Australian Government

Department of Defence
Science and Technology

Annual Review
2017–18

Defence Science and Technology
David Warren Building
24 Scherger Drive
Canberra Airport, ACT 2609

Front cover
Julia Freeman and Dr Brady Gentle inserting a small dosimeter into a manikin for testing.

Back cover
War gaming conducted with various services and groups across Defence.

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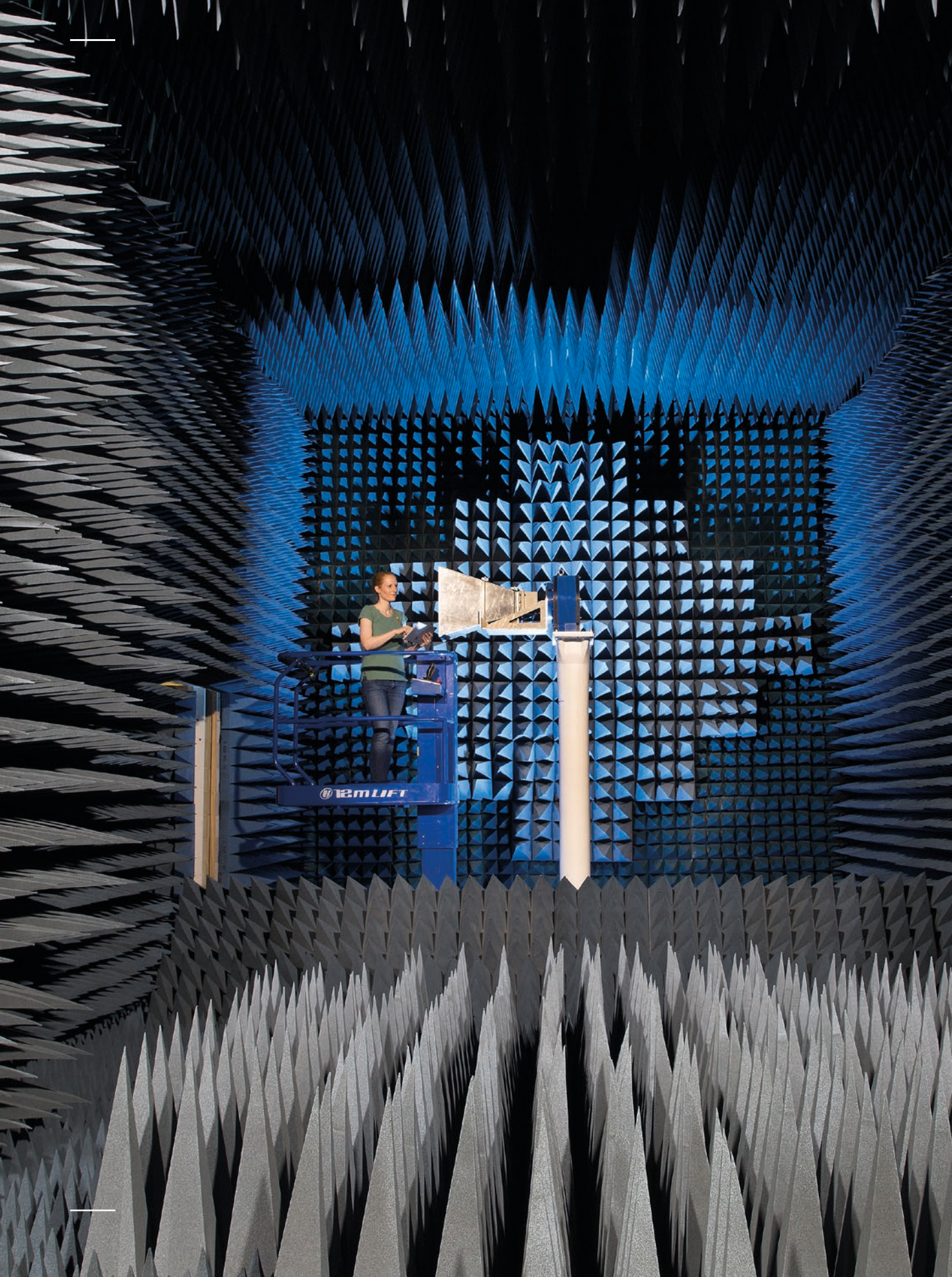
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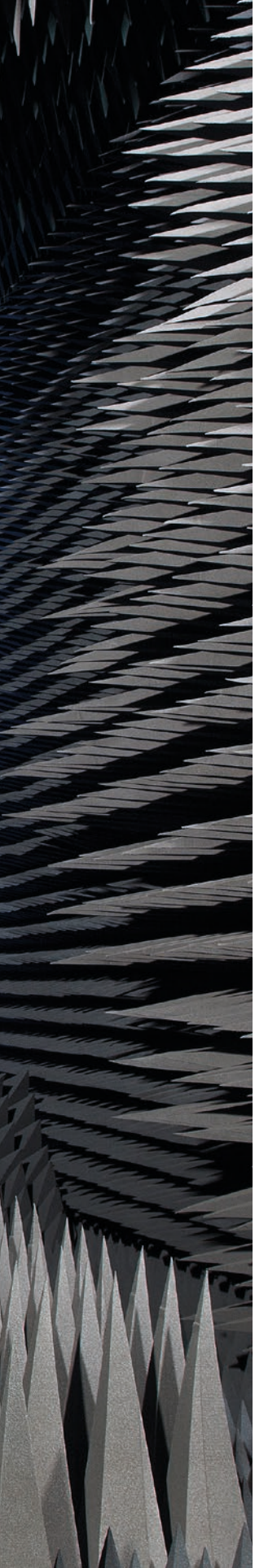


CONTENTS


TECHNOLOGY

OVERVIEW FROM THE CHIEF DEFENCE SCIENTIST

The year 2017–18 marked the completion of our ambitious five-year strategic plan.

Over this five-year journey, we have successfully recalibrated the strategic direction of our organisation, building a resilient business model that has positioned us to operate effectively in the complex and evolving environment in which Defence operates.

We are now reaping the rewards of our efforts. Our strategy has made Defence Science and Technology (DST) a more valued, more collaborative and more innovative contributor to Australia's defence and national security. It has given us a firm footing on which to engage with Australia's research and innovation community to implement the 2016 Defence White Paper and the Defence Industry Policy Statement.

It has been immensely pleasing to see engagement and involvement under the Next Generation Technologies Fund continuing to grow, with seven programs that are now up and running in earnest. So far, the Next Generation Technologies Fund as a whole has attracted more than 900 proposals from academia, business and publicly-funded research agencies around Australia. The Grand Challenge approach, introduced for the first time in Australia, alone drew over 200 proposals to counter improvised threats. Also, for the first time, we made it possible for Australian universities to collaborate with their American counterparts on defence projects under the Multi University Research Initiative of the US Department of Defense. The Defence Cooperative Research Centre (CRC) for Trusted Autonomous Systems, which combines the clout of industry players with the research expertise of universities and the deep domain knowledge of DST, is another far-reaching initiative that encouraged the Queensland government to make a matching investment in the CRC, creating a $100 million research project. I have no doubt the seven programs of the Next Generation Technologies Fund will deliver game-changing capabilities for Defence.

We continue to foster broader engagement with industry and academia. In the past 12 months, we have signed 362 agreements worth more than $43 million with Australian universities. Our Strategic Alliances with industry and public research agencies are expanding with new projects and initiatives to support Defence's $195 billion capability acquisition program. We now have 17 long-term Strategic Alliances in place with industry.

DST support for Defence operations is as strong as ever, responding urgently to 27 science and technology (S&T) requests during the year from deployed commanders. Our S&T advice crucially assisted the government's selection of Rheinmetall's Boxer Combat Reconnaissance Vehicles for the LAND 400 project, and the Hunter class anti-submarine Future Frigates to be built by BAE Systems. The annual desk officer survey continued to rate DST's performance at over 90 percent satisfaction levels for the third year running.

As part of the Scientific Excellence initiative in the Strategic Plan,

Trial Manager for the Contested Urban Environment Strategic Challenge, Mr Trent Burnard (right), talks with project participants during scenario training.

the external benchmarking of Major Science and Technologies Capabilities was completed, with the reviewers scoring 72 individual capabilities as world leading and 67 individual capabilities as world best practice. This outstanding outcome demonstrates that DST is truly a world-class S&T organisation.

During the year, Defence re-entered the space program after 50 years, with the DST launch of the Buccaneer cube satellite into space in the first of two missions that will measure the effect of atmospheric propagation on high-frequency (HF) signals from the Jindalee Operational Radar Network. Buccaneer successfully deployed an HF antenna and has remained in a correct and stable orbit since its launch in November 2017.

Internationally, we are strengthening our relationships with our allies and regional partners. With Japan we negotiated a new cooperation framework for expanded science engagement that includes hydrodynamics research. We are appointing S&T liaison officers to Seoul and Singapore.

During the year, we extended the research capabilities of The Technical Cooperation Program (TTCP) – the primary vehicle for our S&T collaboration with Defence laboratories in the five-eyes community – by establishing a more strategic Memorandum of Understanding that facilitates partnerships with third-party entities such as industry and academia. This will have an enormous impact on research outcomes for all five countries.

The impetus provided by the new arrangement was demonstrated during a major TTCP trial held in Adelaide last December to investigate emerging technologies for enhancing the intelligence, surveillance and reconnaissance capabilities in contested urban environments. This trial provided significant insights into the challenges associated with translating big data into a consumable form for military commanders, and will enable the TTCP nations to shape their research programs accordingly.

To ensure that DST has the capability to support Defence and national security agencies now and into the future, we have implemented important measures to bolster our talent pipeline. This has been done through recruiting programs and career progression opportunities.
We continue our efforts to ensure that DST is a fair and inclusive employer. Significant progress has been made towards addressing gender inequality in our workforce and the number of Indigenous employees within our ranks continues to grow.

DST staff continue to earn recognition for their work. Among them, Marcus McDonald received the highest

Australian Army soldiers with the Rheinmetall Boxer Combat Reconnaissance Vehicle.

award that can be bestowed on a non-US civilian officer by the American Secretary of Defense: the Medal for Exceptional Public Service. Janis Cocking (now retired) was recognised in the Queen's Birthday Honours, receiving a Public Service Medal for her leadership and contribution to S&T.

Such awards are a reflection of the calibre of our people who drive innovation in support of Defence capability. Each page of this Annual Review is testament to their hard work and a demonstration of the difference we can all make to the effectiveness of Australia's Defence and national security agencies.

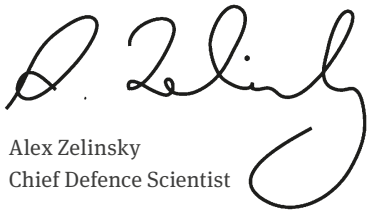
Looking forward, work has commenced in earnest on the next S&T strategy for Defence. The new strategy will build on the achievements of the current one, with a focus on continuing to increase the value of our deliverables to Defence while strengthening a collaborative work culture and taking an innovative approach to our research and operating environment.

This next strategic plan will be driven by a new Chief Defence Scientist, as I move on to the next phase of my working life.

In almost seven years as Chief Defence Scientist, I have worked with an amazing group of people who are delivering exceptional results in support of our national defence. I have been privileged to serve as Australia's Chief Defence Scientist. It has been by far the most rewarding chapter in my career.

I leave DST as it enters an exciting phase, with the organisation playing an increasingly important role leading innovation within the Defence and national security sectors. I will watch with interest as DST continues on its journey. I look forward to undertaking further work with Australia's Defence scientists, albeit in another way.

I sincerely thank my Defence colleagues, industry and university partners for their cooperation during my tenure with Defence. I am indebted to DST staff and thank them all for supporting me. I wish our magnificent staff and DST all success for the future.



Alex Zelinsky
Chief Defence Scientist

MAJOR HIGHLIGHTS

F-35A MODEL FOR EXTERNAL STORES WIND TUNNEL TESTING

DST designed and constructed a six percent-scale half-model of the F-35A Joint Strike Fighter (JSF) for external stores (weapons) separation testing in its Transonic Wind Tunnel. This development has led to the establishment of a new strategic partnership between ADF and the US Air Force SEEK EAGLE Office for F-35A stores integration.

TECHNOLOGY FOR NAVIGATING IN A COMPLEX WORLD

DST and its collaboration partners demonstrated a multi-modal long-range navigation system for operations in denied and contested environments. This work resulted in a world-class closed-loop vision-based navigation technology that provides long-range navigation with GPS accuracy over desert terrain where features are sparse and difficult to differentiate.

FACIAL RECOGNITION FOR IDENTIFYING CHILDREN

DST conducted the largest and most rigorous scientific research program ever mounted on facial recognition for the protection of children, using an operational dataset containing several million images. As a result of the outcomes obtained, government agencies have reviewed and altered the processes they use for identifying children who may be at risk of abuse or trafficking.

MACHINE LEARNING AND DATA ANALYTICS FOR AIRFRAME LOADS MONITORING

An innovative high-fidelity airframe load monitoring methodology to track the in-flight loading of an aircraft was developed, making use of existing airframe sensors. This has the potential to revolutionise aircraft fleet airworthiness management, and to deliver substantial savings to fleet operators while optimising aircraft availability.

STRATEGIC PLAN COMPLETED

Execution of the Defence Science and Technology Strategic Plan 2013–2018 was completed during the 2017–18 year. The 2013–18 Strategic Plan charted a course for DST to become a more valued, more collaborative and more innovative contributor to Australia's Defence and national security.

Silentium Defence working on passive radar technology.

STRONG START FOR NEXT GENERATION TECHNOLOGIES FUND PROGRAMS

Seven programs, each with a different collaboration mechanism, were initiated, including the Counter Improvised Threat Grand Challenge that attracted over 200 proposals, the inaugural Defence Cooperative Research Centre for Trusted Autonomous Sysems, the Small Business Innovation Research for Defence initiative, the international collaborative research program between Australian and US universities, Defence's first spin-off company, Silentium Defence, and the expansion of state-based university research networks into South Australia and New South Wales.

VEHICLE BALLISTIC SURVIVABILITY TRIAL

DST ballistic protection assessments played a key role in the selection process for the ADF's new combat reconnaissance vehicle, through which, the Rheinmetall Boxer vehicle was chosen in March 2018. The ADF's choice was strongly supported by the scientific evidence generated by a large DST team, with their ballistic protection assessments being judged as international best practice by an independent review.

Flight deck operations aboard HMAS *Canberra* at sea.

DST'S SUPPORT FOR OPERATIONS IN 2017–18

During the 2017–18 year, DST responded to 27 urgent operational ADF requests arising mostly in the course of operations in the land domain, with some also coming from the maritime, air and joint domains.

HIGH-LEVEL CLIENT SATISFACTION

The annual desk officer survey registered a 71 percent response rate, with a satisfaction rating similar to the previous year at 90 percent positive. It also showed a distinct improvement, with 38 percent (up from 16 percent) of respondents giving DST a rating of nine out of ten or ten out of ten.

ADVANCED ROCKET PROPULSION TECHNOLOGIES FOR HIGH-PERFORMANCE FUTURE MISSIONS

In order to deliver more advanced rocket propulsion technologies, DST developed a unique nested evolutionary design optimisation method that the US Defense Advanced Research Projects Agency has described as 'highly innovative'. The resulting technology advances are opening up a range of new capability options for Defence previously not considered possible.

INFECTIOUS DISEASE FORECASTING CAPABILITIES

With the University of Melbourne, DST developed two software products (EpiFX and EpiDefence) for forecasting the spread of infectious diseases, EpiFX is currently being used by a number of Australian state governments to predict the start and extent of seasonal flu outbreaks.

1

OUR ORGANISATION

ABOUT US

DST is Australia's second-largest publicly funded research organisation. It is part of the Department of Defence and provides the Australian Government with scientific advice and innovative technologies to meet Australia's defence and national security challenges.

Headed by the Chief Defence Scientist, Dr Alex Zelinsky, DST had a budget of $480 million for the 2017–18 year and employed 2,142 staff, predominantly scientists, engineers, IT specialists and technicians. DST has staff located in nearly every state and territory in Australia. Internationally, it has liaison offices in Washington DC, London and Tokyo, and research scientists located around the world, working on postings, exchanges, fellowships and joint research projects. A small number of DST personnel operate in the Middle East, providing direct support to Australian military operations.

VISION

DST aims to be a world leader in defence S&T – indispensable in supporting and transforming Australia's defence and national security.

PEOPLE

DST has diverse, professional and specialised staff members who work in offices, laboratories, test facilities, weapons ranges and operational theatres. DST provides a work experience that is both challenging and career-developing and treats a safe, healthy and secure working environment as a key priority.

OUR VALUES

DST values guide behaviour and decision-making, and help to demonstrate the attitudes and actions for organisational success.

EXCELLENCE IN SCIENCE

We strive to lead, and take pride in, all our scientific undertakings.

PEOPLE

We develop and support each other to achieve organisational deliverables in a safe environment.

PROFESSIONALISM

We strive for excellence in everything we do.

LOYALTY

We are committed to each other, our leaders and the organisation.

INTEGRITY

We are trustworthy and honourable in all our interactions.

COURAGE

We act with strength of character, both in the courage of our convictions and in our intellectual courage.

INNOVATION

We actively and consistently look for better ways of doing business.

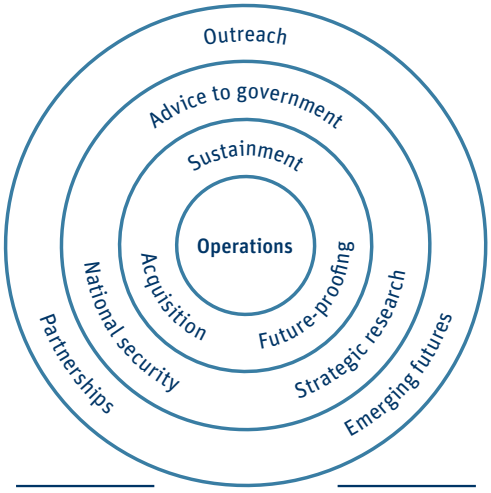
TEAMWORK

We work together with trust, respect and a sense of collective purpose.

OUR PURPOSE

DST's core roles are focused on supporting Australian troops on the ground, sustaining and enhancing existing Defence capabilities, ensuring Defence is a smart buyer of Defence equipment and future-proofing Defence to ensure that the Australian Defence Force (ADF) can meet future challenges. DST has a role in providing expert, impartial advice to government on defence and national security matters as well as coordinating the delivery of whole-of-government S&T support for national security.

As an S&T organisation, DST conducts strategic research to identify high-impact areas for Defence and monitor emerging technologies to assess their potential impact on Defence capability. Underlying all of its activities is an increased emphasis on external engagement and collaboration. This includes taking a stronger role in knowledge and innovation integration, strengthened through partnerships with industry and academia.



DST enablers

Technical services

Science and Technology training and development

Business services

OUR ROLES

CORE

OPERATIONS

Supporting operational capability with S&T expertise.

SUSTAINMENT

Providing support to Defence to sustain and enhance current capability.

ACQUISITION

Providing support throughout the genesis, development, acquisition and introduction into service of major capability projects.

FUTURE-PROOFING

Investigating client-focused future concepts, contexts and capability.

EXTENDED CORE

ADVICE TO GOVERNMENT

Shaping defence and national security strategic policy through expert and impartial advice.

NATIONAL SECURITY

Leading the coordination and delivery of S&T to enhance whole-of-government national security.

STRATEGIC RESEARCH

Conducting research into high-impact areas for future Defence capabilities.

SUPPORTING

EMERGING FUTURES

Scanning the environment to gain an understanding of emerging S&T threats and opportunities.

PARTNERSHIPS

Enhancing impact by collaborating with research and industry partners, nationally and globally.

OUTREACH

Promoting defence science and education in the broader Australian community.

DST LEADERSHIP TEAM

AS AT 30 JUNE 2018

DR ALEX ZELINSKY

Chief Defence Scientist

CORPORATE DIVISIONS

DR JANIS COCKING

Chief of Science Strategy and Program Division

DR IAN DAGLEY

Chief of Science Partnerships and Engagement Division

DR MIKE DAVIES

Chief of Science and Technology Program

MR PETER LAMBERT

Chief of Research Services Division

Science Strategy and Program Division

Science Partnerships and Engagement Division

Research Services Division

Maritime Division

Land Division

Aerospace Division

Joint and Operations Analysis Division

National Security and ISR Division

Cyber and Electronic Warfare Division

Weapons and Combat Systems Division

RESEARCH DIVISIONS

DR DAVID KERSHAW

Chief of Maritime Division

DR PETER SHOUBRIDGE

Chief of Land Division

DR DONG YANG WU

Chief of Aerospace Division

DR LYNN BOOTH

Chief of Joint and Operations Analysis Division

MR ANDREW SEEDHOUSE

Chief of National Security and ISR Division

DR DALE LAMBERT

Chief of Cyber and Electronic Warfare Division

DR RICHARD DAVIS

Chief Technology Officer National Security

DR JOHN RILEY

Chief of Weapons and Combat Systems Division

COMPLETION OF THE STRATEGIC PLAN

Execution of the Defence Science and Technology Strategic Plan 2013–2018 was completed during the 2017–18 year. The five-year Strategic Plan charted a course for DST to become a more valued, more collaborative and more innovative contributor to Australia's defence and national security.

Over this period, the Strategic Plan provided a sound footing for DST to engage proactively with a number of policy and planning statements, including the First Principles Review (FPR) of Defence (and its implementation as One Defence), the 2016 Defence White Paper, the Defence Industry Policy Statement and the Naval Shipbuilding Plan, among others.

