaboration within the Five Eyes community (Australia, New Zealand, Canada, UK, and US) through The Technical Cooperation Program (TTCP), and in specific bilateral collaborations with the UK and US. There is also growing interest in further developing S&T partnerships with Japan, the Republic of Korea, Singapore, India, and other countries in the Indo-Pacific region.[30]

In 2021, AI collaboration with the US and UK was expanded under the AUKUS enhanced trilateral security partnership that was formed to promote deeper information and technology sharing. The early AI research areas include improving the speed and accuracy of decision-making processes and defending against AI-enabled threats. In this, the initial focus is on accelerating AI adoption and improving the resilience of autonomous and AI-enabled systems in contested environments.[31]

Outside of the formal governmental processes, there are other linkages directly between countries and Australian AI companies. For example, the US Air Force's (USAF) venture capital division, AFVentures,[32] a part of the AFWERX technology development organization, has recently funded Australian AI company Curious Thing to reimagine the USAF recruitment process.[33]

3.2 Defence AI Priorities

The structure of the ecosystem impacts the ongoing development of defence AI in Australia. The various organizations and agencies manage a diverse array of programs that both reflect current priorities and the exploration of new areas considered to have high potential to create future priorities. In a similar way to earlier sections, there are stated priorities at the national level for AI development and at the lower-down defence levels. These priorities are at times expressed in terms of technology and other times in terms of functions.

National Blueprint for Critical Technologies

Critical technologies are those considered by the Australian Government to have the capacity to significantly enhance, or pose a risk to, Australia's national interest. They are perceived as fundamental to Australia's economic prosperity, social

30 More, Together: Defence Science And Technology Strategy 2030, p. 9.
31 "Implementation of the Australia – United Kingdom – United States Partnership (AUKUS)."
32 For more on this, see: https://afwerx.com/afventures-overview/ (last accessed 17 May 2022).
33 "Sydney AI startup launches HR tech services in Silicon Valley."

cohesion, and national security, and be increasingly the focus of international geopolitical competition.[34] The 2021 Action Plan for Critical Technologies identifies 63 technologies critical now or anticipated to become critical within the next ten years. From this rather large register, the Critical Technologies Policy Coordination Office has decided the initial focus should be on nine specific technology areas. In the AI technology area, there are four critical technologies of immediate priority: advanced data analytics; AI algorithms and AI hardware accelerators; machine learning (including neural networks and deep learning); and natural language processing (including speech and text recognition, and analysis).[35]

Defence Innovation Hub AI Priorities

The Defence Innovation Hub (noted earlier) has three major innovation priorities of which the second is key enabling technologies including AI, machine learning, cloud adoption, quantum technologies and IT automation.[36] Within this broad listing the Hub has a particular interest in two AI-relevant areas: "leveraging emerging opportunities in AI and machine learning to support complex decision making and reduce the need for human intervention" and "developing and leveraging enterprise-wide cloud capabilities, with consideration of applicability to operational contexts, to deliver enhanced data management outcomes."[37]

Defence Science and Technology Group AI Priorities

In 2020, the DSTG established eight so-called STaR Shots to focus its strategic research investment program and proactively develop new leap ahead Defence capabilities. The STaR Shots collectively support the ADF's ability to prevail in contested environments and will shape how the ADF operates and generates new military effects. STaR Shots involve modelling and simulation, wargaming, prototyping, experimentation, trials and culminate in technology demonstrations during ADF exercises.[38]

Four STaR Shots have particular relevance to AI technology development:

1. The agile command and control STaR Shot seeks both faster and superior decision-making to enable the ADF to deliver synchronized effects across all

34 Blueprint for Critical Technologies, p. 3.
35 The Action Plan for Critical Technologies, pp. 7, 25.
36 The first priority is: Intelligence, Surveillance, Reconnaissance, Electronic Warfare, Space and Cyber. The third priority is: Land Combat, Amphibious Warfare and Special Operations.
37 "Innovation opportunities and priorities."
38 More, together: Defence Science and Technology Strategy 2030, p. 12

domains and operational levels. Work in this area will include AI, human-machine teaming, autonomy, real-time battle simulation modelling, and exploitation through data analytics of very large, diverse data sets.[39]

2. The information warfare STaR Shot will develop information warfare capabilities integrated across human, information and physical dimensions to allow the ADF to fight in and through contested information environments. The research includes applying AI and machine learning to deliver information warfare capabilities at speed and scale.[40]
3. The remote undersea surveillance STaR Shot aims to develop advanced undersea surveillance capabilities appropriate to a congested and highly contested underwater environment, particularly to support future theatre anti-submarine warfare. The research focuses on fully integrated sensor systems and networks that provide persistent coverage over wide expanses of ocean over long periods of time. This involves AI and machine learning in both autonomous systems and in devising trusted unsupervised detection, classification, localization and tracking algorithms.[41]
4. The battle-ready platforms STaR Shot aims to demonstrate the ability of the combined power of digital engineering and AI to enable the ADF to be both ready when needed and fit for purpose in a rapidly evolving threat environment. The STar Shot is intended to shift the current approach of managing platforms to a new digital lifecycle management concept to enhance the speed and accuracy of design, verification, modification, and sustainment of Defence platforms.[42]

The STaR Shots have a near-to-medium term focus. For beyond this, the DSTG manages the Next Generation Technologies Fund that focuses on the "future Defence force after next." The fund has been allocated some €500m to invest over the decade to 2025-26. Innovative technologies and concepts researched under the Next Generation Technologies Fund (NGTF) could then be further developed into being at TRL 6-8 through the Defence Innovation Hub funding.[43]

The NGTF recently sought proposals for the use of AI to process noisy and dynamic data to ensure decision superiority. The proposal call is titled "Patterns in Noisy and Dynamic Data" and envisages researching data fusing and constructing causal models from a wide range of modalities and diverse forms, in large volumes, and collected at varied rates. The diverse data types vary from physically

