TRUSTED AUTONOMOUS SYSTEMS

2020

Trusted Autonomous Systems Defence Cooperative Research Centre.

Annual Report 2019 - 2020

Annual Report
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Executive Summary
Message from the CEO

Prof Jason Scholz

Trusted Autonomous Systems is uniquely equipped to deliver world-leading autonomous and robotic technologies to enable trusted and effective cooperation between humans and machines. Our objective is to improve the competitiveness, productivity and sustainability of Australian industry by:

- developing highly self-sufficient and survivable systems *
- developing highly self-determining and self-aware systems *
- developing human-autonomy systems that are human and context aware
- increasing the speed to reach a deployable state for trusted autonomous systems
- increasing the scalability and reduce the cost of autonomous systems technology solutions
- educating in the ethics and legal aspects of autonomous systems
- advocating and shape national policy and regulations.

    * May be human piloted but never needs to be. If in trouble seeks human assistance. If assistance not forthcoming goes into a safe mode of operation.

Supported by strong interest from Defence, Industry, Government and Academia in the centre's programme, objectives and methodology, TAS has commenced delivery of numerous industry-led Projects and two centre-run Activities in support of those Projects, creating indirect employment and investment opportunities with Project participants in Defence, Industry and Academia. TAS is presently in discussion with partners in respect to further Projects to be undertaken in the next reporting period.

Following a productive 2018-2019 establishment financial year, Trusted Autonomous Systems (TAS - the Centre) has continued to formalise additional Project agreements and support

continued research on established Projects and Activities. The Australian Defence Force, principal client of Trusted Autonomous Systems, has shown considerable interest in the existing projects and Activities and we expect this to escalate as the research matures and demonstrators are delivered. TAS continues to foster close relationships with the Services, Defence Science & Technology, leading sovereign industry and research providers.

The Department of Defence has established and recently revised the Defence Industry Security Program (DISP) as a framework of security practices. Meeting DISP expectations at varying levels of governance, policy and practical procedures ensures industry and researchers safeguard assets and information in the supply chain to Defence. In August 2019, the Centre was granted initial membership of the Defence Industry Security Program (DISP) and has continued to work closely with Defence to ensure security standards are commensurate with the research being undertaken. The Centre also provides continuity of security from conception through to demonstration, consistency for Participants across projects and activities, and support to small-scale enterprises to establish independent security practices under DISP.

The impact of COVID-19 restrictions on travel and workplace collaboration commencing in March 2020 were identified and associated and emerging risks are being managed or monitored with Project and Activity leads to minimise their impact. The impact on the Centre's internal efficiency has been minimal with telework and flexible provisions implemented and supported by appropriate DISP-recommended ICT systems including teleconferencing. Due to COVID-19 restrictions a planned Symposium with the theme 'Accelerating Trusted Autonomous Systems' to be held in in Townsville in May 2020, has been postponed until April 2021.

I am very proud of our team's effort in establishing four new Projects in as many months during lockdown conditions, while maintaining effort on existing work. Their commitment and achievement in steering projects towards high impact outcomes for the ADF has been no less than remarkable. I believe TAS has in 2020 established itself as a role model for Defence to develop and deliver game-changing capabilities through sovereign industry.

The TAS team [some staff absent due to COVID-19 travel restrictions].

Projects and Activities

Work conducted by TAS in FY2019-2020 included:

- **projects** which are industry-led programmes of work with academic and government partners

- **activities** which are centre-wide and aim to deliver a common good to projects, participants and key stakeholders, as well as the wider national and international community. Any IP generated by activities is available to all projects and participants.

Project 1.