Implementation of the Strategic Plan has enabled DST to deliver strongly on its core value propositions: to reduce and mitigate strategic and operational risks and to create and maintain a capability edge for Australia's defence and national security agencies through the innovative application of S&T.

During 2017–18, work on each of the ten strategic initiatives was completed by December 2017 or transitioned to 'business as usual'. The specific achievements and outcomes from each initiative in 2017–18 are presented in the following pages.

In December 2017, the DST Senior Leadership Team assessed each strategic initiative against its objectives and success measures. Seven initiatives were assessed as having fully achieved their targets, one as mostly achieved, and two as partially achieved.

STRATEGIC PLAN 2013–18 SCORECARD

SCIENCE AND TECHNOLOGY EXCELLENCE (D1 STRATEGIC INITIATIVE)

EXTERNAL BENCHMARKING OF DST'S MAJOR SCIENCE AND TECHNOLOGY CAPABILITIES

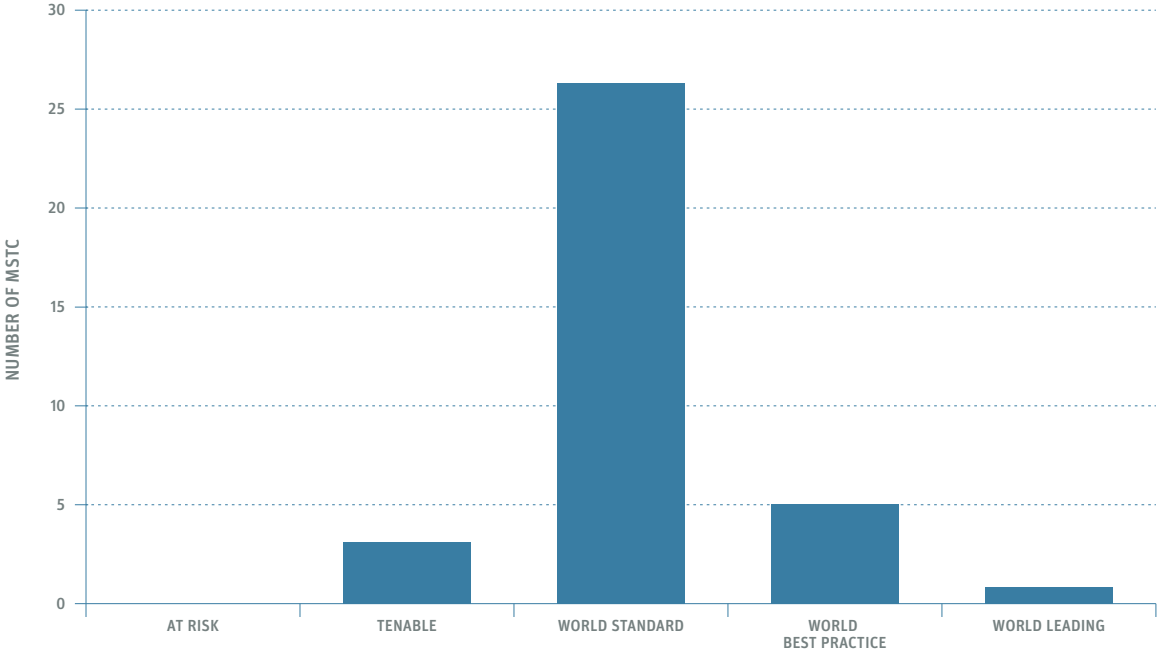
The attainment of science excellence is fundamental to DST's ability to support the ADF. In order to provide Defence with access to this science excellence, DST established a framework called Major Science and Technology Capabilities (MSTC) in which a scientific discipline relevant to a client domain is paired with that domain.

The S&T Excellence initiative established a benchmarking process to determine the health of each MSTC. In addition to annual internal assessments, external reviews of all MSTCs, begun in 2015, were completed, with the final thirteen being finished in the period from July to December 2017. Since 2014, each MSTC has also undergone four annual self-assessments, and the results of the internal assessments and external reviews have been found to strongly correlate.
The review panels assessed the MSTCs against world benchmark standards across seven dimensions:

- Strategy, planning and leadership
- Delivery and impact to Defence
- National security
- Quality and technical review of research
- Engagement and partnering
- Research infrastructure
- Innovation and future focus.

Each MSTC was rated using a five-point scale. The results of the external reviews are shown in diagram 1.

DIAGRAM 1: MSTC EXTERNAL BENCHMARKING RESULTS



Overall the reviewers commented on:

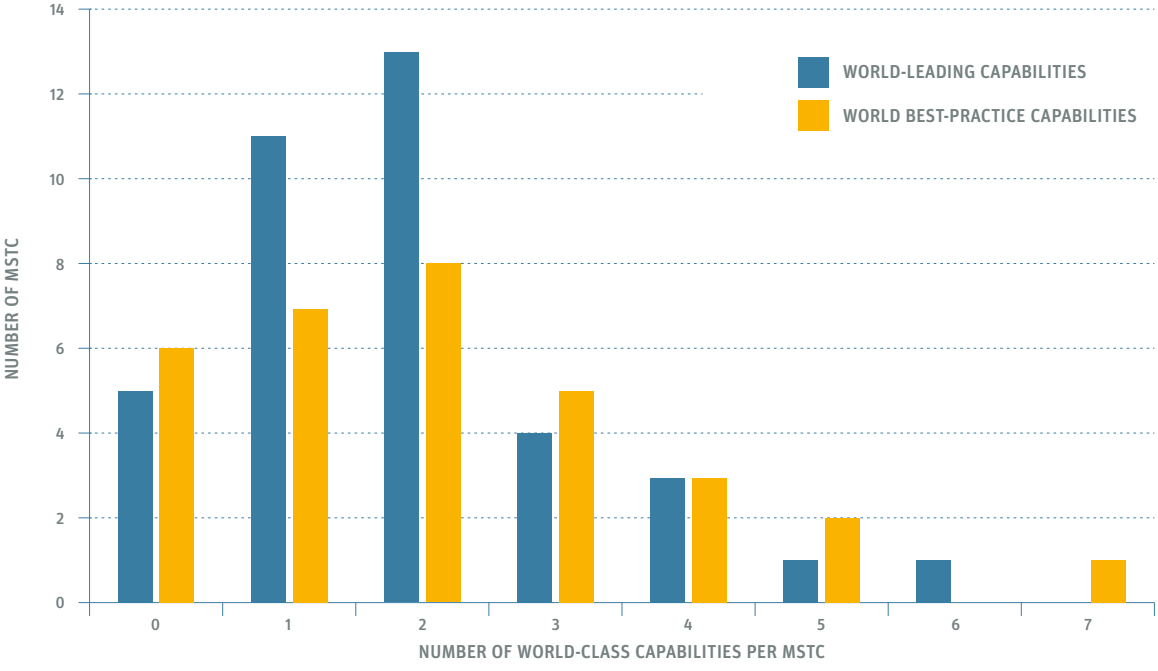
- The high level of satisfaction expressed by clients, many of whom remarked on DST's timely and effective efforts to deliver numerous significant outcomes
- The strength of evidence establishing DST's genuine engagement with key client groups and external collaborators from academia, industry and international defence partners
- DST's strong track record for developing various mechanisms to foster innovation and to future-proof Defence.

In addition to these findings, the reviewers identified 72 individual S&T capabilities as *world leading* and 67 individual S&T capabilities as *world best practice*.

The internal benchmarking of MSTCs combined with external reviews has helped DST to develop strategically driven S&T capabilities that are managed holistically. Over the time that reviews have been conducted, there has been a measurable improvement in outcomes.

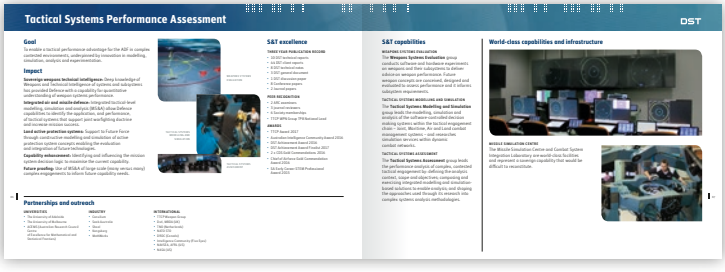
A comprehensive internal report (DST-Group-GD-1007) documents the process and the results obtained for the first full four-year external review cycle.

DIAGRAM 2: DST'S WORLD-LEADING AND WORLD BEST-PRACTICE CAPABILITIES



DEFENCE SCIENCE AND TECHNOLOGY CAPABILITY PORTFOLIO

In 2017, DST published a document called the Defence Science and Technology Capability Portfolio, which described each of the MSTCs. This has been made available as an information resource to DST's partners and external stakeholders. An updated second edition was published in June 2018.



STRATEGIC ENGAGEMENT WITH CLIENT FOCUS (D2 STRATEGIC INITIATIVE)

REALIGNMENT OF CORPORATE DIVISIONS

One of the earliest actions executed through the Strategic Plan 2013–18 was to change the alignment of DST's divisions so that the organisation could more ably deliver to Defence.

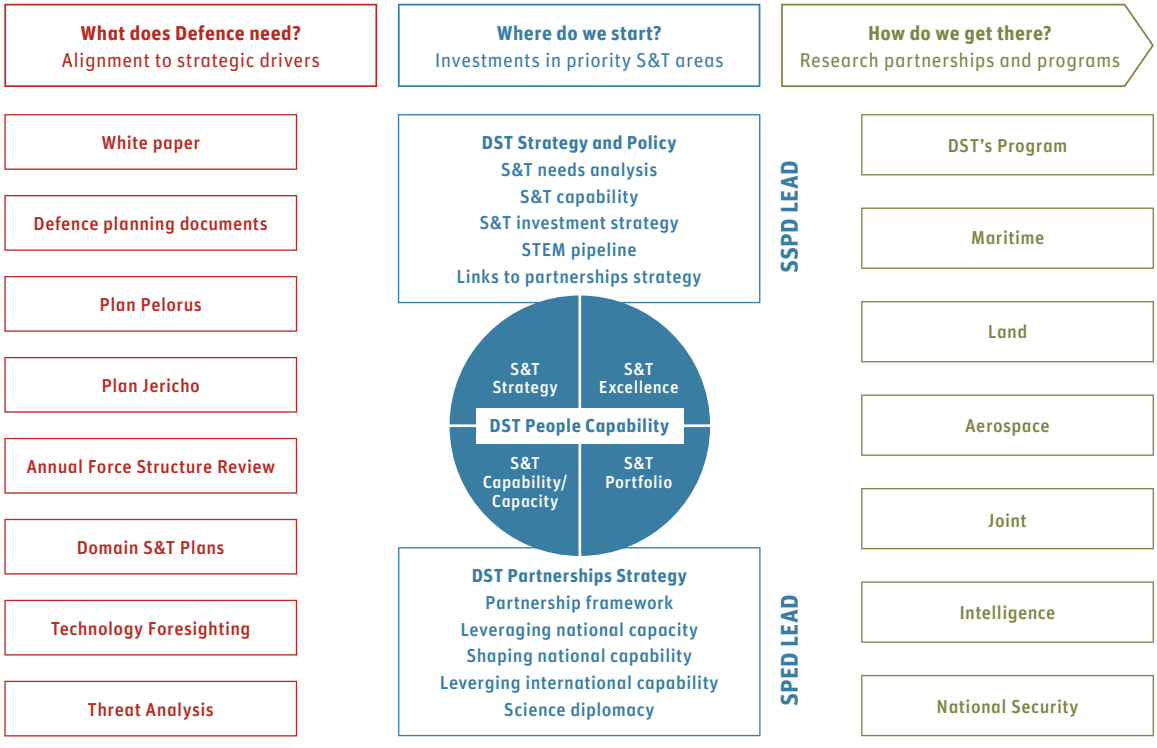
Since the original restructure, the Australian Government has announced the Defence Industry Policy Statement and the Naval Shipbuilding Plan. This has occasioned a further slight realignment by DST of the structures of its divisions to meet new requirements for support.

In order for DST to effectively 'make a difference' for Defence, several key precursors for success need to be created and delivered.

DST developed a corporate perspective with these aims in mind, which involved:

- Developing, monitoring and assuring DST's strategy,
- Planning and investing in S&T capability and the associated assurance of S&T quality
- Planning, monitoring and assuring the application of current S&T capabilities and capacities to Defence priorities
- Assuring the quality of DST advice to Defence and Government on Defence Integrated Investment Program (IIP) projects
- Developing policies, guidance and investment methodology for the Next Generation Technologies Fund
- Ensuring future capability meets future demand by building the talent pipeline for science, technology, engineering and mathematics (STEM) careers.

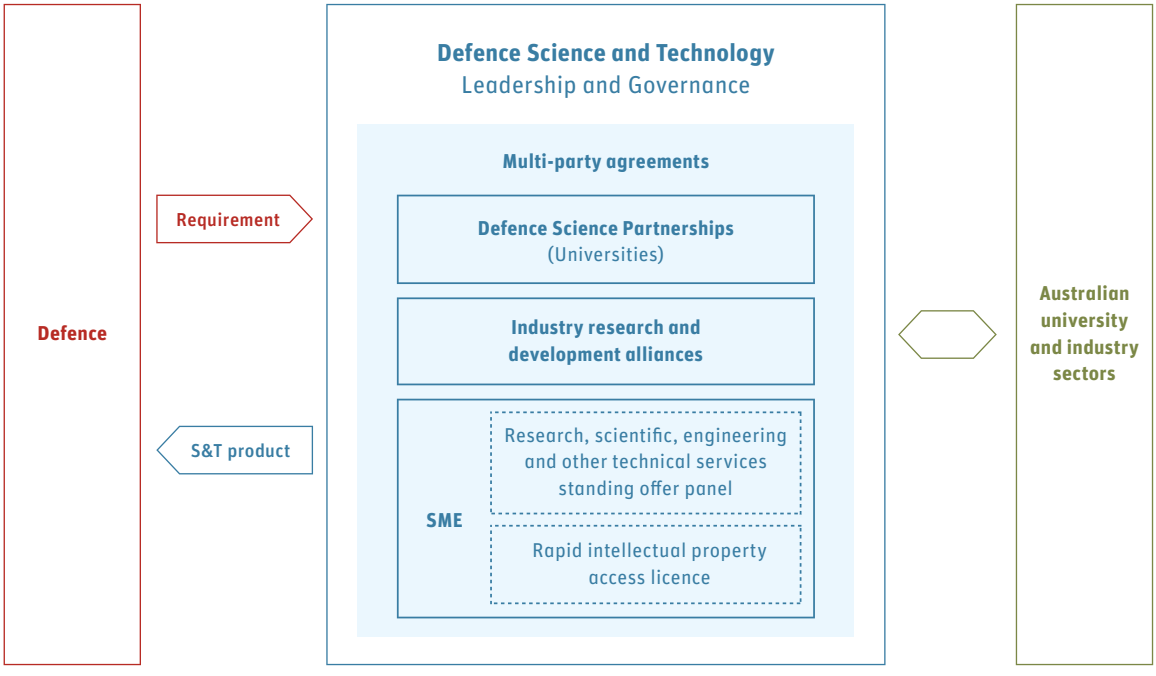
DIAGRAM 3: DST'S DIVISIONAL REALIGNMENTS



DST also developed a corporate perspective to enhance its ability to collaborate and become more innovative by:

- Building the ability to establish and maintain international collaborations with mutual reliance
- Growing Australia's defence industry by transitioning technology from the laboratory bench into fielded systems
- Building a collaborative framework for broader partnerships with academia and industry, locally and internationally, to foster a national S&T base and to transfer knowledge
- Building the visibility of Defence S&T through events, awards and partnership forums such as Partnerships Week
- Building the internal innovation and collaboration frameworks within DST
- Partnering with the Defence Innovation Hub and the Centre for Defence Industry Capability to deliver optimal benefits to Defence and the Australian Government.

DIAGRAM 4: UNIVERSITY AND INDUSTRY PARTNERSHIPS FRAMEWORK



ASSURING THE DEFENCE S&T PORTFOLIO AND PROGRAMS

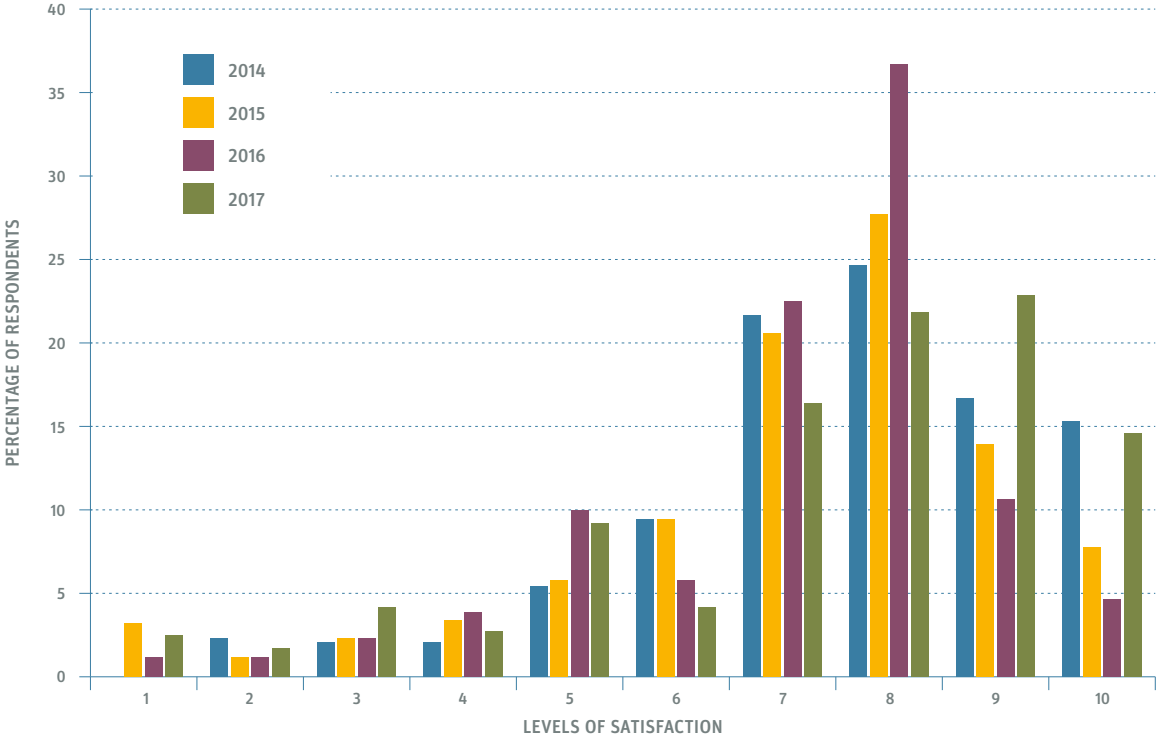
To help assure the value of the DST S&T portfolio, DST undertakes client satisfaction surveys that gather feedback on the timeliness and quality of S&T support delivered to Defence and national security agencies. Two surveys, one of Band-Two/Two-Star stakeholders and one of desk officers at the 05 to 06 level, were conducted by the DST domain program manager and relevant scientific adviser.

The survey results show that DST is highly valued and is meeting the needs of Defence. They also provide insights for DST on how to shape S&T capabilities and the program to increase value for Defence. The responses indicated strong support for S&T program and research contributions, with DST seen to be a valued partner.

The annual desk officer survey had a 71 percent response rate, and the results show that satisfaction was similar to the previous year at 90 percent positive. It also showed a distinct improvement, with 38 percent (up from 16 percent) of respondents giving DST a rating of nine out of ten or ten out of ten (see Diagram 5). DST scientific advisers and project leaders are proactively resolving any identified issues with Defence. Many personnel were praised by name or by work area for the support provided. DST will conduct these surveys again in 2018.

Engagement was identified in both surveys as a key theme for continued DST success. It underpins the quality of communications, partnering and relationships, and enables DST to understand priorities, align S&T programs and deliver value. At the 2018 Defence S&T Client Forum, senior Defence officials commended DST on the transparency of its S&T program and how strongly stakeholders are engaged in its development.

DIAGRAM 5: OVERALL LEVELS OF SATISFACTION, FOUR-YEAR COMPARISON



ON-GOING IMPROVEMENT OF DEFENCE S&T INVESTMENT PROCESS

In 2015–16, DST introduced a new methodology to guide decisions on distribution of the available budget across the annual S&T program and the sustainment of S&T capability. This Defence S&T investment process was refined further during 2017–18. For the 2018–19 year, it was used to prioritise and balance S&T resources across the entire S&T portfolio in accordance with strategic guidance and the research needs of Defence. Proposed S&T programs and projects were prioritised by review panels composed of senior Service and Group representatives as well as DST Leadership Team members, ensuring the S&T program budgeting processes were appropriately consultative and transparent.

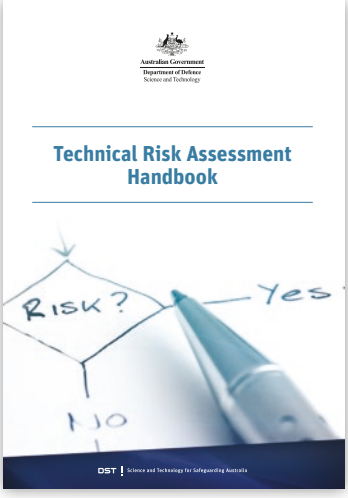
As a result of the 2018–19 investment process consultations, DST is investing the majority of its S&T resources in maritime, land, aerospace, joint, intelligence and national security programs. Funding for DST's Enabling and Strategy Policy & Assurance functions was reduced by identifying efficiencies.