39 "Strategy: Agile Command and Control."
40 "Strategy: Information Warfare."
41 "Strategy: Remote Undersea Surveillance."
42 "Strategy: Battle-Ready Platforms."
43 "Defence Innovation Programs."

measured sensor data to discrete or tokenised data such as in natural language documents.[44]

Continuing in the decision superiority theme, "The Artificial Intelligence for Decision Making Initiative 2022" was recently launched. This program involves DSTG, the Office of National Intelligence and the DAIC funding up to 50 pilot project "challenge based" proposals related to AI and machine learning. Funded projects will demonstrate prototype solutions, in the form of a software tool or related product that demonstrates the solution to the chosen challenge. The intent of the Initiative is to fund individuals to undertake three-month projects at a fixed cost of €20,000 per project.[45]

Decision-making also features in a major program on which DSTG is working with the state-based Defence Science and Universities Network. The "Modelling Complex Warfighting Strategic Research Investment" program aims to revolutionize how DSTG undertakes operations analysis, and in particular analyze the complex interactions of geopolitical, social, technological, economic and cultural factors, and the effectiveness of ADF response options within that operating environment.[46] Program outcomes will contribute to the Defence agile command and control STaR Shot.

The program is broken into three projects with the third being "AI and advanced analytics for decision-making."[47] The project includes investment in an advanced computing environment that supports the big data requirements to train AI, plastic software architecture, and visualization tools for decision-makers.[48]

3.3 Important Defence AI Projects in Development

There are three important defence AI R&D research projects underway that each illustrates various aspects of the current thinking about defence AI, the ecosystem, and R&D priorities.

44 "Defence Artificial Intelligence Research Network (DAIRNet) Research Call."
45 "Opportunity: Artificial Intelligence for Decision Making Initiative 2022."
46 "Modelling Complex Warfighting Strategic Research Program."
47 The other two are "modelling in the grey zone" and "agile whole-of-force analysis." See: "Modelling Complex Warfighting Strategic Research Investment."
48 "Modelling Complex Warfighting Strategic Research Program."

Loyal Wingman Airpower Teaming System

Boeing Australia's Airpower Teaming Systems most visible component is a jet powered Uncrewed Air Vehicle (UAV) with fighter-like performance. Initially called Loyal Wingman and now designated the MQ-28A Ghost Bat, this UAV uses cognitive AI to allow teaming with crewed fighter aircraft for air combat, reconnaissance, and surveillance missions in contested environments. The RAAF Chief, Air Marshal Mel Hupfeld, recently declared:

> The true value [of the project] is…hidden inside the airframe of Loyal Wingman. And that is the development of the code and the algorithms which form the AI behaviours that will optimize its combat capability. The Loyal Wingman project is a pathfinder for the integration of autonomous systems and AI to create smart human-machine teams.[49]

The joint venture between the RAAF and Boeing started in 2017 with some €100m so far invested.[50] A major step forward was a 2019-2020 experimentation project approved by TAS and run by Boeing Australia that embedded machine learning techniques on board four small test-bed UAVs allowing them to detect, decide, and act during missions. In the Ghost Bat the AI is embedded in the BAE Systems (BAES) Australia flight and mission control system.

The prototype flew in February 2021 with five more since built; a final assembly facility for production UAVs is being constructed at Wellcamp in Queensland.[51] The government recently announced a further seven will be acquired to enter service with the RAAF in 2024-25.[52]

M113 Optionally Crewed Combat Vehicle

In 2019, BAES Australia converted two M113 AS4 Armoured Personnel Carriers into Optionally Crewed Combat Vehicles (OCCV). This project involved the TAS and used the Next Generation Technologies Fund. The vehicles assisted the Australian Army's Robotic and Autonomous Systems Implementation and Coordination Office better understand opportunities to employ autonomy on the battlefield and the implementation of the 2018 Robotics and Autonomous Systems Strategy. Natalie Waldie, BAES Program Manager Technology Development observes: "The M113 [is] a convenient (…) experimental platform to demonstrate autonomy. Autonomy doesn't achieve what it needs to unless you can effectively integrate it

49 Laird, "The Australian Army, Navy and Air Force Shape a Way Ahead for the Inclusion of Autonomous Systems."
50 Ferguson, "Loyal Wingman officially named MQ-28A Ghost Bat."
51 Loyal Wingman: A Three-Year Journey From Design To Flight.
52 "Defence orders seven additional Ghost Bats."

into your overall battle space CONOPS, and that's really what we're exploring with Army."[53]

In 2020, a further 16 M113 AS4 vehicles were converted to OCCVs in a €5m project that also funded two years of additional testing. In 2021, four OCCVs participated in Exercise Koolendong, a live-fire warfighting exercise in the Northern Territory, which tested the vehicles' ability to operate in harsh combat environments.[54] The M113s use the BAE Systems Vehicle Management System (VMS) developed over the last two decades at the company's Red Ochre LABS in Adelaide. The VMS incorporates AI and is derived from the company's' domain agnostic autonomy technologies that have been used on several other programs, including in the Ghost Bat.[55]

Bluebottle Uncrewed Surface Vessel

The OCIUS Technology Bluebottle is an uncrewed, long-duration, autonomous, 5 knot surface vessel that operates on solar, wave and wind power, and can carry a payload of some 300kg including thin line sonar arrays, radar, 360-degree cameras, an automatic identification system (AIS), and other sensors. Bluebottle incorporates AI neural networks, edge computing processing of sensor signals, low bandwidth communication links and a "team" based software architecture where peer vessels independently manoeuvre to achieve the group's assigned common goals, such as making an interception.

Blue Bottle was initially funded in 2015 under Round 19 of the DST Group Capability Technology Demonstrator programme, which is now within the Defence Innovation Hub.[56]

In 2021, four Bluebottles began operating as an intelligent network patrolling Northern Australian Indian Ocean waters fitted with a payload able to detect unauthorized vessels, alert a shore based command centre and then approach the intruder for detailed investigation. Future concepts include several vessels acting together as a wide-area sonar array to detect submarines and a single Bluebottle acting as a 'gateway node' between underwater uncrewed vessels or a seabed sensor system and a shore-based data centre.