Trusted Scalable Search with Expendable Drones (Commonwealth NGTF Funded)
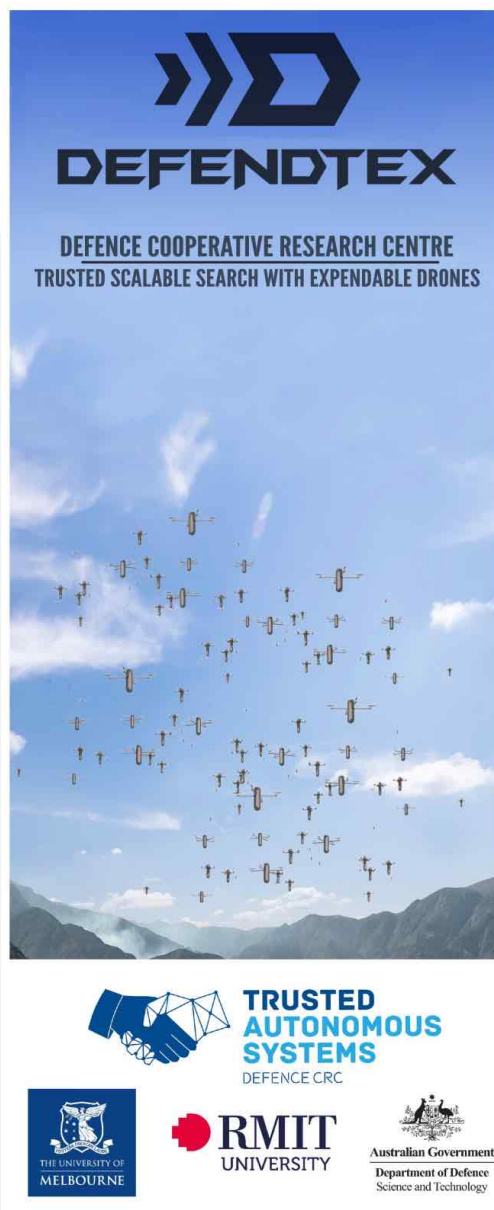
DefendTex: led with RMIT University, the University of Melbourne, and the Department of Defence Science and Technology (DST). Approved by the Board in August 2018. The project is set to place the team in a position to compete in the US on the DARPA Subterranean Challenge.

Project 2.

Distributed aUtonomous Spectrum managemenT (DUST) (Commonwealth NGTF Funded)

Led by Consunet Pty Ltd with RMIT University, the University of Melbourne, the University of Sydney and DST. Approved by the board in November 2018. DUST aims to research, develop and demonstrate near real-time autonomous spectrum management to deliver orders of magnitude increase in agility and efficiency cost savings for Australian Defence and commerce.

Project 3.

Justified Autonomous Unmanned Aerial System (UAS) Effects (Queensland & Commonwealth NGTF Funded)

Led by Skyborne Technologies and Cyborg Dynamics Engineering with the University of Queensland (UQ) and Defence Science and Technology (DST) Group . Approved by the board in February 2019. The project aims to research and develop autonomous live reconnaissance effects assessment using AI and machine vision for day and night UAS operations over land. The system aims to advise operators on the legal and ethical aspects of fire support missions in near-real time.
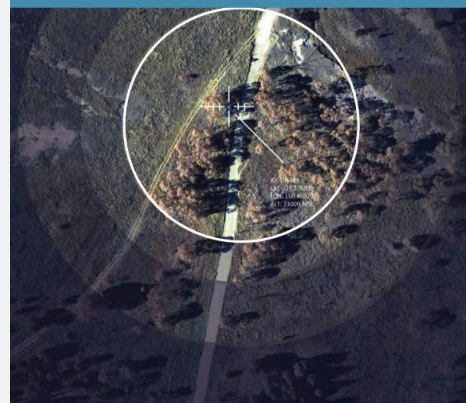
Project 4.

Cognitive Intelligence Surveillance Reconnaissance (Queensland & Commonwealth NGTF Funded)

Led by Boeing Australia and approved by the TASDCRC Board in March 2019, this project will examine the embedding of machine learning techniques on board an uninhabited system to better understand and react to the threat environment. The project will design and test cognitive artificial intelligence algorithms to enable sensing under anti-access conditions and to navigate and conduct enhanced tactics in denied environments.

◁ One of the platforms used in live autonomous demonstrations.

Project 5.

Trusted Autonomous Ground Vehicles for Electronic Warfare (Commonwealth NGTF Funded)

BAE Systems, working with researchers at the Universities of Melbourne and Adelaide, will exploit advanced AI techniques to deliver a prototype demonstration of a next-level trusted autonomous platform capable of robust and persistent operation in complex, contested land environments. A series of M113 vehicles have been fitted with robotics to enable optionally crewed operation as a pathway on this project.

In November 2019, BAE Systems and the Australian Army undertook a demonstration of numerous platforms including two M113 Optionally Crewed Combat Vehicles at the Majura Range, ACT. This has led to an Army decision to convert 20 x M113 for operational use as robotic platforms.

Project 6.