DST maintains a long-range research program. Investment is made in priority strategic research areas as identified by the Next Generation Technologies Fund and previous Investment Committee guidance to ensure that the program is aligned with Defence priorities. As strategic research matures, it is transitioned into applications to enhance future Defence capabilities.

As has been the situation in previous years, the demand for S&T support exceeds DST's capacity. DST has identified areas of workforce risk that will be mitigated through a combination of recruitment, reskilling and partnering. Additional resources have been invested to develop S&T staff capability in priority areas to ensure better outcomes can be delivered in these areas in future.

The resultant S&T portfolio investment balance was presented for agreement at the Band-Two/Two-Star Defence S&T Forum held on 8 May 2018, and was subsequently approved by the Defence Investment Committee on 20 June 2018.

ASSURANCE OF TECHNICAL RISK IN DEFENCE ACQUISITIONS



As part of delivering on its value proposition, DST supports all major investment projects, both approved and unapproved, in the Defence Integrated Investment Program.

The Chief Defence Scientist is required to provide independent advice to the Australian Government and Defence on the technical risks of, and risk mitigation strategies for, all major capital equipment projects seeking government approval. This advice assures government that the difficulty of achieving technical developments needed to deliver projects has been adequately and consistently assessed. DST is uniquely positioned to give such advice because of its deep knowledge of military capabilities, and the independence it has from the effects of project outcomes.

On 23 January 2018, DST released an updated Technical Risk Assessment Handbook, which had been redrafted in consultation with Defence stakeholders to reflect the new capability life cycle. About 50 staff received training on the technical risk assessment process in 2017–18.

During this time, DST provided 47 technical risk assessments for Defence capability acquisition projects, and certified the technical risk for 32 such projects. Significant capability acquisition projects for which technical risk assessments were conducted included:

- LAND 400 (Phases 2, 3) Land Combat Vehicle System
- SEA 5000 (Phase 1) Future Frigate
- AIR 7000 (Phase 1B) Multi-mission Unmanned Aircraft System.

Overall, DST generated 127 project briefs in 2017–18 for the Investment Committee and Capability Manager Gate reviews, in addition to providing analysis and advice for:

- 32 cabinet or ministerial submissions
- 13 technical risk assessment reports
- 18 technical risk assessment minutes
- 16 technical risk indicator reports.

SHAPING DEFENCE (S1 STRATEGIC INITIATIVE)

EMERGING DISRUPTIVE TECHNOLOGY ASSESSMENT SYMPOSIUM

The Emerging Disruptive Technology Assessment Symposium (EDTAS) series was initiated in 2015 to investigate areas of science and technology with the potential to offer game changing capabilities over the next 20-plus years.

This twice-yearly event brings together internationally recognised leaders for discussions to understand and shape the long-term vision in a multi-disciplinary immersive workshop environment. In addition to providing an understanding of technical developments, EDTAS considers social, ethical, legal and economic perspectives as well as examining the potential implications for future Defence.

Two EDTAS symposia were held in 2017–18:

- Advanced Materials and Manufacturing (November 2017)
- Biotechnologies and Human Performance (May 2018).

Dr Dong Yang Wu, Chief of Aerospace Division presenting at EDTAS.

PRESENTATIONS TO STRATEGIC COMMAND GROUP AND JOINT COMMANDERS

DST provides regular briefs on technology trends, threats and opportunities to both the Strategic Command Group and the joint commanders. These briefs enable DST to provide ongoing credible and robust forecasting as well as analysis of future S&T challenges and opportunities for Defence. In 2017–18, ten presentations were provided either by DST or jointly with other Defence partners. The topics included Big Data, Human Performance, the Emerging Disruptive Technology Assessment Symposia series, Malaysian Airlines MH370 disappearance, Training Needs Analysis and High Performance Computing for Defence Research.

NEXT GENERATION TECHNOLOGIES FOR SAFEGUARDING AUSTRALIA (S2 STRATEGIC INITIATIVE)

THE NEXT GENERATION TECHNOLOGIES FUND – ONE YEAR ON

The 2016 Defence White Paper and associated Defence Industry Policy Statement directed DST to establish and lead Defence's Next Generation Technologies Fund. The purpose of the fund is to engage Australia's broad innovation enterprise in research to deliver game-changing capabilities for Defence. The focus of this program is far-sighted; it aims to ensure the ADF of the future can call upon a whole suite of new capabilities, giving it a clear advantage over potential adversaries.

Nine technology domains were identified as priorities for development under the Next Generation Technologies Fund. They included cyber; space capabilities; trusted autonomous systems; enhanced human performance; medical countermeasures; quantum technologies: multi-disciplinary material sciences; integrated intelligence, surveillance and reconnaissance; and advanced sensors, hypersonics and directed energy capabilities.

To support these priority themes, seven 'collaboration vehicles' were created. These vehicles range from large-scale initiatives – the grand challenges and Defence cooperative research centres – that account for up to 60 percent of the investment, down to smaller and more agile initiatives such as the Small Business Innovation Research for Defence (SBIRD) program. While the collaboration vehicles vary in scale and research scope, they all have two common characteristics: first, they feature a large proportion of investment by research partners outside Defence, and secondly, DST is engaged in every case as an active research contributor.

During 2017–18 the program matured very successfully, achieving a high level of engagement with Australia's innovation community. Individual projects are raised via public calls for participation. Every call released to date has resulted in very high response rates from the Australian innovation community. For example, the call for participation in the Counter Improvised Threats Grand Challenge resulted in over 200 responses. Across the whole program, around 950 proposals have been received involving the majority of Australia's universities, many public-funded research agencies and many defence industry organisations. The evaluation processes for project selection have been exhaustive, with robust assurance checks being undertaken to ensure that only the 'best of the best' applications are funded. The research projects chosen have addressed the full range of priority themes, and projects have been funded in all Australian states plus the ACT.

Some activities have attracted additional, non-Defence support. For example, the creation of the Defence Cooperative Research Centre for Trusted Autonomous Systems (Defence CRC) resulted in the Queensland Government committing to a dollar-for-dollar co-investment. As a result, this Defence CRC is to be a $100 million enterprise. In like manner, participants in the Counter Improvised Threats Grand Challenge have committed significant amounts of in-kind co-contribution.

The following examples illustrate the growing research portfolio under the Next Generation Technologies Fund:

COUNTER IMPROVISED THREATS GRAND CHALLENGE

The Grand Challenge program to counter improvised threats is a first for Australia and Defence. Based on NASA's strategy for the Apollo program, a grand challenge approach invites solutions from multiple sources and disciplines to solve intractable problems that defy conventional solutions. Twenty two organisations were selected to collaborate on a threat detection and defeat prototype to be delivered in four years. Defence is investing $19 million over four years to address this grand challenge.

DEFENCE COOPERATIVE RESEARCH CENTRE FOR TRUSTED AUTONOMOUS SYSTEMS

Announced in December 2017, the inaugural Defence Cooperative Research Centre was formally established in May 2018 to undertake a seven-year research program on autonomous systems for Defence applications. The inaugural participating members are BAE Systems, DefendTex, RMIT University and DST, representing the Department of Defence. Initial work will include

research in the maritime domain with a focus on littoral operations, led by Thales Australia; research in the land domain focusing on networked autonomy, led by BAE Systems Australia; and research in the aerospace domain with a primary focus on persistent autonomy, led by Lockheed Martin Australia. The Defence CRC will progressively feature significant engagements with universities and industry participants additional to those in the lead roles.

SMALL BUSINESS INNOVATION RESEARCH FOR DEFENCE (SBIRD)

SBIRD is a program specifically designed to facilitate research by small to medium enterprises (SMEs) and allow them to explore new concepts for solving specific Defence problems. This is a two-stage program valued at $10 million over 10 years.

Attaching the Fight Recorder to a soldier.

For the inaugural SBIRD project, the startup telecommunications company, Myriota, has teamed with the wearable technology company, IMeasureU of New Zealand, to develop a soldier-worn emergency beacon called the Fight Recorder to capture battlefield data that can be used to expedite the delivery of medical aid and minimise casualties.

UNIVERSITY RESEARCH

Universities in two Australian states, assisted by their state governments, formed collaborative networks in 2017–18 to undertake joint research on Defence priority projects. The Defence Innovation Partnership in South Australia and the Defence Innovation Network in NSW followed the example set by Victoria with the Defence Science Institute in 2010.

Thanks to the Next Generation Technologies Fund, Australian universities for the first time had the opportunity to collaborate with their US counterparts by participating in the US Department of Defense's Multidisciplinary University Research Initiative (MURI) on Defence capability projects. In 2017–18, four universities – the University of Sydney, the University of NSW, Griffith University and the University of Technology Sydney – were selected to collaborate with a number of US universities on quantum technologies and advanced material sciences. The University of Tasmania's Australian Maritime College and seven top-flight US universities also began joint research on hydrodynamics to study the effect of cavitation on naval vessel performance.

OTHER PROJECTS UNDER THE NEXT GENERATION TECHNOLOGIES FUND

DST sought proposals from industry and academia to partner in a quantum technologies research network to study sensing navigation, timing, communications and computing. Eighty submissions were received for this $6.6 million project.

Existing research accelerators are used to fast track promising innovations. This approach led to the spin-off of a company called Silentium Defence formed by two Defence scientists who completed the CSIRO ON-Prime accelerator program using passive radar technology developed at DST. Silentium Defence has received further funding from the Defence Innovation Hub, and plans to enter the commercial transportation market.

Defence has continued to invest in a strategic partnership with CSIRO's Data61 in cyber S&T. Through this partnership, DST, Data61 and more than eleven Australian university partners have been participating in a research program that focuses on trustworthy systems, artificial intelligence applications to cyber security, network technologies and the human element. The partnership has also had an influential role in building an Australian cyber security S&T community through the conduct of a Defence Cyber Research Networking Forum and a number of cyber security summer schools.

FOSTERING INNOVATION (T1 STRATEGIC INITIATIVE)

COLLABORATION SPACES

Highly configurable physical spaces, designed to foster collaboration, brainstorming and innovative work methods, are being established at most DST sites. Known as Hubs, they facilitate unclassified meetings and video conferences, and a capability for rapid prototyping via 3D printers and basic electronics fabrication equipment to demonstrate and test novel concepts and ideas.

The Fishermans Bend Hub was formally opened in November 2017. The Hub has an unclassified presentation venue for up 35 people, a smaller video conference room for up to nine people, a quiet room where people can get away from the office to read and reflect, a Maker Space for prototyping and fabrication with a 3D printer and laser engraver, and a larger open reconfigurable area with desks and seating for solo or team work.

The building works were carried out by Bapra Construction Services – a partnership between the Federation of Victorian Traditional Owner Corporations and Cockram Construction that undertakes federal, state and corporate capital procurement projects aimed at 'closing the gap' for indigenous Australians.

The Hubs in Canberra and Adelaide were also opened in early July 2018. The Canberra Hub was named the Galambany Suite, an Aboriginal term meaning 'we, including you'.

S&T ASHES (STASHES)

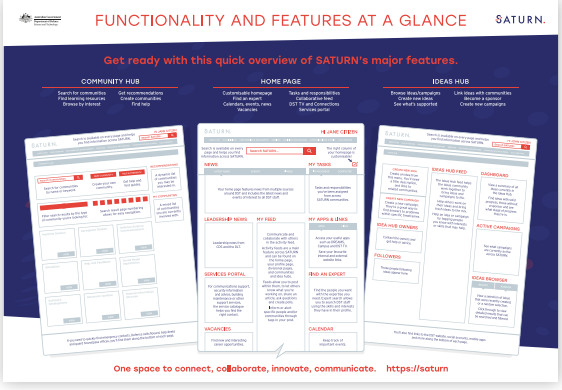
The SolveIt concept of crowdsourcing solutions to specific challenges was extended during the year to involve a team from the UK's Defence Science and Technology Laboratory (Dstl). Ten early career scientists from DST and Dstl explored novel applications for a 2017-era Android-based phone to improve the capability of soldiers operating in a complex 2020 urban setting.

Two ideas were chosen from the STASHES exercise for further development – haptic-assisted mobility to track the movement of soldiers in GPS-denied urban environments, and the creation of an enhanced situational awareness map to enable hands-free voice interaction with improved situational awareness for dismounted soldiers.

SATURN

A new internal collaboration system called the Science and Technology Unified Research Network (SATURN) was launched in July 2017. The system combines the DST intranet with an enterprise social networking tool onto a single platform.

SATURN allows all DST employees to gain a better understanding of other related areas of excellence across the organisation to discover and build on opportunities for collaboration. The network serves a particularly valuable role as a conduit for collaboration between staff located at DST sites in different parts of Australia.



INVIGORATING S&T FOR NATIONAL SECURITY (T2 STRATEGIC INITIATIVE)

NATIONAL SECURITY SCIENCE AND TECHNOLOGY POLICY AND PRIORITIES DOCUMENT

As foreshadowed in the 2016 Defence Industry Policy Statement, a National Security Science and Technology Policy and Priorities document was released by the Minister for Defence Industry in May 2018.

This document provides the science and defence industry community with a view of the endorsed national security S&T focus areas, governance arrangements and engagement mechanisms. Its delivery represents the culmination of the work of this initiative to establish government-wide coordination of S&T effort in support of national security. DST, through the National Security Science and Technology Centre, is responsible for administering the policy and priorities.

The six endorsed priorities contained in the policy are:

- Cyber security
- Intelligence
- Border security and identity management
- Investigative support and forensic science
- Preparedness, protection, prevention and incident response
- Technology forecasting.

Australia's national security arrangements are underpinned by multiple agencies working across a range of areas. These agencies are increasingly using advances in S&T to enhance Australia's national security capability. The National Security Science and Technology Inter-Departmental Committee (NSST IDC) working at the Band-Three level (co-chaired by the Chief Defence Scientist and the Department of Prime Minister and Cabinet) is steering the national security S&T program and provides governance. This Committee gives strategic direction for national security S&T, coordinates investment across the sector, enables interdepartmental coordination, and oversees the development and delivery of the S&T program. A cross-agency Band 1 Round Table actively shapes the national security S&T requirements against the agreed priorities.

5RD INITIATIVE

In 2018, a five-nation Research and Development (5RD) Initiative was established to create new opportunities for collaboration, deliver more efficient and cost-effective access to results, expand capacities for research, development, testing and evaluation, and maximise the research budget available to the five nations; Australia, Canada, New Zealand, UK and USA.

The objectives of the 5RD Initiative are to:

- Discover collective knowledge of emerging threats and risks
- Connect with each other to coordinate the planning and prioritisation of research, development, testing and evaluation in order to optimise efficiency and cost-effectiveness
- Access each other's capabilities to avoid duplications of research efforts.

FIVE program participants and facilitators.

LEADERSHIP, ACCOUNTABILITY AND PERFORMANCE MANAGEMENT (O1 STRATEGIC INITIATIVE)


FIVE program participants.


Participants in the mentoring circles program at Fishermans Bend.

FIVE PROGRAM

During 2017–18, the FIVE program was made available to all S&T5 level staff to develop their skills in effective engagement, partnering and professional interactions, as well as persuasive communications, and to improve their understanding of career and action plans.

All program participants had the opportunity to engage directly with the Chief Defence Scientist in small group settings to discuss their research and its place within DST's strategic context and priorities. About 75 percent of DST's S&T5 cohort completed the program.

MENTORING CIRCLES FOR WOMEN

A pilot program of mentoring circles for women was organised during the year, attracting 25 women. The program learning modules included:

- Authentic leadership
- Mindfulness and positive psychology
- Personal style and presence
- Career planning and negotiation.

The program was augmented with a series of talks by inspirational guest speakers.

TALENT, DIVERSITY AND CAREER DEVELOPMENT PIPELINE (O2 STRATEGIC INITIATIVE)

SAGE PILOT OF THE ATHENA SCIENTIFIC WOMEN'S ACADEMIC NETWORK

DST has joined the Science in Australia Gender Equity (SAGE) pilot of the Athena Scientific Women's Academic Network (SWAN). SAGE is a nation-wide program that aims to improve the recruitment, retention and progression of women in science, technology, engineering, mathematics and medicine in Australian universities and research agencies. DST is applying for the bronze-level SAGE award, which is given to organisations in recognition of the solid foundation they have established for eliminating gender bias and for having developed an inclusive culture that values all staff. During 2017–18, the SAGE team worked closely with the Defence People Group and DST's divisions to compile the data required for the SAGE award application, which involved drawing on data collected by the DST Insights surveys and the Defence YourSay surveys. The SAGE team also analysed the data to identify important trends and characteristics to better understand the issues faced by women and staff from diverse backgrounds. These issues were further explored in a series of focus groups.

GENDER EQUITY WORKING GROUP

A Gender Equity Working Group, established to promote gender equity, made a DST-wide call to gather ideas for improving inclusiveness in DST. These ideas are being actioned to include them in the next DST Strategy, or by other Defence organisations such as the Defence People Group.

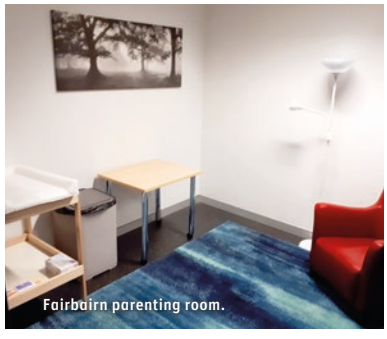
Areas in which achievements were made include:

- Gendered language: Guidance to use alternative terms to 'manned' and 'unmanned'.
- Diversity and Inclusion Speakers: A series of talks by speakers with diversity and inclusion expertise was initiated.
- Keeping DST Informed: SATURN now has a service catalogue listing support services available for DST personnel to balance their work and personal lives. SATURN also keeps DST personnel abreast of gender equality issues in the Australian STEM space.
- Gender Identity Awareness Sessions: Facilitators ran an information session at DST Edinburgh, on sexual orientation and gender diversity, the issues that those who are not heterosexual and cisgendered (the status of identifying with one's birth gender) can face in the workplace, and what people can do to support others whatever their sexual orientation and gender.

The Chief Defence Scientist is a member of the Male Champions of Change for STEM, which provides DST with a window into the actions taken by other organisations to promote gender equity.

PARENTING ROOMS

DST recognises the importance of achieving a work-life balance for parents with children. Dedicated parenting rooms were established at all DST sites to provide an appropriately furnished environment for the care of babies and young children.



Fairbairn parenting room.

Edinburgh parenting room.

TRANSFORMATION OF RESEARCH ICT TO DRIVE INNOVATION AND COLLABORATION (O3 STRATEGIC INITIATIVE)

ICT TRANSFORMATION AND UPDATES

DST's Information Management and Technology transformation delivered a number of critical foundational capabilities in 2017–18, enabling DST to advance its focus in future years from the underpinning technology infrastructure towards enhancing the application of advanced technology to our clients' S&T needs. In this past year, DST delivered four key pillars of its future environment:

- A pilot High Performance Computing (HPC) system that enables DST to push forward with confidence to deliver a secure HPC capability that rates as one of the world's top 50 capabilities
- The Science Research Compute Environment (SRCE), a high capacity secure computation facility to service research needs that do not require HPC
- Storage – an enterprise research data storage system to securely store research data
- Standalone Networks – a substantial rationalisation and security uplift to the networks dedicated to specific S&T research projects.

HIGH PERFORMANCE COMPUTING

A HPC system was installed at DST Melbourne and brought into service in May 2018. This system is a pilot program for a larger project to deliver a secure centralised HPC capability that will facilitate advanced S&T research, modelling, simulation and experimentation for Defence. The system is designed to deliver multi-petaflops of processing power at peak levels, a level of computing power that would rank it within the top 50 facilities worldwide.

The pilot HPC comprises:

- 48 compute nodes each with two Intel Xeon Gold 6148 processors and 192 GB RAM
- 24 Graphics Processing Unit compute nodes each with four NVidia V100 GPUs, two Intel Xeon Gold 6148 processors and 192 GB RAM
- One large memory node with four Intel Xeon Gold 6148 processors and 3072 GB RAM
- Data Direct Networks storage solution with 3.8 petabytes of high-bandwidth low-latency media.

SCIENCE RESEARCH COMPUTE ENVIRONMENT

The DST SRCE is designed to enable the latest in advanced research information management technology applications to bear on Defence and national security client needs. It enables the rapid provision of new environments customised for research tasks, and is ideal for horizontally scalable workloads such as research software development, machine and deep learning, data analysis and visualisation, modelling and simulation and flexible infrastructure-as-a-service provision.

The SRCE facility comprises:

- 154 servers across two sites, with over 3,600 CPU cores, across both the Protected Research Network and Secret Research Network
- 420,000 Graphics Processing Unit cores
- 39 TB of random access memory
- 1.3 PB high performance disk space.

Clarke Towson and Lachlan Carlile work on the HPC pilot system.

STORAGE

As next-generation Defence platforms substantially increase the amount of data they produce, and as science and technology research tools consume and produce rapidly increasing amounts of storage, DST's need for storage is growing at a prodigious rate. The central research data store has been upgraded with 4 PB of high performance storage for research data, enabling both the necessary storage of new research data, as well as the modernisation and consolidation of aged and underperforming storage systems.