53 Levick, "Keeping the M113 relevant as unmanned platforms."
54 McLaughlin, "Australian Army receives 20 optionally-crewed, M113AS4s."
55 Levick, "Keeping the M113 relevant as unmanned platforms."
56 Durrant, "Bluebottle ASW USV trial success."

Assessment

The three projects are quite different in aims although in each, AI and human machine teaming is at the core of their capabilities. The Bluebottle is on the cusp of being operational as an Exclusive Economic Zone (EEZ) patrol system with the Ghost Bat intended to lead directly to an operational air combat capability in the next few years. In contrast the M113 OCCV is simply an experimental platform for technology and operational concept development purposes. There are some company crossovers with Boeing Australia behind the Ghost Bat and BAES Australia's AI VMS on both Ghost Bat and the M113 OCCV.

In terms of exports, Ghost Bat would require US approval. Boeing is already pitching some of the Ghost Bat technology for inclusion in emerging USAF uncrewed air vehicle programs. Similarly, BAES Australia exports of its VMS would probably require UK approval.

4 Organizing Defence AI

Defence is deeply involved in numerous experimentation projects to better understand AI and the contribution it may make. Even so, initial steps concerning organizational matters are being undertaken.

Within the Joint Capabilities Group noted earlier, a central organisation has been established to coordinate Army, Navy and Air Force efforts and ensure common AI approaches are taken. This central organisation will also advance the development of the ADF's operating concept, common terminology, and joint force integration.

Implied in this approach is that AI will not cause significant structural change within Defence but rather be simply absorbed as just another new technology. AI is conceived as being used to either enhance, augment, or replace existing capability, meaning the existing Services will not be greatly impacted. Organizationally, Defence will apparently remain as it now is well into the future, at least in terms of AI. This replicates the approach being taken by Australia's major allies but importantly allows interoperability to be more readily maintained than if there were major structural changes.[57]

As part of the initial organizational steps, it is considered the acquisition of data storage and access capabilities must commence immediately. Such capabilities will be the foundation of AI used by Defence in the future. Moreover, building human confidence in AI will also begin, with trust built on relatively simple systems in preparation for the introduction into service later of more complex systems.[58]

The focus on experimentation has led to the development of the already discussed, well-defined organizational innovation pathway that leads from "good idea" to in-service use. The DSTG manages the Next Generation Technologies Fund that funds the initial research into innovative technologies and concepts. Successful innovations then pass to the Defence Innovation Hub that funds up to the stage of prototyping and integrated capability demonstration and evaluation (TRL 6-8). Successful prototypes then pass into the defence acquisition system, run by the Capability Acquisition and Sustainment Group (CASG), to be turned into an in-service operational capability.

There are several issues with this pathway. First, in considering AI priorities, these tend to reflect not just Defence needs but also the various organizational imperatives. The design of the ecosystem can influence what is researched and this may not be thought high priority by other parts of Defence, or even address ADF requirements. The result can be that the innovation system funds developing a technology up to TRL 6-8 which then needs to find a problem to solve. If a problem

57 Concept for Robotic and Autonomous Systems, pp. 54-55, p. 60.
58 Concept for Robotic and Autonomous Systems, p. 56.

can't be found by the developer, then the technology can't be acquired by CASG and so make the final jump in the innovation pathway. The Hub's Information Guide somewhat unhelpfully advises companies reaching this stage: "Acquisition decisions are made through separate processes that you will need to navigate."[59]

Second, in considering AI research financing, the Defence Innovation Hub is effectively attempting to be a Defence-internal venture capital fund. Such funds though are high risk and Defence as a government entity must follow government procurement guidelines which are designed to be risk averse.

Finally, and with experience from several years of operation, the structure has also come under criticism. The major critique is that the pathway is fragmented into three major areas each managed by a different organization, each with different responsibilities and ambitions.

Reflecting upon these three aspects, Chris Deeble, Chief Executive of Northrup Grumman Australia, argues it's important not to look at innovation in isolation from every other part of the ADF capability development process. Instead, a coherent approach is needed where every part of the innovation chain feeds and supports the other parts, instead of being separate.[60] To achieve such an outcome, Richard Williamson, Defence Science Centre, suggests aligning the Defence Innovation Hub with CASG, creating an integrated acquisition system that avoids problems such as the: "Defence Innovation Hub investing $7.35 million in an alternative to rigid-hull inflatable boats when CASG had already committed $53.3 million to procuring 41 vessels of an existing solution."[61] Former chief Defence scientist Alex Zelinsky agrees but instead wants change at the start of the process, arguing the Next Generation Technologies Fund and Defence Innovation Hub aren't well connected and need to be made seamless. Even so, he returns to the role of CASG as the ultimate acquisition authority in noting that acquisition is the key to success and should be used to support innovation.[62]

An alternative position is put by Jason Scholz, CEO TAS, who argues that Defence future force structure funding should move away from being dominated by the big, long-term acquisition projects that CASG runs and instead include funding shorter-term, high-impact innovation opportunities. This would allow opportunities for seriously disruptive innovation from outside the defence ecosystem, noting: "You didn't get Uber from within the taxi industry."[63]

59 Defence Innovation Hub: Industry Information Guide
60 Ferguson, "Peever Review could transform defence innovation and acquisition."
61 Williamson, "Putting defence innovation into the hands of the ADF personnel who use it."
62 Ferguson, "Peever Review could transform defence innovation and acquisition."
63 Ferguson, "Peever Review could transform defence innovation and acquisition."

In late 2021, the Australian Government announced a comprehensive, independent review of Defence innovation headed by former Rio Tinto Australia managing director David Peever. The review was to report by the end of 2021 however, by mid-2022 it had not yet publicly released.[64] Amongst the issues to be assessed by the review were improving links between academia and industry, finding better ways to commercialize Defence-funded innovation, simplifying contractual arrangements for companies receiving innovation funding and strengthening the involvement of the three Services to direct 'mission-set' specific innovation.[65]

64 Price, "Defence innovation system goes under microscope."
65 Terms of Reference for the independent review into Defence Innovation.