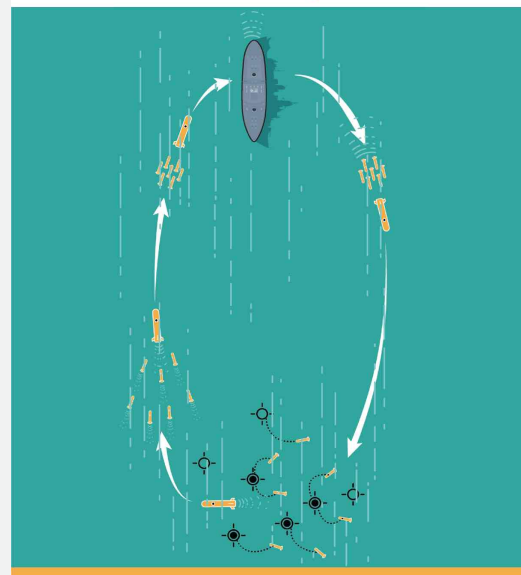# Mine Counter-Measures in a Day (Commonwealth NGTF Funded)

Thales is partnering with DST, INENI Realtime, Mission Systems, the University of Sydney, Western Sydney University, Flinders University and the University of Technology Sydney to develop new autonomous technologies that will revolutionise mine clearance capability in littoral operations. The project will demonstrate a prototype system capable of Rapid Environmental Assessment, mine-like object detection and localisation, mine target recognition and simulated neutralisation, enabling zone preparation and clearance in a significantly shorter period of time – 'MCM in a day'.

The 'MCM in a day' concept aims to remove divers from underwater mine fields.

A small number of additional TAS Projects are not described in the report.

Activity 1.

Ethics and Law of Trusted Autonomous Systems

Led by [University of New South Wales (UNSW)](#) [Ethics] and the [University of Queensland (UQ)](#) [Law], with [DST](#). Approved by the board in November 2018. Activity 1 (A1) aims to develop ethical and legal assurance for projects and the benefit of participants, through advice and policy development at National and International levels. TASDCRC are represented as a non-government organisation at the United Nations (UN) [Group of Governmental Experts (GGE)](#) on Lethal Autonomous Weapon Systems (LAWS) to ensure the development of autonomous systems accord with ethical principles and the laws of armed conflict (LOAC). The activity has demonstrated a high-level influence in the development of law, policy and doctrine to ensure that Australia's reliance on TAS satisfies both humanitarian imperatives and national security interests and is consistent with Australia's commitment to upholding international law.

Key achievements:

- Creation and incorporation of an ethical and legal framework into participant project and systems architecture.
- Numerous webinars and workshops for participants (post-COVID).
- Consultation on matters relating to AI and autonomy pertaining to international law and international humanitarian law (including autonomous weapons systems) to a number of Government departments, Government lawyers, Defence staff, TAS staff, and Assurance industries.
- Submission to the ADF Robotic & Autonomous Systems 2040 Concept paper and ongoing to the UN CCW GGE process.
- Coordination of the Defence Sector chapter contribution to the Australian Robotics Roadmap V.2 due 2021.
- Ethical AI for Defence Workshop organised by DST, TASDCRC & Plan Jericho Air Force 31-Jul to 1-Aug 2019 resulting in DST Technical Report 'A Method for Ethical AI in Defence'. [Post the reporting period, Defence have now published the technical report '[A Method for Ethical AI in Defence](#)'].

Activity 2.

Assurance of Autonomy

Led by TAS and funded by the Queensland Government. Approved by the board in February 2019. The Assurance of Autonomy activity (A2) aims to unlock Queensland's, and by extension Australia's, capacity for translating autonomous system innovation into operational capability, leveraging regulatory and technical expertise and strong stakeholder relationships to support industry and regulators. The TAS team, drawn from the Australian Maritime Safety Authority, Civil Aviation Safety Authority, and the University of Adelaide, have deep regulatory and technical expertise in autonomous systems, and bring a wealth of practical experience and strong stakeholder relationships to the project.

Projects within A2:
- Enabling Agile Assurance of Drones in Queensland, led by Biarri Mathematical Consulting, supported by QUT; and
- National Accreditation Support Facility Pathfinder Project (NASF-P), led by TAS.

The A2 team collaborates with domestic and international Industry, Academia, Government, and Regulators including the Assuring Autonomy International Programme (AAIP) at the University of York.

A2 will improve the assurance and accreditation process for autonomous systems, support and promote Queensland test ranges, and pave the way for a new independent third-party entity that will offer world-class assurance support and consultancy services to domestic and international businesses. The activity will bring business to Queensland, and enhance its growing reputation as the Smart Drone State, including through the Queensland Drones Strategy.