STANDALONE NETWORKS

DST substantially reduced its number of standalone research networks to better focus resources in priority areas. Standalone research networks are Information Management and Technology systems dedicated to particular research activities that cannot be combined with other research systems for security or operational reasons, thereby consuming a larger proportion of resources to maintain them. Improvements in technology, information security services, and governance enabled these networks to be rationalised from an initial 174 down to 74 networks at the end of the year.

BEST PRACTICES FOR BUSINESS PROCESSES AND ADMINISTRATION (O4 STRATEGIC INITIATIVE)

RESHAPING THE DEFENCE INTERNATIONAL TRAVEL PROCESS

Previous work by this strategic initiative had implemented a prototype software system to reduce the administrative burden of submitting paper work for an overseas trip. However, while the software system was effective, it did not address the underlying issues of the complexity of the international travel approval business process.

In partnership with the Estate & Infrastructure Group (E&IG), owner of the Defence International Travel Process, DST initiated and significantly shaped a total reform of the process. E&IG has undertaken to implement this with ongoing support from DST, with the new process to be rolled out across Defence in late 2018.

This work is expected to deliver savings to Defence of around $1.4 million per annum through cheaper airfares that can be secured by being able to book earlier, and through reduction in staff time by using a single smart form to replace ten different forms for travel approval currently in use.

DST's success in initiating this One Defence reform can be considered a significant achievement given that DST only accounts for two percent of the Defence travel budget, that five different Defence groups each own a part of the Defence international travel process, and that Defence must comply with whole-of-Australian Government constraints.

AUTOMATION OF BUSINESS PROCESSES

Through work done with its Technology Partnership Office (TPO), DST undertook to improve and automate the business processes underlying the creation of new research agreements. This involved creating process maps of the TPO business processes that facilitated improvement and automation, and developing a prototype automated system using JIRA Service Desk software. The work is expected to develop deep expertise for DST in business process best practices, and to ensure that DST's policies and processes are uniform, succinct, easily understood by staff and aligned with Defence and whole-of-Australian Government policies.

2

DELIVERING CAPABILITY FOR DEFENCE AND NATIONAL SECURITY

SUPPORTING AUSTRALIAN DEFENCE FORCE OPERATIONS

DST's support for operations is the highest priority work it undertakes. This support helps ensure that Defence personnel undertaking military operations overseas can do so safely and successfully.

The ways in which support is offered include:

- S&T staff deployments for immediate on-the-ground advice and assistance
- Expedited access to DST's research laboratories through a program called the Operational S&T Support Request (OPSTSR)
- Access to high-readiness S&T capabilities.

The DST Operations Support Centre (DOSC) manages and certifies a pool of deployment-ready staff. It selects, prepares and deploys S&T personnel to operational theatres to assist significant operational decision-making, address immediate operational needs and provide S&T advice and assessments to Joint Task Force (JTF) commanders.

'Fly Away Teams' made up of scientists with specific skills to address particular problems can be put together at short notice in cases of urgent need. Should these scientists face a problem they are unable to solve with available resources, they can access DST scientific assistance back in Australia through a support system called Reachback.

DOSC also maintains a 'watch keeper' function and facilitates the management of specified high readiness S&T capabilities for an emergent operational contingency or national crisis.

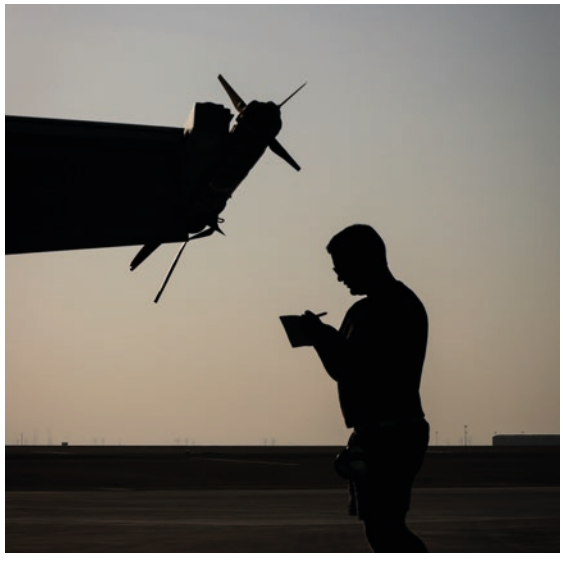
DST'S SUPPORT FOR OPERATIONS IN 2017–18

During the 2017–18 year, DST responded to 27 urgent operational ADF requests arising mostly in the course of operations in the land domain, with some also coming from the maritime, air and joint domains.

The range of work undertaken included developing countermeasures to improvised threats, managing aircraft IR signatures, investigating the effects of vibration on aircraft-mounted missiles, and conducting operations analysis.

Some requests required the development of urgently needed ADF operational equipment, and all DST divisions assisted with this work, which the DOSC coordinated.

DST has also supported domestic security operations.



Australia's Force Protection Electronic Countermeasures Advisor in the Middle East Region, Australian Army officer Major Shane Lacey with a 'Greygum' device at Australia's main operating base.

PROTECTING ADF PERSONNEL AGAINST IMPROVISED THREATS

To enhance the safety of ADF personnel deployed overseas and within Australia, DST has devised better ways of countering existing improvised threats, developed force protection electronic countermeasures against new and evolving threats, conducted analysis on recovered adversary materiel, and undertaken studies to predict the nature and deployment of future threat systems.

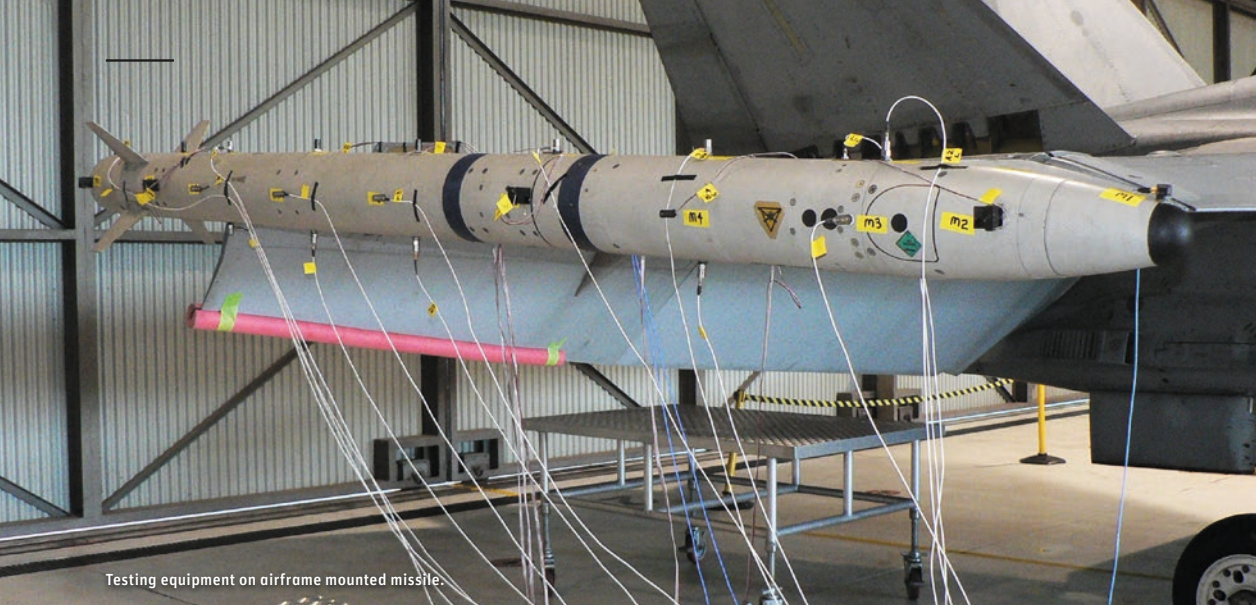
Some of the countermeasure techniques developed by DST have been implemented in current force protection systems to address several new types of radio-controlled improvised threats posed to ADF and government personnel deployed on Operation Highroad in Afghanistan and Operation Okra in Iraq.

DST also undertook a number of counter-improvised explosive device (IED) field trials in support of several urgent operational S&T support requests, which were conducted at the new Counter-IED Test Facility near the Woomera Test Range.

Testing at the facility was undertaken to support both urgent operational S&T requests and longer-term counter-IED research and development. Its inauguration allows for far more extensive and rigorous testing than before of over-the-air radio frequency (RF)-based countermeasure techniques against target IED technologies.

PLUME AND EFFECTS MODELLING SUPPORT TO DEFENCE AND NATIONAL SECURITY OPERATIONS

The Chemical, Biological, Radiological and Nuclear Effects Modelling (CBRNfx) team provided rapid analyses to support operational decision making in many Defence agencies, including Headquarters Joint Operations Command and various intelligence agencies. In 2017–18, these analyses included modelling the consequences of deliberate and unintended releases of CBRN and other toxic materials in various situations. DST support was also extended to national security agencies in relation to specific counterterrorism operations.



Testing equipment on airframe mounted missile.

MISSILE VIBRATIONS EFFECTS STUDY

DST assisted research conducted by The Technical Cooperation Program (TTCP) into the effects of vibrations on the rocket motors of missiles mounted on aircraft.

The work DST undertook, which was also carried out to facilitate ADF's contribution of airpower to Operation Okra, was to establish the appropriate level of vibratory loading to apply to missiles and their components during static testing procedures done on the ground. This enabled studies to be carried out on the vibration mechanisms that cause damage to a missile's rocket motor.

The international team created a suite of tools and methodologies to inform current and future TTCP member countries about ways of mitigating the capability and safety risks associated with vibration-exposed missile assets. DST's work was recognised by TTCP with an award.

In another missile-related venture, DST worked with RAAF Air Combat Group to determine how the target location error for the F/A-18 Classic Hornet laser targeting pod had changed following recent aircraft software modifications. This work enabled RAAF's aircraft to be more closely integrated into the US-led coalition force engaging in Operation Okra and also for strikes to be made against more target categories with less likelihood of collateral damage.

AIRCRAFT SIGNATURE MANAGEMENT

Other major tasks undertaken in support of operations during 2017–18 included work on managing the signatures of ADF aircraft to be deployed in the Middle East to enhance their survival against airborne threats. DST's work involved finding ways to reduce both radar and IR signatures.

In the area of IR signature management, DST assisted the Australian Airborne Countermeasures Team (AACT) by applying its world-class expertise to develop IR signature datasets for RAAF's E-7A Wedgetail, C-27J Spartan, F/A-18A Hornet and Navy's MH-60R Seahawk. This latter aircraft has been equipped with DST's 'Low-E' zero-weight IR signature reduction apparatus, which the AACT will assess for survivability benefits through simulations and trials during 2018.

In other IR signature management work, DST has modelled the IR emissions given off by F/A-18A afterburners to assist the process of predicting the IR emissions of aircraft with plume-dominant signatures. The outcomes will be used to develop ways of protecting such aircraft against IR-guided missile threats.

OPERATIONS ANALYSIS (OA)

DST completed 121 operations analysis tasks for commanders in the Middle East and 35 tasks elsewhere. This involved training, preparing, supporting and reintegrating seven deployed DST analysts.

A deployed DST analyst contributed to work done by the CT-150 team of 25 Australian and Canadian sailors based in Bahrain, laying the grounds for the largest-ever seizure of drugs made over a five-month period, worth over $2 billion in total. This analyst worked closely with both the DST Reachback team in Australia and another DST analyst deployed in the Combined Maritime Force HQ.

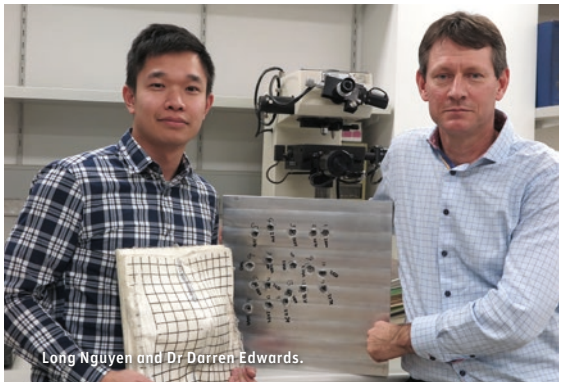
Some of DST's OA during 2017–18 was done to assist the conduct of exercises by Headquarters Joint Operations Command and Special Operations Command Division. These included Exercise Hamel, Exercise Northern Shield and Exercise Talisman Sabre 17. Operations analysis assistance was also provided for various tasks on multiagency and multinational operations, such as APEC18.

SUPPORT TO SURVIVABILITY PROGRAMS

The Airborne Countermeasure Development and Validation Program and the Joint Survivability and Tactical Validation Program continued to enhance the electromagnetic survivability of ADF platforms and personnel by addressing ever-evolving threats. Strategically partnering with RAAF, Navy, Army, the Defence Intelligence Organisation, the Capability and Acquisition Group, industry, NATO, and TTCP, DST undertook the annual domestic SURFRIDER and WAVERIDER campaigns and several international activities to assess, validate, optimise and investigate new ADF Electronic Warfare capabilities across the RF and electro-optical spectrum. To support these activities, significant investment was made in acquisition of critical infrastructure, such as the Future Advanced Threat Simulator and the Airborne Signature Measurement System, in addition to the construction of a new building to facilitate the work conducted under the Joint Survivability and Tactical Validation Program. The totality of these programs will address issues associated with both accurate threat warning and validated countermeasures and hence increase the survivability of platforms into the future.

APPLIQUE ARMOUR PROTECTION FOR VEHICLES

DST and Thales developed new applique armour concepts to enhance the protection afforded to vehicles for deployed operations. In recognition of the changing roles of armoured vehicles and their increased use in urban environments, a holistic approach to the protection of vehicle capabilities was undertaken to identify critical failure paths that have the potential to jeopardise mission success. With reference to tight vehicle requirement constraints as well as insights into current and emerging threats, the research partners' expertise in armour mechanics was applied to develop growth options for improving vehicle survivability.



Long Nguyen and Dr Darren Edwards.

SUSTAINING AND ENHANCING EXISTING DEFENCE CAPABILITY

One of DST's prime responsibilities is to sustain and enhance current Defence capability. This work involves improving the ADF's operational effectiveness, enhancing the safety of troops, maximising the availability of Defence platforms and minimising the costs of owning and operating Defence assets.

Silvershield installed on a typical support vehicle.

SILVERSHIELD

During 2017–18, DST continued the very successful Redwing program through which it has delivered a suite of unique low-cost robust and lightweight counter-IED protection systems.

Its most recent product, developed with an Australian defence industry partner, is called Silvershield – a second-generation state-of-the-art Redwing device that provides vehicle protection against an additional class of priority IED threats. Over the past year, the development of Silvershield has progressed from initial concept testing through to prototype demonstration and trials and then to low-rate initial production.

In 2017–18, the Afghan National Security Forces placed a multi-million dollar order for 16,000 Silvershield systems, which are currently being manufactured. The development and commercialisation of counter-IED protection systems through the Redwing program is considered an exemplary case of DST collaboration with Australian industry.

RAAF PC-9/A ENGINE FAILURE INVESTIGATION

Following the in-flight engine shutdown and emergency landing of a RAAF PC-9/A in November 2017, DST provided specialist support to the Directorate of Defence Aviation and Air Force Safety team investigating this incident, which was found to have involved a catastrophic engine failure.

DST's work included conducting forensic analysis to determine the mechanisms that led to the failure of critical components. It also conducted analysis of the various flight data sets and cockpit recordings captured, thereby enabling the events leading up to the engine failure to be identified, correctly sequenced and understood. In-depth engine performance analysis by DST then identified a likely root cause for the failure, and this was subsequently validated through modelling undertaken by the engine's manufacturer.

The outcomes of the investigation included recommendations to improve aircrew awareness of the conditions that increase the risk of engine failure, and to change the way the aircraft is operated during training flights. These recommendations will enable RAAF to enhance the safety of PC–9/A fleet operations.

INTERGRANULAR CORROSION RESEARCH

In collaboration with RMIT University, DST developed a world-leading capability to assess the effect of intergranular corrosion (IGC) on the operational availability of the RAAF AP-3C Orion fleet.

The discovery of corrosion in the Orions' wings prompted RAAF to ask DST to determine whether the IGC had to be removed or whether it could be left in place, since the aircraft are nearing retirement and are due to be replaced soon by P-8A Poseidons.

In response, DST executed a combined program of fatigue testing and numerical modelling. This program found that the IGC could be safely left in place for the remaining service life of the Orions, thus delivering savings of $30 million to Defence in deferred maintenance costs.

DST's IGC model has subsequently been incorporated into a software package called AFGROW that is being used worldwide by aircraft designers and aerospace researchers to model the growth of fatigue cracks in materials and components.

Stephen Lam with the JSF model.

F-35A MODEL FOR EXTERNAL STORES WIND TUNNEL TESTING

During 2017–18, DST designed and constructed a six percent-scale half-model of the F-35A JSF for external stores (weapons) separation testing in its Transonic Wind Tunnel. The model features fully actuated leading and trailing edge flaps, weapon bay doors and external store pylons.

The model constitutes a key part of Australia's contribution to the F-35A weapons integration program. Its development has led to the establishment of a new strategic partnership between ADF and the US Air Force SEEK EAGLE Office for F-35A stores integration.

It will also enable the conduct of F-35A stores integration work to reduce the stores acquisition and integration risks for Australia while informing Australian decision-makers about the considerations involved in setting weapon certification priorities.

PROBABILISTIC ANALYSIS FOR RAAF FLEET

RAAF is transitioning to a probabilistic risk analysis approach for assessing the structural integrity of its aircraft fleet. To support this transition, DST developed a numerical modelling tool known as FracRisk that analyses the probability of airframe and component fractures. The tool was verified by successfully replicating a previous risk analysis of C-130H aircraft and also positively evaluated by comparing its performance to a risk analysis tool developed by the US Air Force. The use of FracRisk on RAAF's fleets, scheduled to begin in 2020, is expected to significantly reduce the costs of ownership while improving aircraft availability, with the potential for general aviation industry use.

Kai Maxfield with the test equipment.

C-130J-30 FATIGUE TESTING

DST successfully completed the test cycling phase of the C-130J-30 Hercules Wing Full-Scale Fatigue Test Program in 2016, and has since continued to play the leading S&T role in this international collaborative research effort. Drawing upon its extensive structural test and airworthiness certification experience, and through strategic partnering with Australian industry, it has now undertaken follow-on structural teardown, forensics and test interpretation activities.

This work established that wing replacements will not be required for the C-130J-30, thereby delivering savings to Defence in excess of $250 million. The research has uniquely placed the ADF in a highly informed position that will enable it to efficiently manage its C-130J-30 fleet through to retirement while maximising capability and minimising the cost of ownership.

DST has meanwhile finalised the transition of this capability to Australian industry, and significant maintenance efficiencies and capability gains are now being realised by RAAF fleet managers and commercial operators alike.

NEW RAAF SUSTAINMENT WAR-GAMING CAPABILITIES

DST has developed a novel sustainment war-gaming capability for the Logistics Branch–Air Force under RAAF Plan Jericho. Its purpose is to help RAAF quantify the sustainability of various modes of operation, as determined by a range of logistics and enabling capability factors including major systems, infrastructure, personnel, processes and information technology.

Models previously developed and used by DST were able to quantify the sustainability of some of the logistics and enabling capability factors individually, but none could both quantify and prioritise their relative risks. DST therefore undertook to develop a means of systematically analysing the disparate factors in unison to permit on-time mission-capable sortie generation.

MH-60R STUDIES

DST conducted a comprehensive analysis of the capabilities of Navy's MH-60 Romeo (MH-60R) helicopter fleet to support a task group operation in a high surface-threat environment. This study has been used to advise Navy's aviation acquisition programs as well as Navy Strategic Command, Headquarters Fleet Air Arm, the Australian Maritime Warfare Centre and Navy's 816 Squadron about MH-60R weapons effectiveness, fleet availability, employment options and constraints, and the development of tactical procedures.

MACHINE LEARNING AND DATA ANALYTICS FOR AIRFRAME LOADS MONITORING

Aircraft buffet loading, a critical design consideration, is inherently difficult to predict and to successfully account for in fatigue estimation processes due to its random and transient nature. DST has developed an innovative high-fidelity airframe load monitoring methodology to track the in-flight loading of an aircraft, making use of existing airframe sensors.

DST's way of improving the accuracy of of airframe load predictions has been to apply machine learning and multi-variable frequency response analysis to sensor measurements for airframe buffet, strain and manoeuvre loads taken at various structural locations.

With the airframe load monitoring approach having been successfully demonstrated at 'proof of concept' stage, the methodology will now undergo further test and evaluation to progress it towards readiness for implementation on aircraft.

The Hornet Aircrew Training System (HACTS) simulator at RAAF Base Williamtown.

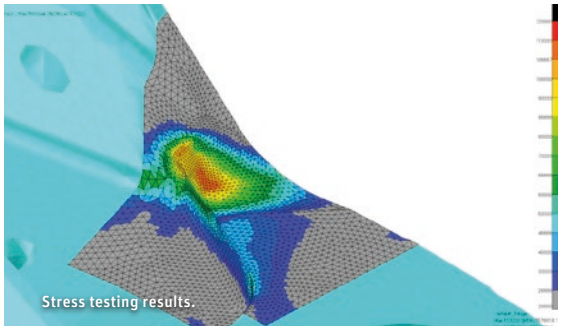
SUPPORT FOR THE CLASSIC HORNET

DST has developed a novel rework shape optimisation capability for the repair of safety-critical aircraft components. This has already delivered major outcomes for the ADF, including the repair of F/A-18 centreline pylons in support of Operation Okra, repair of the LAU-7 missile launcher housing rails fitted to F/A-18 aircraft, and the inner wing aft spar shear tie in the same aircraft. In collaboration with RAAF, DST is now transferring selected aspects of the technology to Australian industry for application more broadly.