5 Funding Defence AI

Earlier sections have included details of the planned R&D spending over the next several years. Beyond R&D, funding is provided by major capital equipment acquisition projects that will each involve extensive use of AI and machine learning technologies. The latest force structure plan was issued in 2020 and had six relevant major projects, one Army, three Air Force, one information and cyber domain, and one Navy. Four projects are in this decade: Air Force Teaming Air Vehicles, Integrated Undersea Surveillance System, Joint Air Battle Management System, and the Distributed Ground Station Australia.

5.1 Army

Under the new Future Autonomous Vehicles project, a fleet of uncrewed systems and vehicles, sufficient for up to brigade operations in size, will be acquired to support land force operations. This project will build from the M113 experimentation program and aim to enhance the war-fighting capability of the ADF while also protecting Australian personnel. The acquisition phase of the project is scheduled to run 2033-2040 and has been allocated a budget for planning purposes of €5–€7.5bn.[66]

5.2 Air Force

The Ghost Bat/Loyal Wingman R&D program is envisaged being bought into service through a major project titled "Teaming Air Vehicles." This project will involve the "acquisition of remotely piloted and/or autonomous combat aircraft, including teaming air vehicles, to complement existing aircraft and increase the capacity of the air combat fleet." The project's acquisition phase is scheduled to run 2026-2040 with a currently allocated budget provision of €5–€7.4bn.[67]

The Distributed Ground Station Australia acquisition project will run between 2024-2031 and cost an estimated, €0.8–€1.2bn. [68] This processing, exploitation and dissemination facility will be responsible for the analysis of data collected from Air Force intelligence, surveillance, and reconnaissance aircraft. Staff will be able to access national and open-source intelligence resources and use AI to rapidly fuse collected information to provide decision-makers with greatly enhanced near-real time situational awareness of events.

66 Force Structure Plan 2020, pp. 72, 77.
67 Force Structure Plan 2020, pp. 51, 57.
68 Force Structure Plan 2020, p. 57.

The Joint Air Battle Management System (JABMS) acquisition project running from 2023-2031 has a budget provision of €1.2–€1.9bn.[69] JABMS will provide greater situational awareness to deployed ADF forces from advanced air and missile threats and improve interoperability with allies. The project has short-listed Lockheed Martin Australia and Northrop Grumman Australia. The former is working with Australian company Consilium Technology on examining modelling, simulation and AI technologies that can be rapidly combined into an open architecture framework. Consilium Technology is also exploring the use of machine learning to support future all-domain data transfer capabilities during contested warfighting environments.[70] Another company, Consunet, is also participating in the project using AI for developing spectrum awareness and management tools, and electromagnetic spectrum modelling.[71]

5.3 Information and Cyber Domain

Defence has responsibilities for some defensive and offensive cyber capabilities, and certain intelligence collection systems. The force structure plan states that "funding will be set aside to ensure Defence remains competitive in the future as emerging technologies, such as artificial intelligence, arise in this domain." A new major acquisition project titled Emerging Technologies has been pencilled in for 2033-2040 with a budget provision of €1.14–€1.7bn.[72]

5.4 Navy

The Integrated Undersea Surveillance System acquisition project runs between 2025-2040 and has a budget provision of €3.38–€5bn. The project will bring into service an integrated undersea surveillance system and examine the utility of optionally crewed vessels, uncrewed surface systems and uncrewed undersea systems.[73]

69 Force Structure Plan 2020, p. 57.
70 "Consilium Technology designs and tests AI capability for Air 6500."
71 "Consunet developing AI technologies for AIR6500."
72 Force Structure Plan 2020, pp. 27, 31.
73 Force Structure Plan 2020, pp. 39, 45.

6 Fielding and Operating Defence AI

There are more organizations involved in Australian defence AI than only those at the government department level, joint service, dedicated science agencies or universities. The individual services, Navy, Army, and Air Force, each have their own internal entities that consider and support emerging technologies that might enhance their discrete warfighting capabilities.

6.1 Navy

To guide its adoption of AI, the Navy has a three-part policy of engagement, design, and demonstration. First, Navy will engage widely across Defence, with defence industry and with allies. Second, Navy will use a concept-led design approach to architectures, mission management and common control systems. Third, Navy will generate opportunities to demonstrate emerging and developed AI capabilities to operational users. This will both help develop new AI systems and expedite the introduction of fit-for-purpose capabilities into naval service.

Within the Navy, the Warfare Innovation Navy (WIN) branch established in 2018 is the AI focal point both within Australia and internationally, including at the NATO Maritime Unmanned Systems Initiative meetings. WIN is located within Navy's operational level headquarters at the Fleet Base East in Sydney and is currently facilitating an experimentation program to support force structure options development and capability improvements.

In terms of demonstration, the Autonomous Warrior (AW) series regularly displays, evaluates, and trials emerging AI capabilities at various TRLs. AW provides an opportunity to increase mutual understanding between industry and the Navy in a realistic environment while fostering collaborative relationships. AW involves four events conducted annually with each event having a specified operational focus and undertaken at different exercise locations, depending on the nature of the activity and convenience for industry.[74]

6.2 Army

In 2020, the Australian Army set up an organization somewhat like the WIN. A difference however is the Robotic and Autonomous Systems Implementation and Coordination Office (RICO) is within the Future Land Warfare Branch of Land

74 RAS-AI Strategy, p. 22,

Capability division at Army's strategic level headquarters in Canberra. RICO's role involves exploration, coordination, and concept development of disruptive technology, specifically including AI. Director General of Future Land Warfare, Brigadier Ian Langford, states that RICO fits Army's "vision of being future-ready by looking for opportunities to integrate technology as well as becoming a more intelligent customer."[75]

6.3 Air Force

In 2015, the Air Force set up Plan Jericho to begin building an ecosystem in which good ideas, whether from within Air Force or externally, could answer military problems by translating and accelerating leading-edge knowledge and thinking into new defence capability. The intent was for partnerships with industry, academia, and broader society to support, inform and enable the rapid exploration and realization of ideas of researchers, innovators, and entrepreneurs. Since then, the concept has been sharpened and re-oriented to provide the infrastructure and services to make it easier to build partnerships across organizations and access the expertise and resources necessary.