The A2 activity represents a unique collaborative endeavour to better equip Australian industry and regulators to accelerate innovation in a way that meets a clear and coherent regulatory framework and enhances safety and efficiency.

Post the reporting period, a Director of Autonomy Accreditation – Maritime has been employed from August 2020 and has been appointed as an Industry Fellow with Queensland University of Technology School of Law.   Directors of Autonomy Accreditation for Air and Land domains will commence Q4 2020. These leaders have in-depth regulatory understanding in their domains and networks with regulators AMSA, CASA, and DASA and industry. QUT Law has recruited post-doctoral researchers in computational law beginning Q4 2020.

Highlights:

• TAS leadership and co-authorship of 'Trust & Safety' chapter for the Australian Robotics Roadmap V.2 due 2021. Chapter includes contributions from the TAS, 3A Institute ANU, Humanising Machine Intelligence Project ANU and the Qld Robotics Network.

• Numerous seminars/webinars.

• Engagement with FAA, AMSA, AARB, CASA, ADVI, DASA, AAUS, Australian Institute of Marine Science, AMC Search, Greenroom Robotics, Ocius, University of Queensland, Queensland University of Technology and York University

• Project 'AI experts for autonomous vessel accreditation' in progress with QLD AI Hub to accelerate the certification process, lower risk and expense, and bring business to Queensland by increasing available autonomy expertise.

Governance and Staff

Defence CRC TAS Limited (Company) manages the centre and is an unlisted public company limited by guarantee, incorporated and domiciled in Australia. Its national office is located in Brisbane, Queensland.

Membership of the board, including key skills are detailed below. The board conducts activities of the Trusted Autonomous Systems Defence CRC through the Chief Executive Officer (CEO) and delegates specific powers and responsibilities to the CEO.

The Board's role is to govern the Defence CRC by:
* providing appropriate leadership
* contributing to and approving the Defence CRC's strategic plan
* approving operational plans and budgets to ensure consistency with the goals and objectives
* monitoring performance of the Defence CRC and its management
* assessing risks and ensuring that appropriate risk management strategies are in place
* setting and promoting appropriate values and standards.

The board has met on seven occasions over the reporting period.

There has been considerable continuity between the staffing of 2018-2019 and this financial year and minor changes have been undertaken to ensure role clarity. TAS continues to offer itself as a workplace for key Brisbane-based DST interlocutors on TAS Activities as a more appropriate location than other local DST facilities.

Communications

TAS creates and distributes material to participants on a regular basis. TAS has also established a presence in a number of social media forums for external open communication, in addition to a Blog and Fellow page on the website.

TAS website: https://tasdcrc.com.au

Publications

Numerous publications and presentations were advised to Defence Science & Technology in the 2019-2020 FY for approval. TAS Projects, leadership and primarily Activities, have contributed to publications in a diverse range of journals and books (some publication pending) including: Australian Defence Magazine; ASPI Reports ("From concentrated vulnerability to distributed lethality —or how to get more maritime bang for the buck with our offshore patrol vessels") and others. Where publicly available, publications are linked to the TAS website.

Education, Training and Engagement

TAS continues to create a vibrant community of collaboration between universities, Defence and industry through industry-led projects and centre-led activities. Co-investment and engaged stakeholders provide strong evidence of TAS success against this overarching objective. TAS is also generating significant workforce capacity, with a projected level of effort of nearly 200 person-years invested in Projects and Activities across TAS's term, and with 34 individual students and post-doctoral positions created. Strong participation from Defence primes and SMEs, and from academia and DST, has been achieved, generating significant intellectual and technical outcomes through collaborative effort. Combined with the workforce achievements, TAS's efforts are producing an enduring capacity in autonomous systems expertise across industry and academia.

Research Fellows

Four TAS Research Fellows were appointed over the FY2019-20 as part of the Advance Queensland TAS DCRC Fellowships programme. The selected candidates will support projects as part of working closely with TAS, but they will undertake original research independent of Projects to address fundamental challenges in areas pivotal to realising trusted autonomy.