In the area of flight simulation capabilities, DST in collaboration with Raytheon Australia has developed and installed simulation gateways that enable the F/A-18 Classic Hornet flight simulators at RAAF Williamtown and Tindal to operate together for the first time, thereby delivering simulations that combine visual, communication and electromagnetic environment inputs to facilitate the training of RAAF's future fighter pilots. A second gateway was also developed, enabling the Hornet simulators to integrate with external simulators, including the Virtual Wedgetail Simulator at RAAF Williamtown and the C130-J Full Flight Mission Simulator at RAAF Richmond. This gateway was used during the 2017 Air Warfare Instructors Course to provide RAAF operators with specialist training.

In the area of F/A-18 airframe maintenance, DST implemented phased array ultrasonic testing to check Hornet wing structures for incidences of disbonding between carbon-epoxy and titanium components. In 2018, ultrasonic testing identified an affected aircraft wing, which was subsequently withdrawn from service. DST continues to investigate the causes of disbond growth in carbon-metallic joints to inform RAAF's management of current and future fleets.

Pylon cutaway.



Stress testing results.

MRH90 VULNERABILITY ASSESSMENTS

During the year, DST carried out a detailed assessment of the vulnerability of Army's MRH90 helicopter when undertaking its primary mission roles. This research arrived at recommendations on ballistic protection configurations to support aircraft and personnel survivability. The results of this work have informed decision-makers in nations with MRH90 fleets about the configurations of aircraft ballistic protection that may improve fleet-wide survivability and mission effectiveness.

PHYSICAL EMPLOYMENT STANDARDS ASSESSMENT FOR NAVY

The University of Wollongong and DST have worked with Navy over the past two years to develop a fitness-for-role evaluation system called the whole-of-ship physical employment standards assessment. This system takes into account the physical and physiological demands of activities applicable to all sea-going Navy personnel.

During the project, researchers engaged with Navy personnel at all levels across the entire fleet for extensive data collection activities.

By defining a set of employment standards that represent the real demands of sea-going roles, Navy will be able to ensure that personnel have the appropriate capacity to safely and effectively carry out those tasks. The project will provide a simple and manageable way of assessing personnel for roles when the fitness-for-duty regime is implemented across Navy.

An Armed Reconnaissance Helicopter taking off from HMAS *Canberra*.

FIRST-OF-CLASS FLIGHT TRIALS ON LHD

DST has undertaken work to prepare for the conduct of first-of-class flight trials on the Landing Helicopter Dock (LHD) ships. The aim of the trials is to determine the limits at which new ADF aircraft can operate at sea, and the modifications that would need to be made to the ship, aircraft or other equipment to ensure these aircraft can fly safely.

A major focus of the work has involved investigating aircraft operations from Navy's two Canberra-class LHD ships, which have six landing spots unlike other Navy ships that have just one. Due to interactions between the LHD's hull and superstructure and the surrounding air, the airflows over and around LHDs are complex and turbulent, thus posing hazards that pilots need to anticipate during take-off, approach and landing.

Through highly complex computational analysis and simulations, DST identified and applied a number of modelling tools to characterise the ship airwake and its effect on helicopter operations.

This work has aided preparations for LHD first-of-class flight trials for the CH-47F Chinook, Tiger ARH and MRH90 Multi Role Helicopter, while also assisting the Air Warfare Destroyer first-of-class flight trials involving the MH-60R Seahawk as well as trials involving HMAS *Choules* and the Maritime Aviation Training Vessel.

EXERCISE OCEAN RAIDER 2017 ANALYSIS

DST provided OA support to a Navy-led joint-enabled field training exercise called Exercise Ocean Raider 2017, conducted in late 2017 off the east coast of Australia.

Five DST maritime OA were deployed on Navy ships during the exercise to record observations and collect data relevant to anti-submarine and surface warfare operations.

The findings will assist the development of future ADF warfighting tactics. The support provided by DST staff embedded in the Australian Maritime Warfare Centre attracted acclaim for its high quality.

HMAS *Canberra*'s landing craft during Exercise Ocean Raider 2017.

FEATURE

MITIGATING BINOCULAR NIGHT VISION DEVICE FATIGUE

Binocular night vision devices offer the advantages over the monocular kind by giving a more natural view as well as providing depth perception. However, because they deliver separate images to each eye, and need to be correctly aligned for this to occur, problems due to misalignment can arise. End-user feedback has in fact reported high levels of visual fatigue, indicating that this problem is prevalent.

DST undertook to investigate the problem by producing a test-bench apparatus that can quickly and accurately measure the alignment of binocular device images. This apparatus was then used to test a large number of in-service devices and to track the alignment of a sample of devices over time.

The work established that when devices were new, their alignments were within manufacturers' tolerances but increasingly diverged with use. While realignment is possible, the costs of doing so are substantial and there is also the impost of loss of capability during the downtime required.

To mitigate these costs and ensure users experience minimal visual fatigue, DST has established recommendations for the degree of misalignment that can be sustained before realignment is required. It has also set guidelines for the tolerances to be achieved during realignment.

In addition, DST's experimental work has included manipulating the alignment of binocular images to match typical levels of misalignment and then measuring the impact of this on the performance of pilots in flight simulators. This work was carried out with scientists from the University of Melbourne and the US Air Force School of Aviation Medicine.

Meanwhile, a survey of Australian pilots was carried out to determine the optometric parameters that influence responses to binocular misalignment. The findings obtained through this and the flight simulator studies will help identify sensitivities in individuals, and establish how binocular misalignment affects pilot performance and physiological responses.

RADAR ABSORBING MATERIAL DEVELOPMENT

Partnering with Mackay Defence Technologies and Forward Defence, DST designed and manufactured radar-absorbing materials to reduce the radar signature of vessels, thus increasing their survivability in a high-threat environment.

The Collins class submarine and Adelaide class guided missile frigate fleets have been fitted with this material. The 2018 Lewis Essington Award for a Minor Sustainment Acquisition Project was presented to Mackay Defence Technologies and DST for developing the radar absorbing material in a tight timeframe.

SATELLITE COMMUNICATIONS MANAGEMENT

The Cortex Satellite Communications Management system, developed by DST and installed at the Defence Network Operations Centre, Canberra, was upgraded to include monitoring of the highly contested military ultra high frequency (UHF) band.

DST custom software along with dedicated monitoring hardware now provide operators with a unique management interface for the ADF's UHF satellites, tailored for military uses. Within weeks of commencing operations, the system was providing timely anomaly alerts for Defence operators that would have previously gone undetected.

With further development work on the Cortex operational system, DST continues to be a major provider of expertise on satellite communications anomaly detection and characterisation to the ADF.

EVALUATION OF PANEL DEVICE FOR DIAGNOSING Q FEVER

At the request of the US Joint Program Executive Office, DST coordinated an evaluation of the capacity of the Film Array Warrior Panel to diagnose Q fever. This affliction is endemic to Australia, and with 400 to 500 cases annually, it is the most commonly notified zoonosis (infectious disease transmitted from animals to humans) reported in this country.

Since the Australian Rickettsial Reference Laboratory in Geelong receives blood from suspected Q fever patients from all over Australia, it was given the task of evaluating the panel. The evaluation involved testing archived sera and recently collected blood with the Film Array Warrior Panel as well as the industry 'gold standard' technology for diagnosing Q fever. The results indicated that the panel performs well in diagnosing Q fever.

ENSURING DEFENCE IS A SMART BUYER

DST supports Defence acquisitions by providing critical scientific and technical advice, assisting all stages of the process from initial capability definition through to selection and introduction into service. Each project submission made to a government capability acquisition committee includes work done by DST to produce a detailed technical risk assessment and to provide certification of the technical risks associated with acquiring a new capability.

EVALUATION OF PASSIVE EXOSKELETONS FOR DISMOUNTED COMBATANTS

During 2017–18, DST worked with Diggerworks, the Victoria University and Mawashi Science & Technology to evaluate the utility of the Ultralight Passive Ruggedised Integrated Soldier Exoskeleton (UPRISE) for ADF close combatants.

For an exoskeleton to be of value, it must substantially enhance the combatant's mobility and sustainability while adding only a negligible weight burden to the wearer. The initial work of the project involved developing a structured and systematic evaluation methodology, which was followed by a study in controlled laboratory conditions of the movements that dismounted combatants typically make.

The results of this work have been used to inform Army about the current technical maturity of UPRISE, thereby shaping future acquisition planning strategies. The work has also identified further research and development (R&D) work to be carried out to advance the development of key enabling technologies that will facilitate a rapid adoption of UPRISE when it has reached an acceptable level of maturity.

BALLISTICS STUDIES FOR LAND 400

In conjunction with industry partner, Ballistic Systems, DST has developed tools to assess the lethality of cannon ammunition to inform decisions being made on the LAND 400 project. The tools were applied during experiments to test the relative effectiveness of contender cannon ammunition, with further analysis conducted through detailed computer modelling. A related research and modelling capability is now quantifying the effectiveness of the proposed active protection system hard-kill countermeasures against ballistic threats. The outcomes from this research will shape the understanding of the collateral damage sustained as well as providing vital data for combat system decision-making algorithms.

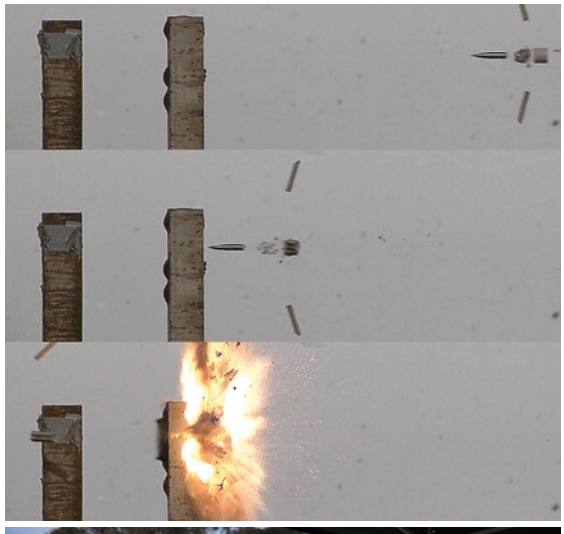
Rheinmetall Boxer Combat Reconnaissance Vehicle

VEHICLE BALLISTIC SURVIVABILITY TRIAL

DST ballistic protection assessments played a key role in the selection process for ADF's new combat reconnaissance vehicle, through which the Rheinmetall Boxer vehicle was chosen in March 2018.

The ADF's choice was strongly supported by the scientific evidence generated by a large DST team, with their ballistic protection assessments being judged as international best practice by an independent review. Director-General, Combined Arms Fighting System, Brigadier Greg McGlone, personally thanked the DST researchers for their invaluable contributions.

DST is also providing critical support on protection matters to the capability development and acquisition of other combat and logistics vehicles, including the future LAND 400 Phase 3 Infantry Fighting Vehicle and the LAND 121 Hawkei Protected Mobility Vehicle-Light as well as internationally deployed vehicles. It has, in addition, assisted national security agencies, delivered expert support to landmine protection assessments and has provided human factors expertise to an extensive user trial on competing vehicles.



Scaled compartment test containers used to test deformation.

EXPLOSIVE BLAST TESTING OF NAVY STEELS

In 2017 and 2018 DST undertook two sets of trials to compare candidate steels for Navy shipbuilding. The trials were conducted to evaluate the plastic deformation, fracture performance and failure responses of surrogate structures caused by subjecting the candidate steels to blast loading.

The experiments investigated the performance of parent plate and butt-welded candidate steels using a standard explosive bulge test arrangement to induce large plastic deformations and fractures, with measurements being made using displacement and strain gauge methods.

Data recorded during the trial will be used to support the validation of finite element simulation procedures and to develop predictive models for structural failure of the Hunter Class Future Frigate when subjected to blast loading. The knowledge and expertise acquired will assist the Future Frigate design process and development of operational vulnerability assessments for it.

SENSOR INTEGRATION INTO NORWEGIAN JSF MISSILE

DST has worked with Kongsberg Defence & Aerospace, BAE Systems and the Norwegian Defence Research Establishment (Forsvarets forskningsinstitutt (FFI)) on the integration of a passive RF sensor (PRS) developed by BAE Systems Australia into the Norwegian Joint Strike Missile (JSM).

JSM is a fifth-generation long-range maritime strike weapon being developed for integration onto the F-35 JSF aircraft, and is a potential candidate for Australian acquisition. The PRS fitted to the JSM will add an RF sensor capability to the existing imaging IR seeker, thus giving JSM a dual-mode seeker with enhanced targeting capabilities.

DST has integrated the PRS into its Woods Pod (an airborne instrumentation and sensor pod carried on a Learjet) for flight trials, the first of which with the PRS was conducted in May 2018 against a number of test emitters. It has also tested the sensor in its Missile Simulation Centre.

In support of the development of JSM concepts of operation, DST conducted a collaborative trial with the Norwegian agency in Darwin on maritime IR target detection and recognition in harsh tropical environments. This trial provided validation data for IR target modelling, and will be used to assess the performance of IR systems, such as JSM's imaging IR seeker, in adverse environmental conditions.

HMAS *Canberra*.

Richard Gregory from DST and Lieutenant Commander Mark Williams analyse data from a Nulka trial onboard HMAS *Canberra*.

TACTICS UPDATE FOR NULKA

In order to give the Nulka active missile decoy superior capabilities for protecting ships against missile attack, DST participated in and led a research effort to develop and deliver new tactics.

The work involved a significant modelling and simulation effort aimed at optimising the performance of Nulka against a range of threats. The performance of the new Nulka tactics was validated during two exercises involving HMAS *Canberra* and HMAS *Toowoomba*.

SURFACE SHIP HABITABILITY ASSESSMENT

DST undertook a Surface Ship Habitability Assessment Survey to establish if there were any issues with current Navy vessel designs and habitability arrangements to assist planning for the Future Frigate.

Working and living at sea on naval vessels can be challenging for many personnel, and vessel design may significantly impact on how the challenges are perceived and tolerated. Attention to on-board habitability in particular can have a substantial effect on crew fatigue, endurance, performance, morale and retention of crew.

DST's questionnaire identified a number of relatively simple changes that could be made to improve comfort, sleep, morale and work performance, which may have a profound effect on how well future Navy crews take to sea-going life.

An artist's impression of the BAE Systems SEA 5000 Future Frigate, Global Combat Ship - Australia.

SUPPORT FOR FUTURE MARITIME PLATFORMS

The government's plans for the acquisition of the $50 billion Future Submarine program and the $35 billion Future Frigate program as well as the Naval Shipbuilding Plan involve extensive science and technology support provided by DST.

The Competitive Evaluation Process was underpinned by DST's high quality advice in the platform selection for the Future Frigate (SEA 5000) and the Offshore Patrol Vessels (SEA 1180) during 2017–18. DST provided operational analysis and made a significant technical contribution to the development of capability requirements for the Future Frigate.

DST continues to support Navy in understanding and defining stealth needs of current and future platforms. Modelling and analysis have supported the definition of stealth requirements for the Future Submarine. Modelling, simulation, and analysis have helped characterise the ability of the Hunter Class Future Frigate and Hobart Class Destroyers to detect and prosecute submarines and, more defensively, evade detection and prosecution by submarines.

As well, DST has raised awareness and Defence expertise in human sciences and their application to submarine operations. DST led the collection of the Navy's anthropometry reference data in 2015 and is now applying that to the Future Submarine program and Collins Class Submarine upgrade activities. Critical input has been provided to control room design and space allocation for the Future Submarine. DST engaged La Trobe University to clarify the longer term implications of poor ergonomics in the constrained environment of maritime platforms and has been a key contributor to the development of a human-centred design assurance methodology for the Future Submarine program.

EXPLOITING NAVY'S UAS INFORMATION BOOM

As Navy increases its ability to capture information via maritime tactical uninhabited aerial systems (UASs), it faces the challenge of how best to exploit that information. One possibility is to use intelligent agents, which are adept at processing data and providing recommendations, but are unlikely to have a complete understanding of a mission and to always deliver reliable assessments. Agents and personnel thus need to combine their strengths in order to improve system performance.

To explore this situation, DST conducted an experiment in which operators were presented with analysis undertaken by an intelligent agent for maritime target identification, with the analysis being offered at different levels of transparency. The outcomes were that increased transparency improved an operator's trust and ability to accept a correct recommendation, but it also increased the time it took to reject an incorrect decision.

These findings demonstrate that giving intelligent agents greater transparency has the potential to improve human-agent teaming performance. Such findings may inform the design and use of autonomous vehicles and intelligent agents in the maritime context for target identification.

FEATURE

TESTING PROTECTIVE ENSEMBLES FOR AIRBORNE THREAT PROTECTION

Using its newly developed fluorescent aerosol system test (FAST), DST conducted testing of individual protective ensembles (IPEs) to assess their dermal protection against aerosolised chemical biological radiological nuclear (CBRN) materials.

The FAST method, developed by DST and the international partners it has been collaborating with under the arrangements of the Chemical Biological Radiological Memorandum of Understanding, was successfully demonstrated through tests undertaken in DST's Environmental Test Facility in November 2017.

These tests involved the use of an articulated mannequin in the Environmental Test Facility chamber, where an aerosol hazard was introduced and measurements were taken of any aerosol penetration through the protective ensembles onto the mannequin's skin. This work was undertaken to support ADF's acquisition of protective ensembles as well as R&D to develop better protective ensembles.

FAST complements a vapour-based IPE system assessment test method, thus providing DST with the full range of methods needed to evaluate IPE effectiveness against CBRN airborne threats.

SUPPORTING THE FUTURE SOLDIER COMBAT SYSTEM

DST and Flinders University are collaborating to investigate the use of photochromic dyes for use in adaptive camouflage for soldiers. Unlike traditional photochromic dyes in transition lens for sunglasses, the aim of the work is to develop negative photochromic dyes for combat uniforms that change their brightness and pattern with lighting conditions, i.e., combat uniforms that become brighter in sunlight and darker in shadows, affording reduced contrast and improved signature management.

This project is part of a larger program to explore how next-generation technologies can be used to enahance the performance and protection of soldiers in the future. It draws on significant advances in materials science, sensor technologies and autonomous systems. Three key areas of research being undertaken are power and energy, specifically energy harvesting and storage; situational understanding, including how augmented reality and digital mapping might be used to provide a forward scout capability; and soldier-machine systems, focusing on control and the soldier-machine interaction.

Enhanced human performance is also a strong focus of DST support to Army. Seven Australian universities and DST have established a special research network called HyperNet to enhance the physical and cognitive performance of Defence personnel.

BAE Systems Australia AMV-35 Combat Reconnaissance Vehicle.

Rheinmetall Boxer Combat Reconnaissance Vehicle.

SUPPORT FOR LAND PLATFORMS

LAND 400 will acquire and support the next generation Armoured Fighting Vehicles for Defence. DST played a key role in the Phase 1 project definition study. In the subsequent phases it undertook analysis of the final comparative evaluation of tenders, which supported the decision-making process and led to the Combat Reconnaissance Vehicle and Infantry Fighting Vehicle and Manoeuvre Support Vehicle progressing in the acquisition life cycle. Rheinmetall will supply 211 Boxer Combat Reconnaissance Vehicles for LAND 400.

FUTURE-PROOFING DEFENCE

An important responsibility for DST is to ensure that Australia is prepared for the defence and national security challenges of the future. This involves keeping abreast of emerging technologies to assess their potential as possible threats or critical capabilities. DST undertakes forward-looking strategic research in technologies that may provide game-changing capabilities for Defence in the future. These include autonomous systems, cyber and electronic warfare, undersea warfare, intelligence, surveillance and reconnaissance, signature management, bioterrorism preparedness, hypersonics, materials and energy, and space systems.