Jericho has three main teams. The Jericho Edge team initially engages with partners to identify and understand opportunities. The Edge team then brings in Jericho Labs to assemble communities of interest across large-organizations, start-ups, small companies, and universities to discover, test, and prototype the identified opportunities. The separate Jericho Analytics team then tests the new ideas using net assessment, wargaming and red teaming.[76]

Jericho's present thrust is in augmented intelligence, a concept developed from ideas of human-machine teaming. It is seen as combining the creativity and flexibility of humans with the tempo, precision, and mass of machines. The intent is to generate human-inspired dilemmas at machine speeds to cognitively overwhelm adversaries.

75 Smith, "New office to oversee disruptive technology (ARMY NEWS)."
76 "Jericho implementation model."

7 Training for Defence AI

7.1 Future Training Requirements

Within Defence, some organizations have begun thinking about the training issues that the widespread introduction of AI will bring.[77] Such training is situated within the national approach. In Defence, the single Services are responsible for raising, training, and sustaining their assigned force elements. The Navy is the furthest advanced in considering the impact of AI with the Army having given training matters some initial thought. The Air Force has not publicly released its thinking on training.

Joint Workforce Perspective

The relevant ADF joint concept publication only briefly mentions training. Importantly though, it notes that with the introduction of AI military training will involve not just humans but also the AI. AI systems will need to be trained in a manner similar to their human operators by exposing them to operationally realistic scenarios so that the AI can develop knowledge bases from the data collected during these events. This training will not just be at the individual AI system level but also at the formation level where multiple AI systems will interact with multiple human-machine teams.[78] AI machine learning is where most attention is currently focused. However, in the future collective training involving humans and AI will become increasingly important. Such events will also allow humans who are teamed with AI, or who work with AI systems, to gain confidence in their reliability and dependability.

Navy Workforce Perspective

The Navy presently leverages expertise from industry and academia to deliver formal AI training and on-the-job upskilling. The latter "learning by doing" approach is increasingly important in growing the Navy's AI workforce. The Navy plans to continue to build upon these industry and academic relationships but sees the need to start Navy-wide AI education and training in three streams: specialists, generalists, and integration with industry.

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77 In addition, AI education raises more general issues that are relevant to Australia's overall workforce. For example, the CSIRO has estimated that Australian industry will need up to 161,000 new AI specialist and AI shrewd workers by 2030. In response, CSIRO is funded to Deliver the Next Generation AI Graduates Program that aims to train at least 234 home-grown, job-ready AI specialists through competitive national scholarships. For more, see: "Australia's Digital Economy: Digital Skills"; "Next Generation Graduates Programs."

78 Concept for Robotic and Autonomous Systems, p. 34.

- Specialists: In the near-medium term, the Navy considers it will need to rapidly develop new specialist skills through either instituting new employment categories or expanding and re-defining existing ones. The more important new specialist skills are Technician, Data Specialists, AI System Operators and Test & Evaluation.

- Generalists: The Navy's total workforce will need to incorporate foundational AI technology literacy. All commanders, operators and decision-makers will need to have a foundational understanding of AI. This is likely to include basic skills in machine learning, as well as an understanding of teaming and social decision-making. The Navy believes that introductory AI courses should be introduced into ab initio training as soon as possible.

- Integration with Industry: The speed of AI development will not allow the Navy to maintain in-house all the necessary AI skills required. Industry will be required to house, maintain, and deliver AI systems and will also increasingly play a role in analysis and decision support to deployed forces. These elements of workforce transformation are not mutually exclusive. While by 2040 Navy's whole workforce will require foundational AI knowledge, the Navy will still require specialists with deep knowledge and training as well as the ongoing delivery of specialist training and education by industry and academia. For some categories, such as Combat Systems Operators, the change will be evolutionary. For other categories, the introduction of AI will be disruptive and require close collaboration between AI technologists, category managers and workforce planners.[79]

Army Workforce Perspectives

The Army is taking a more philosophical approach than the Navy. This partly reflects that the changes to the Army education and training that AI bring may be far-reaching. Army personnel often perceive their service as being personnel, not equipment oriented. An oft-used saying declares that "the Army equips the man, but the Navy and Air Force man the equipment." This logic would suggest the Navy and Air Force would find it easier to adjust their existing education and training approach as AI is simply another digital technology to absorb. There is an emerging belief that in the age of AI, the Army may have to rethink the importance of technical training to be comparable to the other services.

79 RAS-AI Strategy, p. 19.

Looking to the future, with AI already proliferated across the commercial domain, AI is similarly likely to proliferate across the Army. It may be used in intelligence analysis, strategic decision support, operational planning, command and control, logistics, and weapon systems. To use AI however, organizations will need their personnel to be well informed to both shape the application of AI and provide quality assurance.[80]

Armies will need more than just deep technical experts in the development of algorithms and the design of AI for military systems. The Army's future workforce using AI should be a mix of those with a basic understanding, more informed users, and specialists with advanced skills. Over the coming years, at almost every rank level, Army personnel will require basic literacy in AI, including knowledge of its application, how to provide a level of assurance and quality control, and how to optimally combine it with human intelligence. The Army's military education and training system does not currently provide technological literacy for all their personnel. However, it is the coupling of technical experts with a heightened technological literacy across the entire force that will allow future military organizations to fully exploit the benefits of artificial intelligence.

7.2 Enhanced Training Using AI

AI may change the way militaries educate their personnel. AI tutoring systems can already provide one-on-one human tutoring and this concept could be further developed into having an AI lifelong-learning partner accompanying individuals from entry into the military and through their career. In a similar manner, military instructors may have their own teaching assistant able to communicate with their students' AI partners to interpret individual students' profiles and provide suggestions on tailored learning.