Name	Affiliation	Project
Dr Andrew Back	University of Queensland	Synthetic Language and Information Topology (SLAIT) AI
A/Prof Pauline Pounds	University of Queensland	Embodied Autonomy for Dynamic Control of Unmanned Systems
Dr Jessica Korte	University of Queensland	Auslan Communication Technologies Pipeline
Dr Beth Cardier	Griffith University	Tipping Points: Modelling Emergent Trust in Narrative

Dr Andrew D. Back

Dr Beth Cardier

The challenge for artificial intelligence systems is to discover ways to encapsulate social dynamics in realms such as meaning, nuance, implication, intent, interpretation, feeling and understanding. This research introduces a new approach to AI called Synthetic Language and Information Topology (SLAIT) AI.

Beth models narratives and dialogue to show how implicit information can be included in reasoning systems. She was originally an award-winning fiction writer and media analyst, when, in a plot twist, she learned knowledge modeling for a US Navy-funded research program to demonstrate how writers communicate unexpected events.

Dr Jessica Korte

Dr Pauline Pounds

Jessica's TASDCRC Fellowship Project, the Auslan Communication Technologies Pipeline project, looks to foreground the visual-gestural language expertise of Deaf signers in the creation of technologies for the recognition, production and processing of Auslan (Australian Sign Language) communication and a modular pipeline for artificial intelligence.

My TASDCRC project involves exploring robotic whisker technology we originally developed in 2016, and finding ways of using them to allow drones to fly through interior spaces and around objects and obstacles without needing to use heavy cameras or complex, expensive lidar systems.

Engagement

Engagement has continued with defence, industry and research institutions via a number of forums, including direct contact, project-based meetings and collaborative workshops to develop project proposals and activities.

TAS Networking Event

TAS held a Queensland networking event on 20 November 2019 as part of its Queensland focussed activities. This was held in William St in Brisbane with over 60 people in attendance. The event was opened by the Hon Kate Jones, Minister for Innovation.

Presentations by TAS CEO, Chief Engineer and Chief Scientist were given on new opportunities of value to universities and industry. Dr Julia Playford from Queensland government briefed on the Defence Science Alliance about to stand up between the Queensland State Government, DST and Queensland Universities. Kevin Hernan from the Defence Innovation Hub invited proposals relevant to Defence. The networking event was very productive, with several potential collaborations already being pursued in assurance of autonomous systems and in future Fellows under the AQ TAS Fellowship.

Top - Bottom: Minister the Hon. Kate Jones addressing the Networking Event; Minister Jones, CEO Prof. Jason Scholz, Chief Scientist Dr Kate Devitt; CEO Scholz briefing the Networking Event.

Symposium - Townsville

TAS was well advanced in the process of organising a Symposium, 'Accelerating Trusted Autonomous Systems' to be held in Townsville during May 2020 which would have been a key engagement opportunity with Projects and Activities, in addition to broader Defence, industry and researchers. Due to the impact of COVID-19 this Symposium has been postponed until 20-22 April 2021. Current site: https://tasdcrc.com.au/symposium2021/

Industry and Global Defence Outreach

Engagement undertaken with Biarri, QinetiQ and Nova Systems general managers were also conducted, with a view to maximising the potential for Queensland test ranges, and to gain updates on the status of the Cloncurry range. Post reporting, more details were released on the Cloncurry Range in November 2020

TAS Strategy Director Prof. Rob Sale represented at the maritime environmental working group conducted by Navy for industry. Prof Sale received an award for his contribution to that workshop from RADM Peter Quinn.

TAS has provided advice to the NATO Maritime Unmanned Systems Initiative (MUSI) Steering Board and applicable Program Groups on a number of levels. This has occurred through Navy and directly by invitation in regard to Australia's technical requirements, ethics and legal frameworks. This has helped to highlight gaps and opportunities for Australian industry and academic research for future Projects and Activities.

Finance, Commercialisation and Intellectual Property Management

TAS is in a sound financial position at 30 June 2020. TAS has implemented robust financial process to ensure prudent financial management and oversight on milestone and progress reporting to third-party Participants.

Despite the TAS Projects and Activities still being principally in the early stages, progress has already been made by some participants in translation to commercialisation. Uptake by Industry of research outputs is ensured by early engagement with Defence to better match outputs with needs. There are also fallback provisions whereby if the IP is not taken up ownership reverts to Defence.

Throughout the reporting period intellectual Property (IP) is identified by means of each Project Lead (that is, those companies leading the various projects and activities), consolidating and submitting each quarter a list of IP generated. The IP is protected and managed by the Project Lead using typically well-established internal procedures relevant to the relevant company.