Members of the NIFTI supersonic flight trial team at RAAF base Williamtown

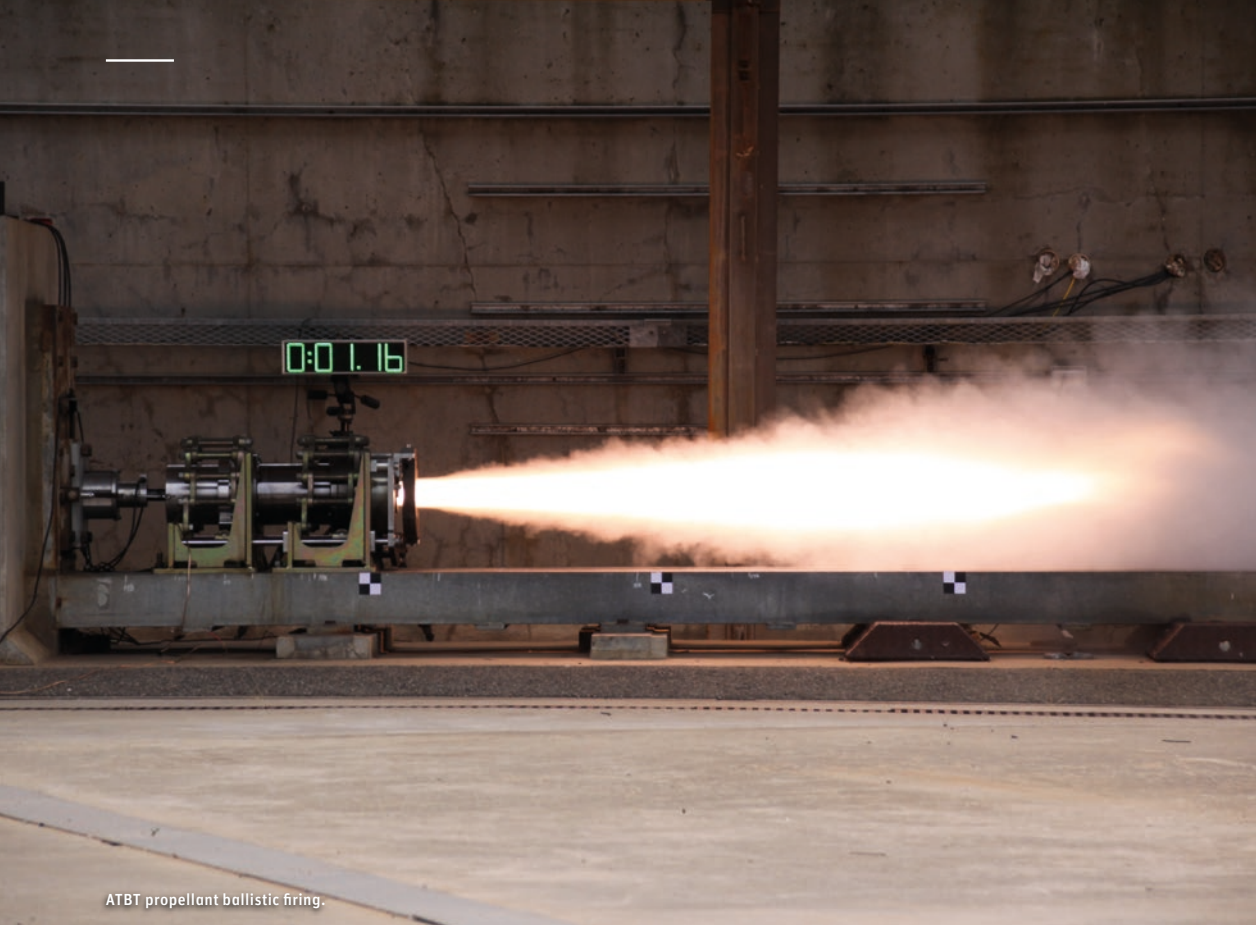
NIFTI FLIGHT DATA MONITORING SYSTEM

In partnership with the Air Warfare Centre (AWC) and Defence Innovations Pty Ltd, DST has developed a state-of-the-art wireless instrumentation apparatus to facilitate in-flight testing, known as the Non-Intrusive Flight Test Instrumentation (NIFTI) system.

NIFTI was devised in response to the decision taken by RAAF to reassign aircraft previously dedicated to the conduct of test and evaluation work back into the operational fleet, meaning that aircraft from now on could only be non-intrusively modified for test purposes.

The NIFTI system consists of an iPad interface connected by radio links to sensors for data capture placed at various points of interest inside and outside an aircraft, and is capable of in-cockpit real-time data monitoring. The advantages of this system setup are that it is far quicker and easier to install (and uninstall) than previous types that require connection by electrical writing, and sensors can be readily placed in locations that are hard to reach with wiring. This highly innovative and flexible capability for measuring test flight data opens the way for bottom-up innovation for RAAF, and has significant potential to facilitate cost-effective force experimentation and preparedness.

Representing a classic illustration of how innovation can proceed through partnerships, NIFTI began as a DST concept demonstrator that was transformed by RAAF AWC input and was then constructed by Defence Innovation. A F/A-18 supersonic test flight of NIFTI was successfully conducted in May 2018, demonstrating that in-flight testing time could be reduced from months to days, saving considerable costs.



ATBT propellant ballistic firing.

INNOVATIVE TOOL FOR SELECTING ADVANCED ROCKET PROPULSION TECHNOLOGIES

In response to the need to deliver more advanced rocket propulsion technologies, DST developed a unique nested evolutionary design optimisation method that has been described as 'highly innovative' by the US Defense Advanced Research Projects Agency.

The tool is designed to assess hundreds of propulsion system designs against mission requirements and a variety of constraints.

As a result of the tool, DST has entered into a multi-year collaboration with the US Air Force Research Laboratory to work on the Advanced Tactical Booster Technologies Program.

This has led to the successful demonstration of several advanced rocket motor technologies, many of which are expected to be introduced into next-generation missile and responsive space launch systems.

At the same time, the technology advances generated by the program are opening up a range of new capability options that will inform future acquisitions and provide more opportunities for Australian industry.

Test firings of fully integrated advanced technology demonstration motors are planned for 2019 in both Australia and the US to complete the current program.


RTP fuel being flame tested.

NOVEL COATINGS FOR MARINE COMPONENTS

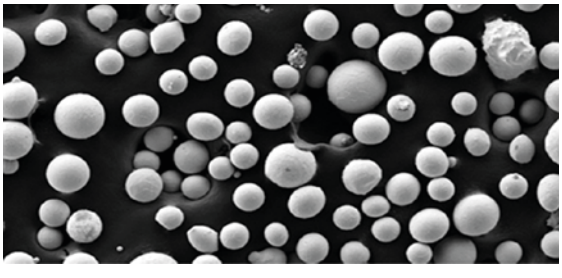
A series of Defence Materials Technology Centre (DMTC) collaborative projects with DST have successfully demonstrated the potential for high velocity oxygen-fuelled coatings to provide better protection against corrosion and biofouling than other currently available coatings used on hydraulic piston rods and shafts in seawater applications.

The work was undertaken by DST in partnership with the Swinburne University of Technology, MacTaggart Scott Australia and United Surface Technologies.

RECYCLING TITANIUM SWARF TO IMPROVE COMPETITIVENESS

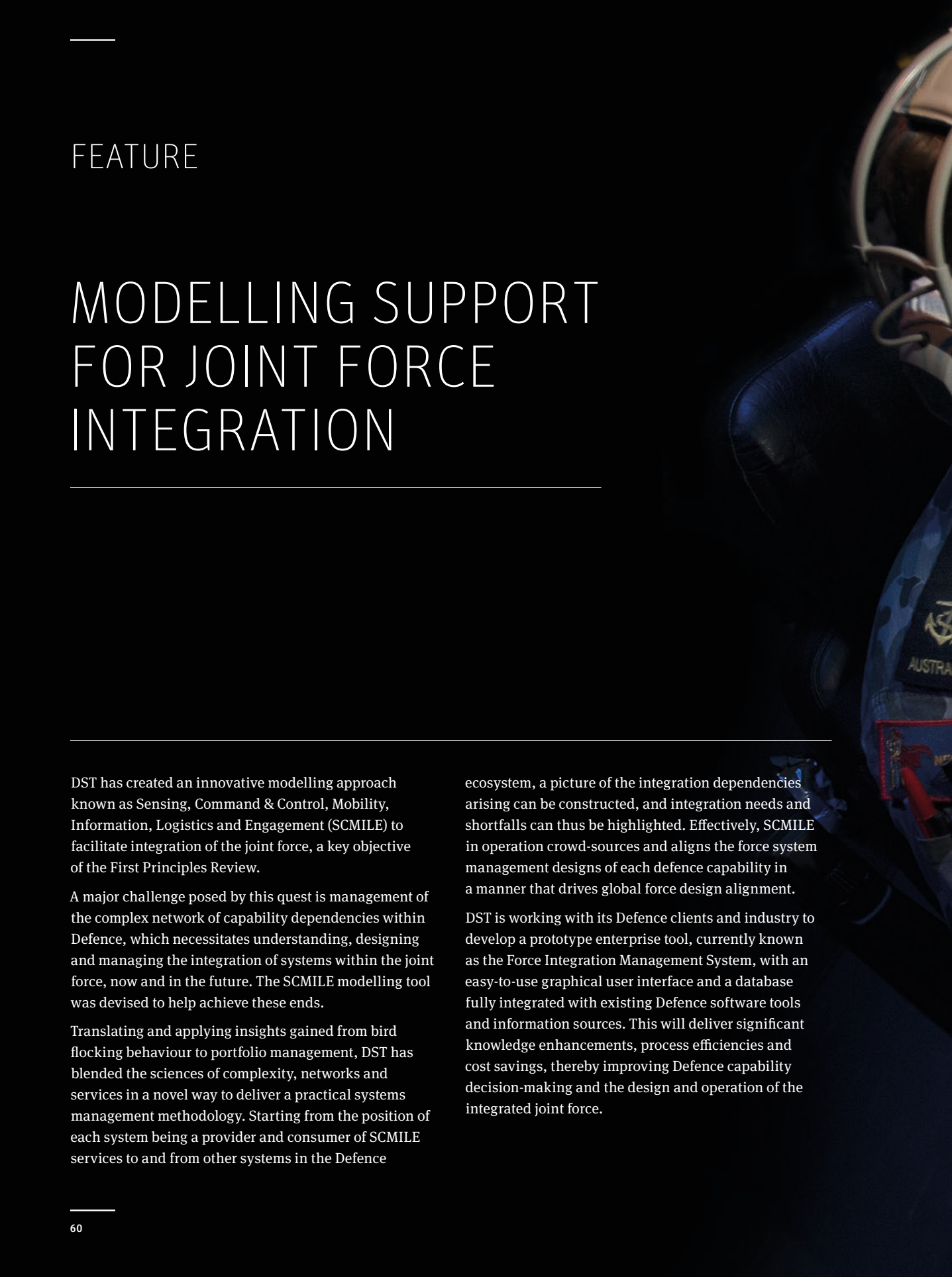
Australian industry has secured a number of manufacturing contracts in the F-35 JSF global supply chain. A number of these contracts involve the machining of titanium alloy billets to produce large aircraft components, which can require the removal of up to sixty percent of this high-cost material as machining chips or swarf.

DST, in partnerships with academia, has developed novel methods of recycling titanium swarf into a high-quality powder suitable for a range of additive manufacturing technologies. These methods, if adopted by industry, represent revolutionary ways for Australian companies to improve their global competitiveness while also reducing waste.



FEATURE

MODELLING SUPPORT FOR JOINT FORCE INTEGRATION



DST has created an innovative modelling approach known as Sensing, Command & Control, Mobility, Information, Logistics and Engagement (SCMILE) to facilitate integration of the joint force, a key objective of the First Principles Review.

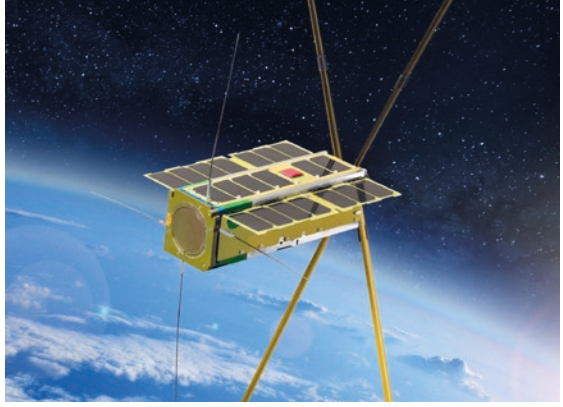
A major challenge posed by this quest is management of the complex network of capability dependencies within Defence, which necessitates understanding, designing and managing the integration of systems within the joint force, now and in the future. The SCMILE modelling tool was devised to help achieve these ends.

Translating and applying insights gained from bird flocking behaviour to portfolio management, DST has blended the sciences of complexity, networks and services in a novel way to deliver a practical systems management methodology. Starting from the position of each system being a provider and consumer of SCMILE services to and from other systems in the Defence ecosystem, a picture of the integration dependencies arising can be constructed, and integration needs and shortfalls can thus be highlighted. Effectively, SCMILE in operation crowd-sources and aligns the force system management designs of each defence capability in a manner that drives global force design alignment.

DST is working with its Defence clients and industry to develop a prototype enterprise tool, currently known as the Force Integration Management System, with an easy-to-use graphical user interface and a database fully integrated with existing Defence software tools and information sources. This will deliver significant knowledge enhancements, process efficiencies and cost savings, thereby improving Defence capability decision-making and the design and operation of the integrated joint force.


AUSTRALIAN NAVY
HMAS

BUCCANEER IN ORBIT



On 18 November 2017 DST undertook a space mission to prepare for Defence use of cube satellites (miniature satellites about the size of a loaf of bread). This involved the launch of a cube satellite called Buccaneer on a NASA Delta II rocket. In the course of the first Australian defence space mission in 50 years, the satellite has now completed over 2000 orbits at altitudes between 440 and 810 kilometres.

The aim was to use a satellite to help calibrate the Jindalee Operational Radar Network (JORN). After a rigorous program of modelling, prototyping and testing, DST, UNSW Canberra and industry partners developed a three-unit cube satellite that integrated a mix of commercial and custom-made components, including a GPS receiver, camera, communications system and HF antenna. They also developed ground station facilities for satellite control and communication.

The successful completion of this risk-mitigation mission paves the way for the main mission, which will use the cube satellite to measure the effect of atmospheric propagation on high frequency radar signals from JORN. The advent of small low-cost space platforms offers the ADF a valuable opportunity to enhance its capabilities and for the Australian space research community to rejuvenate.

SUPPORT FOR HEADMARK TO DISCERN NAVY'S FUTURE

DST conducted the HEADMARK Experiment Campaign (HM17) mounted by Navy. The aims of the experiment were to inform Navy of ways to optimally shape itself for the future, to identify gaps in capability and to find opportunities to exploit.

An outcome of HM17 was a collated list of issues for Navy, Air Force and Joint Force to consider when building force options for 2025–30. This collection of issues was accepted as a key input into the development process for the Future Naval Operational Concept 2018. One of the major concerns emerging from HM17 was the ADF's ability to provide meaningful contributions to a coalition force in the region both now and in the future. The findings will also help future-proof the ADF by informing its processes for force and capability life-cycle design.

HM17 was one of the most challenging Navy experiments ever attempted by Navy and DST, which involved more than 50 subject matter experts from Australia and overseas.

NEXT-GENERATION SUBMARINE SCRUBBER TECHNOLOGY

DST has developed a new technology for absorbing carbon dioxide. While similar in size and weight to available scrubbers, it requires substantially less energy to run, and also eliminates the use of corrosive chemicals that pose a risk to crew and equipment. Moreover, it is capable of reducing carbon dioxide concentrations to levels lower than previously possible. The potential impact of this technology on the capability, safety and operational availability of submarines makes it a prospect for future inclusion on board ADF submarines.

CONTESTED URBAN ENVIRONMENT TRIAL

In late 2017, DST facilitated and led a multi-national trial conducted in Adelaide to investigate emerging technologies for enhancing the intelligence, surveillance and reconnaissance (ISR) capabilities of tactical land forces in future contested urban environments (CUE).

The CUE Adelaide 17 trial, mounted as part of TTCP CUE Strategic Challenge, brought together around 100 ADF personnel from Army and RAAF along with more than 80 defence researchers, technologists, contractors, industry and academic partners from the US, Canada, UK, New Zealand and Australia.

The trial involved the combined use of sensor, integration, analysis, communication and presentation technologies from the US, Canada and Australia, which were being investigated for their ability to provide commanders on the ground with ways to identify and track vehicles and people of interest.

A mixture of air- and ground-based sensors was used. This included camera systems mounted on an aircraft enabling users to view large sections of the Adelaide CBD and also to zoom in on areas or entities of interest. In addition, perimeter surveillance systems were placed in and around buildings. Trial activities occurring in the CBD were complemented by missions simulated in the Battle Simulation Site at RAAF Base Edinburgh.

CUE Adelaide 17 successfully demonstrated the value of integrating data obtained by wide-area aerial ISR and ground sensors as well as facilitiating target sharing to inform tactical commanders. As an example, a detection made by an unattended ground sensor occasioned the cueing of an aerial ISR asset to investigate this detection.

Among the range of insights delivered, the trial highlighted the need to further test and develop technologies for transforming the large amounts of data obtained by sensors into a form that is consumable by tactical commanders.

CRYOGENICALLY COOLED OSCILLATORS FOR JORN

DST developed and demonstrated a range of HF radar capability improvements that have significantly mitigated the risks associated with major upgrades to JORN under AIR 2025 Phase 6.

The JORN system requires a clock capable of delivering long-term signal stability. The cryogenic sapphire oscillator (CSO) clock has an accuracy of plus or minus one second for every 40 million years – an accuracy a thousand times more precise than any commercially available system.

This signal is vital for synchronising electronic components in JORN, such as HF receivers and digital waveform generators, across a physically large distributed system. A key measure of the performance of this distributed system is phase noise levels, and the CSO clock can provide phase noise levels a thousand times lower than the current technology. With the radar signals received thus being much purer, JORN will be able to detect smaller objects, moving slower, at much greater distances.

The work has cleared the way for CSO technology to become an approved option for use in AIR 2025 Phase 6.

Two CSO systems have been delivered to DST for ongoing HF radar tests and to enable work to be done in its Frequency Test Facility. A further two systems are undergoing final testing in preparation for a trial at the JORN Radar 1 receiver site at Longreach, commencing in September 2018.

The University of Adelaide scientists who developed the clock were awarded the DST-sponsored Eureka Prize for Outstanding Science in Safeguarding Australia.

MODELLING COMPLEX WARFIGHTING FOR THE FUTURE

Managing uncertainty and complexity are key features of future warfare. In 2017, DST launched a Strategic Research Initiative focused on modelling complex warfighting. The aim is to revolutionise operations analysis to better handle the interaction of complex geopolitical, social, technological, economic and cultural factors in the design of the future force.

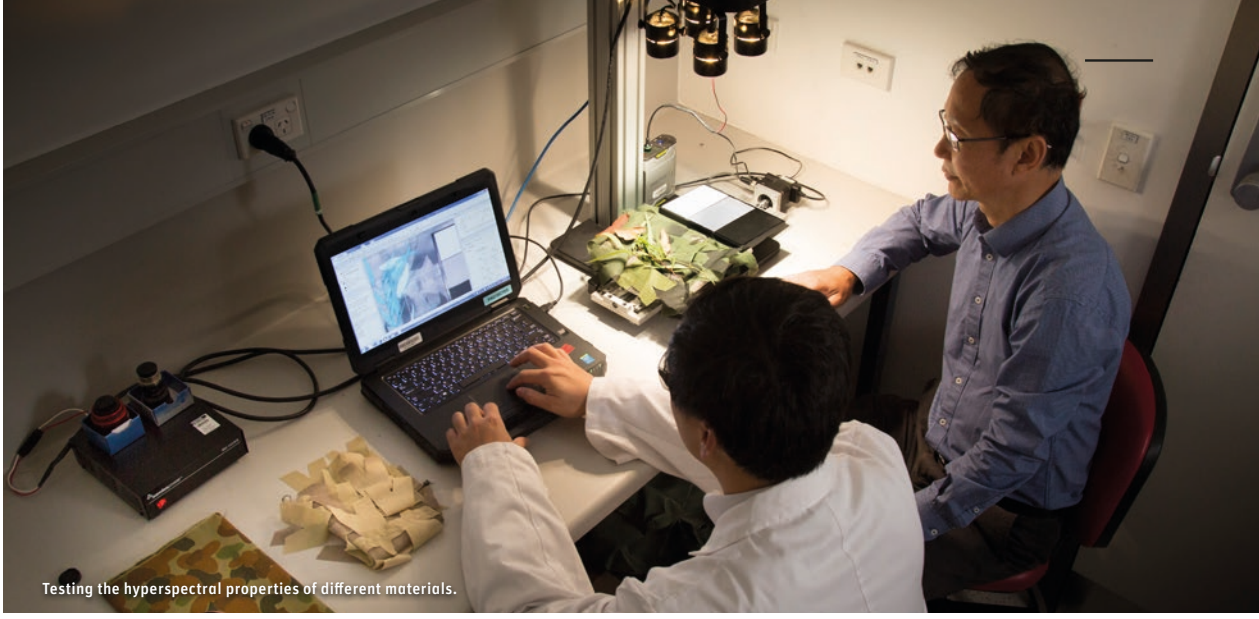
The five-year research program seeks to design the future force for uncertain environments and address long-term defence force employment challenges under four broad themes: Conquering Uncertainty, Innovative Simulations, Knowledge Synthesis, and Modelling Complexity.

Active research topics include:

- Machine-discovered behaviour
- Simulation for future operating concept development
- Data-driven operational analysis
- Modelling complex human systems
- Force effectiveness modelling
- Concepts for complexity-enabled warfare
- Modelling unknowns.

Future-proofing Defence for complex warfighting requires new analytical approaches that will push boundaries and integrate quantitative and qualitative techniques.

Meanwhile, DST is working with the Queensland University of Technology on fundamental aspects of future complex warfare. The partnership is contributing key research into quantifying uncertainty in modelling, simulation and analysis of complex systems as well as characterisation of adversarial behaviours of interacting complex networks. The research has the potential to develop new tools to inform decisions to be made by the ADF on asset acquisitions, tactical decisions and future force design.



Testing the hyperspectral properties of different materials.

LAND SIGNATURE MODELLING AND SIMULATION

The miniaturisation of advanced sensors, delivery platforms and the application of artificial intelligence pose a growing threat to high-value land assets. To protect against these emerging threats, DST has established a program to develop a virtual reality environment for the assessment of signatures from a number of tiered sensor platform systems that detect electromagnetic energy signatures across different spectral bands. In December 2017, DST conducted a successful joint field trial activity with Defence Research and Development Canada at Puckapanyal to collect hyperspectral imagery data of terrain background and representative Army assets including vehicles and camouflaged material. Unmanned aerial vehicles (UAVs) were also used to collect images of the trial area for constructing a high-resolution terrain map and 3D models of ground objects. The data will allow the creation of a virtual proving ground that could be used to assess target signatures and to develop countermeasures against emerging sensors and their delivery platforms.