AI may also help develop the cognitive skills that underpin higher-level operational and strategic planning in teams. This could be done by offering more authentic environments for collaborative learning, large-scale wargame simulations, providing more intelligent adversary systems to challenge students, and using purpose-designed algorithms and curriculum data to amalgamate lessons from previous activities.[81]

Field training using AI has both benefits and warnings. Training will need to evolve to properly incorporate human-machine teams, but these teams should

80 Ryan, "Intellectual Preparation for Future War: How Artificial Intelligence Will Change Professional Military Education."
81 Ryan, "Intellectual Preparation for Future War: How Artificial Intelligence Will Change Professional Military Education."

not become overly dependent, complacent, or uncritical in using the technology. Training scenarios must develop users who "trust but verify," that is, have confidence in the AI without being uncritically accepting of it. In this regard, data powers AI machine learning. Capturing and managing the data generated in training environments will be important to refine machine learning and system improvement.[82]

82 RAS-AI Strategy, p. 19.

8 Conclusion

The ADF's conception of AI's utility for defence purposes is largely conventional. AI is mainly conceived as being used in human-machine teams to improve efficiency, increase mass, and achieve decision superiority while decreasing risk to personnel. Even so, middle power Australia is following a relatively active AI development program with a well-defined innovation pathway and numerous experimentation projects underway.

There is also a reasonable level of force structure ambition. The latest major equipment acquisition plan, covering the next 10-20 years, sets out six defence AI-relevant projects, one Navy, one Army, three Air Force and one information and cyber domain. Even in this decade, the AI associated projects are quite substantial and include Air Force Teaming Air Vehicles (est. cost €6.15bn), Integrated Undersea Surveillance System (est. €4.19bn), Joint Air Battle Management System (est. €1.55bn) and Distributed Ground Station Australia (est. €1.01bn).

Associated with this investment is a high expectation that there will be considerable involvement by Australian AI companies. Indeed, in the last six months AI has been determined to be a Sovereign Industrial Capability Priority. The Australian defence AI sector though is mainly comprised of multiple SMEs that individually lack the scale necessary for major equipment projects and would need to partner with large prime contractors to achieve the requisite industrial heft. There are also wider national concerns about whether Australia will have a large enough AI workforce over the next decade to handle commercial demands, even without Defence drawing people away for its requirements. Both factors suggest Defence could end up buying its AI offshore and principally rely on long-term foreign support, as it does in many other major equipment projects.

An alternative to simple offshore purchases might be funding collaborative AI developments with the US military. A harbinger of this may be the Australian Navy's new experimentation program that involves a recently decommissioned patrol boat being fitted with Austal-developed autonomous vessel technology, featuring AI. Austal is also involved simultaneously in a much larger US Navy program fitting its system to one of the company's Expeditionary Fast Transport, the USNS Apalachicola, currently being built.[83] In this case, Austal is an Australian company with a large US footprint and so able to work collaboratively within both countries. There is a strong possibility though the Australian Navy, simply because of economies of scale, is likely to adopt the US Navy variant rather than a uniquely Australian version.

83 "Accelerating A 'Smart' Path To Autonomous Capability."

The outlier in this option might be the Boeing Australia Ghost Bat program that may see AI-enabled, loyal wingman type, uncrewed air vehicles in limited operational service with the ADF in 2024, and thus before the US services. The US Air Force is running several experimentation programs aiming to develop suitable technologies, some of which also involve the Boeing parent company. There is a high likelihood of cross-fertilization between Australian and US programs. This raises the tantalizing possibility of a two-nation support system of a scale that would allow the Australian companies involved to grow to a size suitable for long term sustainment of the relevant ADF AI capabilities. This possibility might be a one-off however, as there seems to be no other significant Australian AI program.

Australia collaborating with the US on AI or buying US AI products can ensure interoperability. However, in seeking such an objective there is always a tension between being interoperable with specific individual US forces or across the ADF. This tension is likely to remain as AI enters service, especially given its demands for compatible big data.

Interoperability and domestic industry support matters are important issues that to varying degrees have influenced Australian government decisions on major capital equipment acquisitions for many decades. These traditional concerns though may need to be counter-balanced by emerging geostrategic uncertainties and ADF capability considerations.

Australia is now becoming worried about the possibility of conflict in the Indo-Pacific region given rising Chinese assertiveness coupled with the example of Russia's invasion of Ukraine. To offset the numerically large military forces of the more belligerent Indo-Pacific states, some advocate developing a higher quality, technologically superior ADF able to help deter regional adventurism.

In being a general-purpose technology, AI can potentially provide a boost across the whole ADF, not just one or two elements within it. Such a vision though is not what is being pursued. Current AI plans will most likely lead to evolutionary improvements not revolutionary changes. AI is conceived as being used to either enhance, augment, or replace existing capability; this approach will mean the future ADF will do things better, but not necessarily be able to do better things.

A revolution in Australian military affairs seems unlikely under present schemes. For this, defence AI would need to be reconceptualized as a disruptive technology not a sustaining innovation. Embracing a disruptive approach would be intellectually demanding and in suggesting adopting unproven force structures could involve taking strategic risks. These are reasonable concerns that would need careful management.

Against such worries though, must be balanced the risk of China's People's Liberation Army successfully fielding disruptive AI and suddenly becoming qualitatively and quantitively superior to other Indo-Pacific militaries. The business of making war inherently involves balancing risks. Given the stakes, it might be time for Australia to embrace disruptive AI, rather than playing safe with a sustaining innovation approach that simply replicates current force structure thinking. The strategically intelligent choice might be doubling down on artificial intelligence.

Literature

"Accelerating A 'Smart' Path to Autonomous Capability," Austal, https://www.austal.com/ships/autonomous-ships (last accessed 23 May 2022).

"AI primed for future development of unmanned surface vessels," Defence Connect, 27 December 2017, https://www.defenceconnect.com.au/maritime-antisub/1707-ai-primed-for-future-development-of-unmanned-surface-vessels (last accessed 23 May 2022).