NEXT-GENERATION ELECTRONIC SYSTEMS FOR COMBAT VEHICLES

Army's forthcoming land combat vehicles will require electronic systems support. The financial year 2017–18 marked the beginning of a five-year forward-looking research program by DST to demonstrate advanced integrated evolvable electronic systems that will enhance the Australian Army's combat vehicle capabilities.

New facilities were opened to support the Land Open Architecture Vehicle Experimentation System (LOAVES) and Next Generation Mission Systems (NGeMS) research. These programs combine to develop, integrate, and evaluate evolvable electronic systems for armoured fighting vehicles, while identifying technical and commercial paths to fielded solutions for the Australian soldier.

As part of LOAVES, two commercial vans have been fitted out with radiofrequency and sensor systems representative of a future combat vehicle. Systems including electronic warfare battle management and passive radar techniques have been integrated.

Within the NGeMS program, DST is partnering with the Australian company, Solinnov, on demonstrating an open framework for high-density software-defined radios. The system will allow hosted applications to load communications, surveillance and electronic attack capabilities.

FEATURE

TECHNOLOGY FOR NAVIGATING IN A COMPLEX WORLD

In collaboration with the US Air Force Research Laboratory, the US Army Aviation and Missile Research Development Center and the University of South Australia, DST demonstrated a multi-modal long-range navigation system for operations in denied and contested environments.

The purpose of the work was to establish ways of ensuring that uninhabited systems, such as UAVs, can continue to operate in areas where communications, global navigation satellite systems and other external sources of information may be degraded or denied either by the general nature of the environment or by the deliberate actions of an adversary. UAVs currently rely heavily on reach-back to remotely located services such as GPS to remain mission-effective, and without GPS, almost all uninhabited aerial systems cease to function effectively.

This work has resulted in a world-class closed-loop vision-based navigation technology that provides long-range navigation with GPS accuracy over desert terrain where features are sparse and difficult to differentiate.

While this technology has established a benchmark for low-cost lightweight navigation in real-world environments, a great deal of work remains to be done before achieving readiness for service, which includes extending the capabilities of the technology to navigate over deep ocean, littoral landscapes and more complex urban centres. Delivering these capabilities requires the application of smart machine behaviours that will proactively select the best navigation techniques for a given context – a development that is key to producing the more robust autonomous navigation behaviours essential for systems operating in unpredictable conditions.

The work is also being extended to encompass non-visual means of navigation that will have the capability to steer a course through cloud, smoke and darkness; that can combine with visual navigation technology to deliver richer navigational behaviour; and that may even form the basis for comprehensive intelligence collection. This enabling technology, to be demonstrated as part of Autonomous Warrior 2018, is expected to lead to the development of more persistent UAV capabilities.

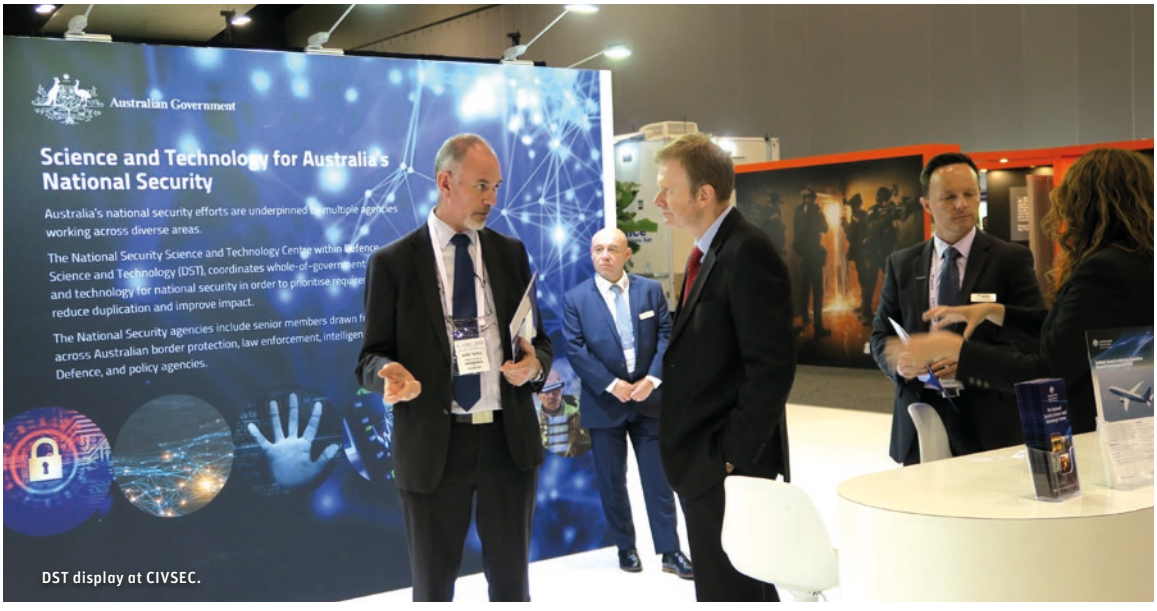
ENHANCING NATIONAL SECURITY

DST leads the co-ordination of S&T research to enhance Australia's whole-of-government program for national security.

DST works with other government agencies to:

- Implement national security S&T policy and coordination processes
- Manage the National Security Program
- Foster international national security research collaborations
- Provide strategic analysis of national security priorities and resourcing
- Integrate counter-terrorism technologies to benefit Defence and civilian agencies.

A large part of this work is undertaken through the National Security Science and Technology Centre established as part of DST.



DST display at CIVSEC.

POLICY AND PRIORITIES RELEASED

The Minister for Defence Industry released the National Security Science and Technology Policy and Priorities document in May 2018. This document provides the science and industry community with a view of the endorsed national security S&T focus areas, governance arrangements and engagement mechanisms.

During the year, DST participated in the Civil Security Congress and Exposition (CivSec 2018) which included a Conference on Science and Technology Innovation for Civil and National Security, convened by DST. The Chief Defence Scientist opened the conference, which featured a number of international and Australian speakers from the national security community.

A long exposure of the International Staging Base, where New Zealand, Australian and United States soldiers converge to set up camp. Talisman Sabre 2017.

INFECTIOUS DISEASE FORECASTING CAPABILITIES

DST and the University of Melbourne have developed two software products for forecasting the spread and rate of infectious diseases, called EpiFX and EpiDefence.

As fresh data about the incidence of cases is fed into the modelling, the predictions are updated. This information enables authorities to take efficient and timely measures to prepare for patient care and to implement ways of preventing the spread of illness, which, in extreme cases, may require school closures or public transport shutdowns.

EpiFX is currently being used by a number of Australian state governments to predict the start and extent of seasonal flu outbreaks, based on data routinely collected by state hospitals. The software can equally be used to inform responses to pandemics and bioterrorism attacks.

These software developments have attracted the attention of the US Government's Department of Defense, which is now working with the Australian researchers to develop a new tool for identifying the level of threat from a bioterrorism attack and recommending appropriate response options.

The team has sought to participate in the Talisman Sabre Exercise series in mid-2019 to initially demonstrate the capability and to test other prototype biosurveillance and decision support capabilities, with full operational testing scheduled to occur during Talisman Sabre 2021. The personnel involved in this R&D work were awarded the CIVSEC 2018 Innovation Award for Disaster Relief, Emergency Management and Humanitarian Services, and the CIVSEC 2018 National Innovation Award for Civil Security.

FACIAL RECOGNITION FOR CHILD PROTECTION

Many government agencies have a mandate to rescue children who have been trafficked, kidnapped, exploited, or radicalised. Facial recognition is one method commonly used to identify children, but very little research had been done to assess the performance of commercial facial recognition systems or of facial recognition personnel working in government agencies.

To inform Defence, national security and law enforcement agencies about these matters, DST conducted the largest and most rigorous scientific research program ever mounted on facial recognition of children. Using an operational dataset containing several million images of children, DST evaluated the performance of commercial facial recognition algorithms as well as that of the facial recognition practitioners employed by government agencies.

As a result of the outcomes obtained, government agencies have reviewed and altered the processes they use for identifying children. Further work is being undertaken in response to requests from agencies within Australia and overseas in a larger research program that now also involves developing better facial recognition technologies for identifying children and their appearance as they age.

SUPPORTING THE CIVILIAN SECTOR

Defence scientists are frequently called upon to offer their unique expertise in crisis situations or to contribute to activities of national significance.

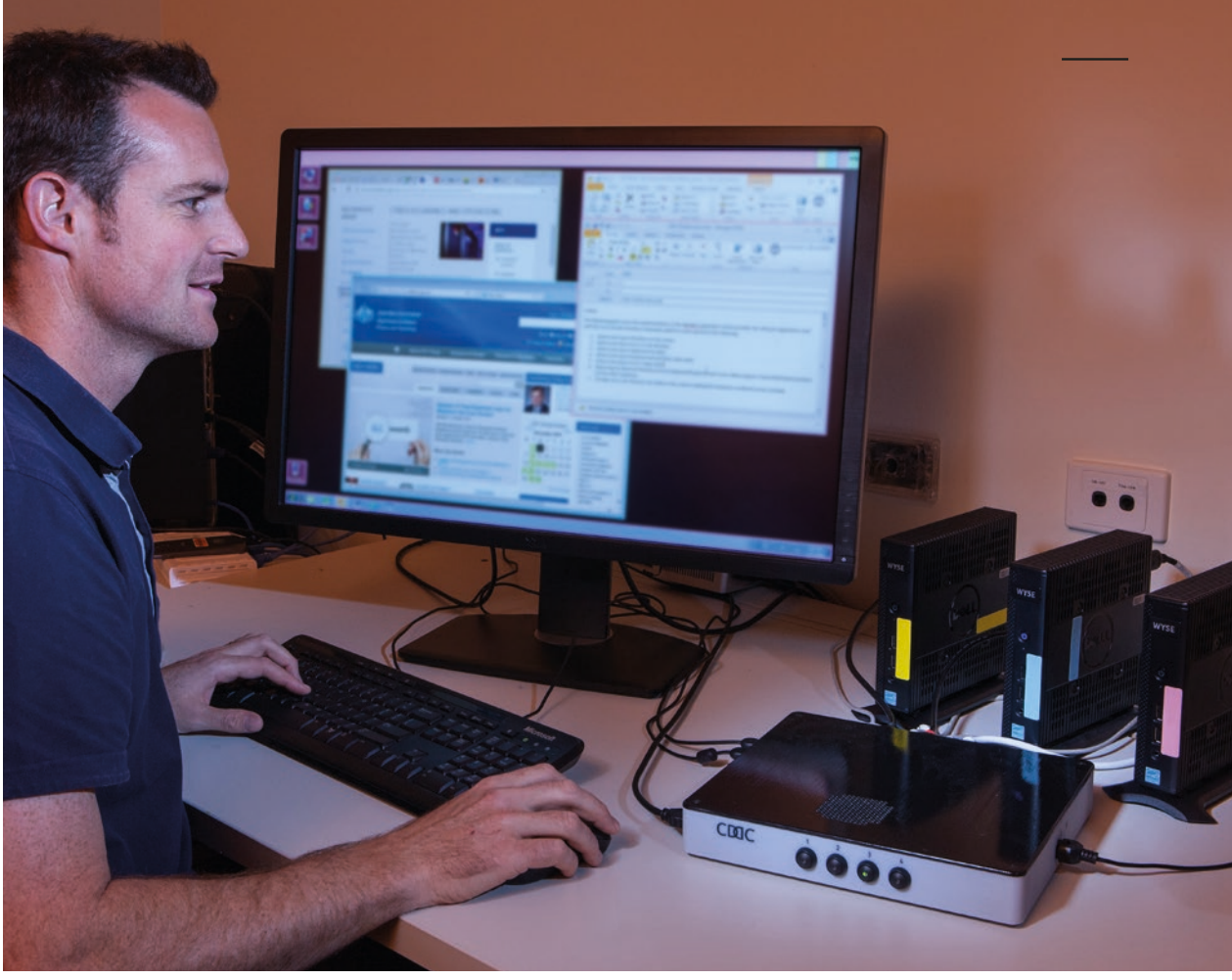
2018 Gold Coast Commonwealth Games Joint Emergency Services Coordination Centre.

SITUATIONAL AWARENESS CAPABILITY TO ASSIST 2018 COMMONWEALTH GAMES

The Situational Awareness Knowledge Infrastructure (SAKI) suite of tools is designed to capture data to support command and control activities. During the year, DST further developed the tools in close consultation with the Vice Chief of Defence Force and Headquarters 1st Division to support the 2018 Commonwealth Games on the Gold Coast.

DST is now looking to build on this capability by engaging in partnering options for the commercialisation of the SAKI service infrastructure.

SAKI was also used in the Defence context for data capture during Exercise Hamel, at the Shoalwater Bay Training Area.



DATA SECURITY APPLICATION TO BE MADE AVAILABLE FOR CIVILIAN USES

DST and CSIRO's Data61 developed a data security application called the Cross Domain Desktop Compositor (CDDC). This allows users to access data and applications on multiple, physically separated networks on-screen simultaneously, providing a seamless user experience without sacrificing security.

DST has been supporting Data61 through a Defence Innovation Hub, Phase 2 project. This project finished in June 2018 culminating in a Concept of Operations document, a Security Accreditation Roadmap and Technology Transition Plan.

The Technology Transition Plan sets out a commercial roadmap for the desktop compositor. In 2018–19, DST will support Data61 as they seek to develop a market-ready version of the system in collaboration with Defence and industry partners.

PRECLINICAL TRIAL OF RICIN COUNTERMEASURE

DST and Defence Research and Development Canada (DRDC) conducted a preclinical trial of a new medical countermeasure against ricin. The objective of the study was to determine the biodistribution and potential toxic effects of an anti-ricin antibody. The results obtained have indicated that the antibody is safe.


HONDA

3

PARTNERSHIPS AND OUTREACH

COLLABORATION AND ENGAGEMENT

DST recognises that collaboration and engagement significantly enhance its ability to provide world-class scientific advice and innovative solutions for Australia's defence and national security. Through its partnerships and alliances with industry as well as academia and other research organisations within Australia and overseas, DST greatly benefits from the knowledge, expertise and capability thus obtained to ensure it can continue to provide world-class outcomes for Defence.

PARTNERING WITH INDUSTRY

STRATEGIC ALLIANCES

In 2017–18 DST had 14 Strategic Alliances with Defence primes and publicly-funded research agencies. There was considerable activity within these alliances during the year. New interactive project agreements were established with:

BAE SYSTEMS AUSTRALIA LTD

- Compact Over the Horizon Radar System
- Neuromorphic Image Processing & Classification using Single Photon Avalanche Diodes (SPAD) Arrays
- Future Maritime Battlespace
- Exploitation of Imagery for Land Vehicles

THALES AUSTRALIA LTD

- Design of Ballistic Survivability Enhancement Kit for Hawkei Mobility Kill Reduction

AIRBUS AUSTRALIA PACIFIC

- Enhancement of Repair Methods for Composite Structures in the Armed Reconnaissance Helicopter and and Multi Role Helicopter 90 High Altitude Pseudo Satellite involving both Airbus Australia Pacific and Airbus Defence and Space.

ASC

- Hydrodynamic Assessment of SEA 1439 Phase 6 Planar Flank Array Fairing Design

AGREEMENTS AND LICENCES WITH SMALL-TO-MEDIUM ENTERPRISES

DST signed collaborative R&D agreements with small-to-medium enterprises (SMEs) to undertake a variety of research activities, including a significant collaboration with CEA Technologies Pty Ltd.

CEA TECHNOLOGIES

In a strengthening partnership between DST and CEA Technologies, a five-year collaborative R&D agreement was signed with the company in February 2018 to develop new active electronically scanned array solutions to meet ADF's future requirements in radar, communications and electronic warfare.

The partners are bringing complementary skills to ensure the ADF maintains comprehensive situation awareness and decision superiority in congested and contested environments. The work so far has involved combining STEM expertise and facilities for research on new techniques and algorithms that will enhance ADF capabilities in signal processing, electronic protection and tracking and data fusion. CEA Technologies participated in electronic protection trials in October 2017 and April 2018. In addition, joint data analysis and algorithm development activities were undertaken in CEA's secure facility.

OTHER COLLABORATIONS

- Sonartech Atlas and DST are doing work in the maritime domain in the areas of short-time signal analysis, on-board signature management systems, multi-sensor detection and tracking and data fusion.
- Navantia is working with DST in the areas of naval platform systems, naval platform sciences, smart ships and integrated platform management systems.
- DEWC is undertaking research with DST on dynamic and cognitive EW mission data re-programming to increase the mission effectiveness and survivability of ADF systems by improving the situational awareness in a networked battlespace.
- TPG Maritime is working with DST to construct a carbon dioxide removal test apparatus, and to perform a set of tests that will support the development of a mathematical model for providing a rough estimate of the performance, size and load of a full-scale submarine carbon dioxide scrubber.
- Ideation Product Solutions is working with DST to develop a prototype Black Canary wearable airborne hazards detector that incorporates new features and enhanced data-handling capabiilties. This development is being undertaken in parallel with work at DST on reactive chemistry research and evaluation protocols.
- Chemring Australia has partnered with DST on R&D and related planning and engagement activities to establish an integrated advanced flare development capability in Australia. The work will deliver innovative prototype countermeasures to meet Defence requirements for air platform self-protection against current and emerging threats.
- DefendTex and DST engaged in several collaborative activities during 2017–18, two of which were in the areas of energetic materials and autonomous aerial systems. The partners are undertaking work at DST facilities to investigate the joint resonant acoustic mixing and planetary mixing of various propellant formulations, and then characterising the mixed samples. In the area of UAV research, DST has developed, tested and demonstrated machine-learning algorithms for use on DefendTex UAVs that enable guidance to be issued to facilitate coordinated formation flying.

TECHNOLOGY TRANSFERS

On the technology transfer front, DST licensed its SonarDetect software to Solutions from Silicon for further development. The sole licence agreement for the sonar processing and display capability will provide a commercial pathway to maturity for a potential ADF capability.

A non-exclusive licence was signed with Silentium Defence for the commercialisation of passive radar technology developed by DST. This technology provides

a way of covertly detecting and tracking targets by capturing the reflections of radio wave illumination emitted by civilian RF transmission sources such as radio and television stations. Silentium Defence intends to market the technology for space surveillance and the monitoring of airborne, maritime and ground-based traffic.

DST's breakthrough digital wideband receiver technology and the embedded digital wideband signal processing system technology were licensed for production and sale worldwide to the companies, Ultra Electronics and Jenkins Engineering and Defence. Ultra Electronics has applied the licensed technology on upgrades of Navy surveillance capabilities, and it is producing airborne surveillance capabilities for sale to Australia's defence partners.

Multi-spectral images by VIRSuite.

DST's VIRSuite visualisation system was licensed to Consilium Technologies, which is marketing the software as Infinite Studio. Over several years, DST has developed a simulation tool called VIRSuite for generating imagery in the visible and infrared wavebands, which is capable of producing imagery more physically accurate than that seen in the best Hollywood movies and computer gaming applications. The latest version, VIRSuite 3, was produced through a DST partnership with Consilium Technology. Created through the use of an integrated suite of game development tools called Unreal Engine 4, the latest version incorporates most of the capabilities provided by the previous versions to an equivalent or superior level of fidelity.

SMALL BUSINESS INNOVATION RESEARCH FOR DEFENCE (SBIRD)

This program was developed under the Next Generation Technologies Fund to encourage Australian SMEs, including university start-ups, to develop solutions that address specific Defence technology challenges. In this two-stage program, the first stage provides an initial funding of $100,000 to research a potential Defence technology over a six- to nine-month period while, in the second stage, the technology will undergo Defence application testing with funding of up to $750,000 provided over one to two years.

In June 2018, adaptive camouflage was chosen as a topic for development under the SBIRD program, inviting SMEs to submit proposals for managing the visual and acoustic signatures of autonomous aerial systems to make them harder to see and hear in a land domain setting.

One of the first technologies to be developed under the SBIRD program is a system called the Fight Recorder, a soldier-worn emergency beacon that is also capable of capturing various kinds of data, including human motion.

Myriota, a small South Australian company known for innovation in small satellite communications and the Internet of Things, is producing a hardware prototype of the Fight Recorder while IMeasureU, a small firm based in Auckland, is applying its specialist expertise in data processing to develop ways of translating the motion data captured by the device into a form that will support event reconstruction.

This two-year project began in early 2018 and is on track to deliver a version ready for field-testing with Army towards the end of 2018. DST and Army have worked closely to formulate the fight recorder concept, and DST's partnership mechanisms have paved the way for its development.

ADDITIVE MANUFACTURE OF ENERGETIC MATERIALS

Further to DST's work with DefendTex on the mixing of propellant materials, the two have engaged in a two-and-a-half year project with RMIT, Flinders University and Cranfield University (UK) supported by $2.6 million of Australian Government funding to demonstrate the use of additive manufacturing for making energetic materials products. The application of this technology has the potential to deliver substantial benefits in relation to munitions performance, logistics, cost and accessibility for deployed forces.