"Australia's Digital Economy: Digital Skills," Australian Government, 29 March 2022, https://digitaleconomy.pmc.gov.au/fact-sheets/digital-skills (last accessed 23 May 2022).

"Australian Defence Science and Universities Network ADSUN)," Defence Science and Technology Group, 2022, https://www.dst.defence.gov.au/partner-with-us/university/adsun (last accessed 23 May 2022).

"Consilium Technology designs and tests AI capability for Air 6500," Australian Defence Magazine, 28 February 2022, https://www.australiandefence.com.au/defence/air/consilium-technology-designs-and-tests-ai-capability-for-air-6500 (last accessed 23 May 2022).

"Consunet developing AI technologies for AIR6500," Australian Pacific Defence Reporter, 7 April 2022, https://asiapacificdefencereporter.com/consunet-developing-ai-technologies-for-air6500/ (last accessed 23 May 2022).

"Defence Artificial Intelligence Research Network (DAIRNet) Research Call," Defence Science and Technology Group, September 2021, https://www.dst.defence.gov.au/partner-with-us/opportunities/defence-artificial-intelligence-research-network (last accessed 23 May 2022).

"Defence Innovation Programs," Department of Defence, https://www.defence.gov.au/business-industry/programs/defence-innovation (last accessed 18 May 2022).

"Defence orders seven additional Ghost Bats," Australian Defence Magazine, 16 May 2022, https://www.australiandefence.com.au/news/defence-orders-seven-additional-ghost-bats, (last accessed 23 May 2022).

"Implementation of the Australia – United Kingdom – United States Partnership (AUKUS)," Prime Minster of Australia, 6 April 2022, https://www.pm.gov.au/sites/default/files/media/aukus-fact-sheet.pdf (last accessed 23 May 2022).

"Innovation opportunities and priorities," Business, 26 November 2021, https://business.gov.au/odis/innovate-in-defence/innovation-opportunities-and-priorities (last accessed 23 May 2022).

"Jericho implementation model," Air Force, 2021, https://www.airforce.gov.au/our-mission/plan-jericho/jericho-implementation-model, (last accessed 23 May 2022).

"Loyal Wingman: A Three-Year Journey From Design To Flight," Defence Connect, Air Special Edition, 2021, https://www.defenceconnect.com.au/pdfs/Air_Special_Ed_compressed_1.pdf (last accessed 23 May 2022).

"Modelling Complex Warfighting Strategic Research Investment," Defence Science and Technology Group, 2020, https://www.dst.defence.gov.au/partner-with-us/university/modelling-complex-warfighting-strategic-research-investment (last accessed 23 May 2022).

"National Artificial Intelligence Centre," CSIRO, 25 March 2022, https://www.csiro.au/en/research/technology-space/ai/national-ai-centre (last accessed 23 May 2022).

"National Security Science and Technology Centre," Defence Science and Technology Group, https://www.dst.defence.gov.au/nsstc (last accessed 23 May 2022).

"Next Generation Graduates Programs," CSIRO, 21 April 2022, https://www.csiro.au/en/work-with-us/funding-programs/programs/next-generation-graduates-programs (last accessed 18 May 2022).

"Opportunity: Artificial Intelligence for Decision Making Initiative 2022," Defence Science and Technology Group, March 2022, https://www.dst.defence.gov.au/

opportunity/artificial-intelligence-decision-making-initiative-2022 (last accessed 23 May 2022).

"Special Notice: Artificial Intelligence Applications in Defence," Defence Industry and Innovation, 23 November 2020, https://innovationhub.defence.gov.au/call-for-submissions/solicitation/?id=ba5f6b3f-10c6-4c79-8038-458896fb736d (last accessed 23 May 2022).

"Strategy: Agile Command and Control," Defence Science and Technology Group, August 2022, https://www.dst.defence.gov.au/strategy/star-shots/agile-command-and-control (last accessed 23 May 2022).

"Strategy: Battle-Ready Platforms," Defence Science and Technology Group, March 2022, https://www.dst.defence.gov.au/strategy/star-shots/battle-ready-platforms (last accessed 23 May 2022).

"Strategy: Information Warfare," Defence Science and Technology Group, August 2020, https://www.dst.defence.gov.au/strategy/star-shots/information-warfare (last accessed 23 May 2022).

"Strategy: Remote Undersea Surveillance," Defence Science and Technology Group, August 2020, https://www.dst.defence.gov.au/strategy/star-shots/remote-undersea-surveillance (last accessed 23 May 2022).

"Sydney AI start-up launches HR tech services in Silicon Valley," Australian Trade and Investment Commission, 2022, https://www.austrade.gov.au/landingpads/news/case-studies/sydney-ai-startup-launches-hr-tech-services-in-silicon-valley (last accessed 23 May 2022).

"Trusted Autonomous Systems," Defence CRC Tas Limited, 2022, https://tasdcrc.com.au/about-us/ (Accessed 22 April 2022).

Australia's AI Action Plan. (Canberra: Australian Government, June 2021) https://www.industry.gov.au/sites/default/files/June%202021/document/australias-ai-action-plan.pdf (last accessed 23 May 2022).

Blueprint for Critical Technologies (Canberra: Critical Technologies Policy Coordination Office, 2021), https://www.pmc.gov.au/sites/default/files/publications/ctpco-blueprint-critical-technology.pdf (last accessed 23 May 2022).

Concept for Robotic and Autonomous Systems (Canberra: Australian Defence Force, 2020), https://defence.gov.au/vcdf/forceexploration/_Master/docs/ADF-Concept-Robotics.pdf (last accessed 23 May 2022).

Defence Annual Report 2019–2020 (Canberra: Australian Government, 2020), https://www.defence.gov.au/sites/default/files/2021-10/AR-2019-20.pdf (Accessed 23 May 2022).

Defence Data Strategy 2021–2023 (Canberra: Australian Defence Force, 2021), https://www.defence.gov.au/sites/default/files/2021-08/DataStrategy2_0.pdf (last accessed 23 May 2022).

Defence Innovation Hub: Industry Information Guide (Canberra: Australian Government, 2020), https://www.innovationhub.defence.gov.au/defence-innovation-hub-industry-information-guide-v1 (last accessed 23 May 2022).

Durrant, Patrick, "Bluebottle ASW USV trial success," Australian Defence Magazine, 24 August 2017, https://www.australiandefence.com.au/defence/unmanned/bluebottle-asw-usv-trial-success (last accessed 23 May 2022).

Ferguson, Gregor, "Loyal Wingman officially named MQ-28A Ghost Bat," EX2, 22 March, 2022, Gregor Ferguson, https://www.ex2.com.au/news/loyal-wingman-officially-named-mq-28a-ghost-bat/ (last accessed 23 May 2022).

Ferguson, Gregor, "Peever Review could transform defence innovation and acquisition," The Australian, 30 October 2021, https://www.theaustralian.com.au/special-reports/peever-review-could-transform-defence-innovation-and-acquisition/news-story/8bdda80a3be8d606a00f17e9635e70bd (last accessed 23 May 2022).

Force Structure Plan 2020 (Canberra: Department of Defence, 2020), https://www.defence.gov.au/sites/default/files/2020-11/2020_Force_Structure_Plan.pdf (last accessed 23 May 2022).

Laird, Robbin, "The Australian Army, Navy and Air Force Shape a Way Ahead for the Inclusion of Autonomous Systems," SLDinfo.com, 6 May 2021, https://sldinfo.com/2021/06/the-australian-army-navy-and-air-force-shape-a-way-ahead-for-the-inclusion-of-autonomous-systems/ (last accessed 23 May 2022).

Levick, Ewen, "Keeping the M113 relevant as unmanned platforms," Australian Defence Magazine, 16 November 2020, https://www.australiandefence.com.au/partners/keeping-the-m113-relevant-as-unmanned-platforms (last accessed 18 May 2022).

McLaughlin, Andrew, "Australian Army receives 20 optionally-crewed, M113AS4s," Australian Defence Business Review, 25 November 2021, https://

adbr.com.au/australian-army-receives-20-optionally-crewed-m113as4s/ (last accessed 23 May 2022).

Modelling Complex Warfighting Strategic Research Program (Canberra: Department of Defence, 2017), https://www.dst.defence.gov.au/sites/default/files/basic_pages/documents/Modelling%20Complex%20Warfighting%20-%20DSC%202355%20PRO1%20LR.PDF (last accessed 23 May 2022).

More, Together: Defence Science And Technology Strategy 2030 (Canberra: Department of Defence, 2020), https://www.dst.defence.gov.au/sites/default/files/basic_pages/documents/Defence%20Science%20and%20Technology%20Strategy%202030.pdf (last accessed 23 May 2022).

Patrick, Rex, "4571 - Patrick, Senator Rex to the Minister representing the Minister for Defence Industry," PARLWORK, 27, Feb 2022, https://parlwork.aph.gov.au/Senate/Questions/4571 (last accessed 23 May 2022).

Price, Melissa, "Defence innovation system goes under microscope," Department of Defence, 13 September, 2022, https://www.minister.defence.gov.au/minister/melissa-price/media-releases/defence-innovation-system-goes-under-microscope (last accessed 23 May 2022).

RAS-AI Strategy (Canberra: Royal Australian Navy, October 2020) https://www.navy.gov.au/sites/default/files/documents/RAN_WIN_RASAI_Strategy_2040f2_hi.pdf (last accessed 23 May 2022).

Robotic & Autonomous Systems Strategy (Canberra: Army, October 2018), https://researchcentre.army.gov.au/sites/default/files/2020-03/robototic_autonomous_systems_strategy.pdf (last accessed 23 May 2022).

Robotics Roadmap for Australia 2022 (Fig Tree Pocket: Robotics Australia Group, 2022), https://roboausnet.com.au/wp-content/uploads/2021/11/Robotics-Roadmap-for-Australia-2022_compressed-1.pdf (last accessed 23 May 2022)

Ryan, Mick, "Intellectual Preparation for Future War: How Artificial Intelligence Will Change Professional Military Education," War on the Rocks, 3 July 2018, https://warontherocks.com/2018/07/intellectual-preparation-for-future-war-how-artificial-intelligence-will-change-professional-military-education/ (last accessed 23 May 2022).

Savage, Crispin, "Universities blaze a trail to commercialise defence research," Newsroom, 20 April 2022, https://www.adelaide.edu.au/newsroom/news/list/2022/04/07/universities-blaze-a-trail-to-commercialise-defence-research (last accessed 23 May 2022).

Smith, Robin, "New office to oversee disruptive technology (ARMY NEWS)," Australian Arrny Research Centre, 18 March 2020, https://researchcentre.army.gov.au/library/land-power-forum/new-office-oversee-disruptive-technology-army-news (last accessed 23 May 2022).

Sovereign Industrial Capability Priorities (Canberra: Defence, 2022), https://www.defence.gov.au/sites/default/files/2021-09/Sovereign-Industrial-Capability-Priorities-Factsheet.pdf (last accessed 23 May 2022).

Terms of Reference for the independent review into Defence Innovation (Canberra: Department of Defence, 2021), https://news.defence.gov.au/sites/default/files/090921_terms_of_reference_-_defence_innovation_review.docx (last accessed 23 May 2022).

The Action Plan for Critical Technologies (Canberra: Critical Technologies Policy Coordination Office, 2021), https://www.pmc.gov.au/sites/default/files/publications/ctpco-action-plan-for-critical-technology-amalgamated.pdf (last accessed 23 May 2022).

Williamson, Richard, "Putting defence innovation into the hands of the ADF personnel who use it," The Strategist, 14 April 2022, https://www.aspistrategist.org.au/putting-defence-innovation-into-the-hands-of-the-adf-personnel-who-use-it (last accessed 23 May 2022).

Defense AI Observatory Studies

22|02 Peter Layton, Evolution not Revolution. Australia's Defence AI Pathway

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