PARTNERING WITH UNIVERSITIES

Murdoch University became the 33rd Australian university to join the Defence Science Partnerships (DSP) framework.

During 2017–18, DST signed 362 DSP agreements with a total value of $43.4 million, the majority of these being research agreements and collaborative project agreements amounting to $33.6 million.

The emphasis for funding allocation was on supporting expertise development in the universities, through which, seven postdoctoral positions were funded to a value of $1.6 million. The sum of $8.1 million, meanwhile, was allocated to six collaborative project agreements through the Counter Improvised Threats Grand Challenge. RAAF and the Capability Acquisition

UNIVERSITIES IN THE DEFENCE SCIENCE PARTNERSHIPS PROGRAM

and Sustainment Group also used the DSP arrangement, with DST negotiating four agreements valued at $800,000 in total on their behalf.

In addition to the DSP framework, DST is engaging with universities by supporting mutually beneficial Australian Research Council (ARC) grant applications. The success of applications made during 2017–18 led to DST signing several ARC collaborative research agreements. While DST's contributions to such arrangements are usually provided on an in-kind basis, a notable exception was the $100,000 per annum commitment for seven years made to the Centre for Quantum Computation and Communication Technology at the University of New South Wales.

UNIVERSITY RESEARCH NETWORKS

DEFENCE INNOVATION NETWORK

The Defence Innovation Network (DIN), established in October 2017 to foster collaboration between NSW academics and industry, is a partnership between DST, the NSW Department of Industry, the NSW Chief Scientist and Engineer and seven NSW universities.

DIN has demonstrated its commitment to growing indigenous industry capability by appointing three industry members to its steering committee, one of them being its chair, William Hutchinson, Chairman of Thomas Global, thus representing both global and regional SME business enterprises. DIN regularly brokers multi-party agreements between academics and industry to solve problems for Defence end-users. Already, it has garnered success through a program of collaborative projects and scholarships backed by the solid in-kind support and endorsement of companies ranging from of micro-business start-ups to large-scale long-standing defence industry primes.

A regular part of DIN's outreach is its coordinator meetings and sandpit workshops, which are hosted by member universities to direct skills and capabilities relevant to Defence problems towards 'hands-on' application, particularly those problems that fit within the priority research themes of the Next Generation Technologies Fund. These events, proactively publicised by Defence NSW, the Sydney Aerospace & Defence Interest Group, the Australian Industry Defence Network, Hunternet and other industry networks, have generated R&D programs on deployable additive manufacturing, certifiably trustable autonomous systems and intelligent human health monitors.

Indicative of its growing significance, DIN was recently invited to testify before the NSW Standing Committee on State Development. This committee issued a report titled, Defence industry in New South Wales, in which opportunities to incentivise and grow the defence industry in that state were highlighted. In support of this objective, DIN also strongly advocates and assists targeted STEM skilling, and actively promotes employment in defence industry as career paths for science and engineering graduates.

DEFENCE INNOVATION PARTNERSHIP

The Defence Innovation Partnership (DIP), a joint initiative of DST, Defence SA and the three South Australian universities, was officially launched in October 2017 with the aim of building R&D capabilities for Defence in South Australia.

DIP has a strong focus on engagement with industry, as reflected by the appointment of two independent board members both with extensive industry experience. In June 2018, the Premier of South Australia announced the successful applicants for DIP's first round of collaborative research grants. These included impressive consortia involving all three universities, industry and DST. The proposals they submitted sought to investigate enhanced passive radar, the effects of augmented reality on human performance, treatments for water contaminants and the development of autonomous surface vessel capabilities.

With the range and quality of all applications being extremely impressive, DIP has opted to work with the unsuccessful applicants to seek alternative funding and

to strengthen their collaborative networks in preparation for future DIP rounds. The next round of DIP grants will be made in the first quarter of 2018–19.

DEFENCE SCIENCE INSTITUTE

The Defence Science Institute (DSI) in Victoria is continuing to bring universities and industry together with DST to collaborate in areas of interest to Defence. It is also helping DST to identify and initiate relationships with sources of expertise based in Australia's universities.

During 2017–18, DSI ran a number of workshops on behalf of DST to explore Defence needs beyond the horizon and to identify potential research directions to address these. Activities such as the Maritime Futures Workshop and the Modelling Complex Warfighting Strategic Research Investment Symposium focused on identifying ways in which the wider research community can contribute to future-proofing the ADF. The expression of interest process used by DSI to invite participation in these workshops allows academics and industry to gain a greater understanding of Defence needs and for DST to identify vital capabilities.

With the success of the DSI operating model now established, DST plans to expand the program across Australia. Similar types of networks have already been set up in South Australia and New South Wales. Through the substantial experience it has gained from working in this space, DSI has been able to provide key advice to DST on ways to establish and operate these networks.

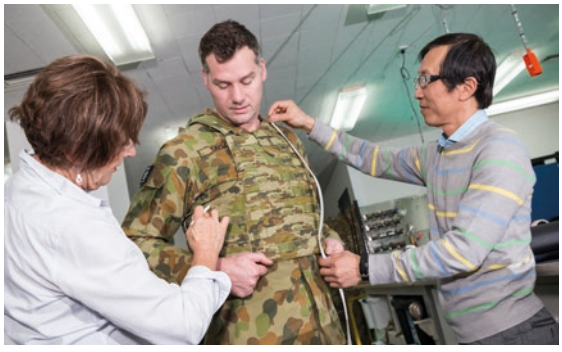
DSI continues to promote university-based defence and national security research capabilities both locally and internationally. The popular PitchFests, providing opportunities for SMEs and academics to showcase their ideas, have become an established part of the Land Forces, Maritime Pacific, Avalon Airshow and CivSec expos. DSI is a regular participant in Team Defence and State Government trade missions, having attended the Singapore Airshow and the Defence and Security Equipment International 2017 as well as making visits to the USA, UK, Germany, France and the Netherlands during 2017–18.

DSI has also importantly added value to DST's collaborations with US Department of Defense research agencies by increasing university engagement. This has led to their involvement in activities such as the inaugural Australian–US Robotics and Autonomy Workshop held in Adelaide in November 2017 and the Annual Review and Workshop of the US Air Force Office of Scientific Research-DST Co-Sponsored Research Program on Trusted Autonomy held in Melbourne in May 2018.

HPRNET

The Human Performance Research network (HPRnet) was formed in 2016 by DST and Army with the objective of promoting linkages between Australian universities, DST and Army to collaboratively manage Army capability development projects.

HPRnet began with a widely published call for expressions of interest from Australian universities to conduct studies addressing one or more of Army's prioritised human performance research areas. Of the 67 submissions received, seven successfully passed through a two-stage process of assessment conducted by DST and Army experts. The assessments they made were based on the criteria of novelty, innovation, co-investment support, excellence and relevance.



HPRnet's approach is based on a principle of partnership in depth. DST's role is critical in providing an understanding of the current and anticipated military challenges, and relating them to the latest advances across multiple scientific disciplines. The contributions from universities include the participation of academic chairs in a range of HPRnet activities such as its annual symposium.

Two years now after inception, HPRnet has already delivered research insights of significance to Army. With Army having identified human performance as a

priority for modernisation, it has taken the decision to directly invest $4 million over four years on research to supplement DST's existing program. Over the course of 2018, a number of studies were mounted in combination to gather experimental data from soldiers in the field, thereby taking advantage of the potential efficiencies on offer through a networked approach to the research.

CENTRE FOR FOOD INNOVATION

The Centre for Food Innovation operates under a collaborative arrangement involving DST, the University of Tasmania and CSIRO.

DST and the Centre have worked to establish a microwave-assisted thermal sterilisation (MATS) food processing research plant at DST Scottsdale, the only MATS capability in the southern hemisphere. MATS uses microwave technology to rapidly produce shelf-stable, ready-to-eat meals and other food products, which retain superior taste, texture and nutrient content compared to conventionally processed products.

The advent of MATS technology is expected to have a major bearing on Defence's next-generation provisioning system.

RESEARCH NETWORK FOR UNDERSEA DECISION SUPERIORITY

As part of the Future Submarine Program's Science and Technology Plan, DST is establishing an initiative to build world-class research capabilities and capacities in Australian universities to harness the significant research skills, expertise, networks and infrastructure residing there.

The Research Network for Undersea Decision Superiority will provide a mechanism to fund and oversee research into decision-making on Australian submarines and to build a sustainable research community in Australia, responsive to ADF needs.

To guide the investment of research resources, an exercise in research capability and capacity building was undertaken with the aim of establishing a consensus on long-term needs and opportunities as well as clear outcomes. The network's strategic investment plan has now been finalised and the underlying governance structure is in the process of being finalised.

The inaugural members involved in establishing the network include Curtin University, the University of Western Australia and Edith Cowan University. An invitation for further network membership along with details of the research projects will be released after DST and the Future Submarine Program have given approval to proceed.

NEW COLLABORATIONS WITH UNIVERSITIES

During the year, new collaborative projects were started with various universities. They included:

- Better Simulation Models and Visualisation for the Joint Domain as part of DST's Strategic Research Initiative in Modelling Complex Warfighting, with the University of New South Wales (as the lead), University of Sydney and Flinders University
- Horizon-three research into new materials for use in infrared countermeasures to defeat advanced future threats, with the University of NSW, University of Queensland, Australian National University and Flinders University
- Research into water mist systems as an extinguishing agent for fires in submarine compartments with lithium-ion batteries, with Victoria University.

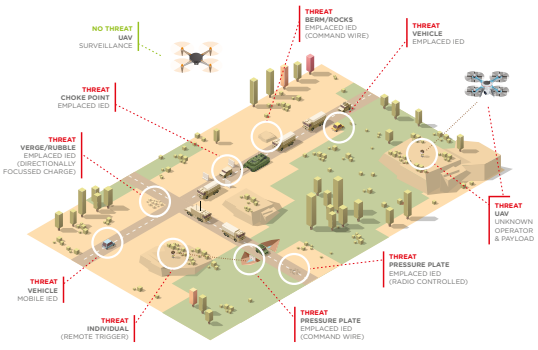
PROGRAMS UNDER THE NEXT GENERATION TECHNOLOGIES FUND

COUNTER IMPROVISED THREATS GRAND CHALLENGE

The goal of the inaugural Grand Challenge under the Next Generation Technologies Fund was to develop ways of countering improvised threats without incurring casualties. Launched in April 2017, it immediately struck a chord with Australia's defence industry and scientific community, with more than 650 people attending information sessions in six capital cities. Over 200 applications were received in response to a call advertised widely via DST's website, AusTender and the Centre for Defence Industry Capability website.

Following a thorough evaluation and assurance process conducted by national and international subject matter experts, 22 organisations were chosen to work with DST.

They included universities in various parts of Australia, small businesses, the CSIRO and two defence industry primes. DST is working actively with the selected researchers and industry partners to guide and focus progress and, in some instances, inject technologies developed in-house into concept developments.

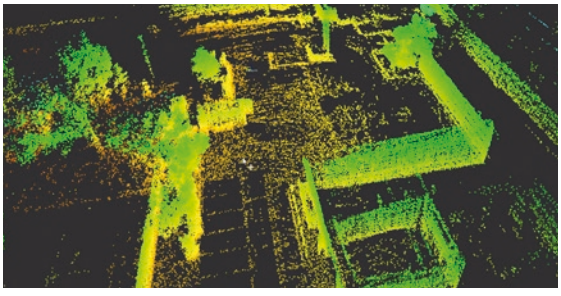


This grand challenge has also generated substantial interest among Australia's allies. The US Joint Improvised-threat Defeat Organisation, for one, has expressed interest in participating, having already entered into high-level discussions on how it can support this effort.

The topic for the next grand challenge is currently being considered in consultation with Defence. The Next Generation Technology Fund plans to have mounted a total of six grand challenges by 2026.

DEFENCE COOPERATIVE RESEARCH CENTRE PROGRAM

The Defence CRC program is one of the major R&D initiatives mounted under the Next Generation Technologies Fund. This program is undertaking to create a number of research centres that bring together industry (particularly SMEs), academia and publicly-funded research agencies (PFRA) to foster mission-driven research on priority technologies for future-proofing Defence.



In early 2018, the first of these CRCs was launched, focusing on trusted autonomous system technologies in the maritime, aerospace and land domains. With the support of the Queensland Government, this Defence CRC company – the Defence CRC for Trusted Autonomous Systems – has been headquartered in Brisbane. DST assisted its delivery by providing expert intellectual property and partnership framework advice. DST also negotiated the funding agreement on behalf of the Australian Government and is providing ongoing relationship management support for the company.

MEDICAL COUNTERMEASURES PROGRAM

The Medical Countermeasures Program at the Defence Materials Technology Centre builds on extensive research already undertaken by government, industry and research partners. To date, CSIRO and DST have each contributed $5 million to the program.

The program aims to:

- Achieve capability outcomes for ADF personnel in line with the broader national preparedness strategy for countering infectious diseases and pandemics
- Create a coordinated multi-stakeholder Australian medical countermeasures capability that can collaborate on achieving priority technology targets
- Make advantageous use of available skills, conduct global-best-practice research activities and improve timelines for the delivery of medical countermeasures research outcomes.

Currently, eight industry partners and ten research partners have engaged in medical countermeasures projects. The program has received over 150 submissions, with eight projects now funded and another four to six projects to be added to the portfolio in the third round. Included among these submissions are proposals to develop vaccines, therapeutics and diagnostics against chemical biological radiological threats, and to conduct research on emerging infectious disease and pandemics.

PARTNERING WITH OTHER GOVERNMENT ORGANISATIONS

DST maintains strong strategic relationships with publicly-funded research agencies including ANSTO, CSIRO, Bureau of Meteorology and the Australian Institute of Marine Science.

These partnerships cover a broad range of technical challenges and activities and have included:

- Collaboration with CSIRO to extend the range and endurance of robotic and autonomous systems through the intelligent management of their own power usage
- Collaboration with CSIRO to improve the Remote Ocean and Atmosphere Model used by Navy, having identified the importance of a parameter – the low-layer sound-speed gradient – previously considered unimportant to sonar that is not predicted well by existing models
- A five-year collaboration with the Australian Institute of Marine Science on biofouling management and bioluminescence research, including the investigation of new ways to control biofouling on marine sensors and instruments and *in situ* assessments of marine bioluminescence
- Collaboration with the Bureau of Meteorology to improve the Ocean Modelling Analysis and Prediction System, which produces seven-day forecasts of the ocean circulation around Australia every day and has been Australia's operational short-range ocean forecast system since September 2007
- Collaboration with the Australian Nuclear Science and Technology Organisation to support the development of at least seven new additional beamlines for the Australian Synchrotron.

OCEAN MODELS COLLABORATION

In partnership with CSIRO, BOM, Curtin University, the Australian Defence Force Academy and the Integrated Marine Observing System, DST carried out work to compare the oceanic features predicted by mathematical models with measurements of these features obtained by a global network of floats and underwater gliders that roam the oceans. The results obtained to date hold great promise for enabling the ADF to better understand and more accurately factor in ocean environment conditions when undertaking mission planning.

CSIRO ON PRIME PROGRAM

DST also partnered with CSIRO on its ON Prime:Defence pre-accelerator program to encourage and support the engagement of university and government research teams in the development of potential Defence applications. In 2017-18, three teams completed the program. The benefits of the program were earlier illustrated by the success of James Palmer and Simon Palumbo who went on to form Silentium Defence and commercialise DST's passive radar technology.

Simon Palumbo and James Palmer.

INTERNATIONAL ENGAGEMENT

International engagement continued to be a key driver within DST for enhancing Australia's defence S&T capabilities. Working collaboratively with allies and regional partners is critical for ensuring Australia's access to world-class technologies that will allow Defence to maintain its capabilities on the cutting edge and to operate effectively. During 2017–18, DST strengthened these relationships.

REGIONAL ENGAGEMENT

A number of initiatives were taken in the Indo-Pacific region. These included hosting visits by personnel from Japan, the Republic of Korea and Singapore, which helped build personal connections while giving DST the opportunity to showcase its world-leading expertise. As the relationships develop, DST will work with its partners to identify and scope potential S&T areas of collaboration that will deliver mutual benefits.

A key activity undertaken during 2017–18 was the inaugural Joint Steering Committee for Defence Equipment & Technology Cooperation between the Japanese Ministry of Defense and the ADF. The Chief Defence Scientist and his counterpart, Dr Hirokazu Hokazono, Deputy Commissioner for the Japanese Acquisition Technology & Logistics Agency (ATLA), co-chaired this meeting and agreed to a new cooperation framework for an expanded bilateral defence S&T engagement program.

Japan Joint Steering Committee.

To complement this important forum, DST and ATLA jointly hosted the first Australia–Japan Multi-Function Technology Symposium during the Pacific 2017 International Maritime Exposition. The purpose of the one-day event was to enhance opportunities for bilateral Australian–Japanese cooperation and exchange information about multi-function technologies in the maritime domain. The event included speakers and participants from government, industry and academia from both Australia and Japan.

During the year, DST and its Singaporean counterpart agency, the Defence Science Organisation National Laboratories undertook further activities relating to their multi-year collaborative research program to develop micro UASs with the capability to operate in urban environments. This research is an important step towards the development of resilient autonomous robotic teams for intelligence collection in future urban environments.

Singapore UAS trial.

September 2017 TTCP Principals meeting at Space and Naval Warfare Systems Command (SPARWAR), San Diego, USA.

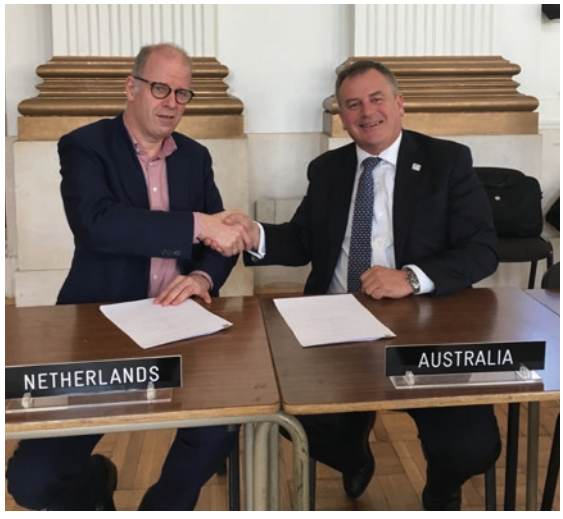
EUROPEAN AND US ENGAGEMENT

DST participated in a range of bilateral defence S&T dialogues with European partners during 2017–18. The Chief Defence Scientist met with:

- The Norwegian Defence Research Establishment to identify opportunities for future cooperation
- The Dutch Ministry of Defence to sign a personnel exchange arrangement
- The French Direction Générale de l'Armement to discuss the development of a new legal instrument to support future S&T engagement
- The British Chief Scientific Adviser to undertake the annual strategic review of collaborative activities.

DST also participated in NATO Science and Technology Board meetings in September 2017 and March 2018. These forums provide DST with the opportunity to undertake productive discussions with world-leading government defence research agencies and engage in collaborative programs in niche areas that deliver access to capabilities not otherwise available to the ADF.

The Chief Defence Scientist travelled to the US to participate in the Australia–US Ministerial Consultations Defense Acquisition Committee in April 2018. Australia and the US are working together to ensure that their S&T programs are aligned and lead to enhanced mutual reliance, so that better capabilities are delivered faster and cheaper to the warfighters in the two nations.



The TTCP is DST's primary multilateral program of international S&T collaboration and Australia's most important link to the defence research of its partner nations.

In April 2018, the five partner countries signed a new and expanded Memorandum of Understanding which expands the trusted innovation network within TTCP, and facilitates an increased ability to work in partnership with third entities such as other government departments, industry and academia.

SMARTER LAND DOMAIN TACTICAL NETWORKING

In a joint US–Australian project, DST is collaborating with researchers from the US Army Research Laboratory to develop and demonstrate a tactical information networking system called SMARTNet. This is designed to manage the ever-increasing amount of information being shared across intermittently connected and bandwidth-limited tactical communication networks operating in complex and contested military environments.

SMARTNet dynamically prioritises, transforms and controls the dissemination of information in accordance with rapidly changing mission priorities and network conditions, helping to ensure the right information gets to the right person at the right time.

A key challenge being addressed is how an autonomous system can capture, represent and reason about the state of its tactical networks and mission priorities. To meet this challenge, DST and US Army Research Laboratory researchers are partnering with academia, industry and Army to iteratively implement, test and evaluate SMARTNet so that it makes the most effective information dissemination decisions possible, in a way that achieves improved operational outcomes.

TORVICE TRIAL TWO

In October and November 2017, over 90 participants from the Australian Army, DST, the US Army Tank Automotive Research Development and Engineering Center and the US Army Communications–Electronics Research Development and Engineering Center gathered at the Woomera Test Range to run a six-week trial involving semi-autonomous ground vehicles.

The experiment was the second international event of the Trusted Operation of Remote Vehicles in Contested Environments (TORVICE) program. This program aims to demonstrate the reliable remote operation of semi-autonomous vehicles. During the recent work, the program set out to identify vulnerabilities and find ways of eliminating them with advanced solutions.

During TORVICE Trial Two, TARDEC provided access to its world-class vehicle autonomy technologies while multidisciplinary DST teams played the role of adversary, seeking to disrupt the operation of the semi-autonomous vehicle. The third TORVICE trial in mid 2019 will seek to mitigate the vulnerabilities exposed in the current trial. The TORVICE program offers DST and the Australian Army a great opportunity to form a strong and enduring partnership with world-leading military vehicle R&D organisations in the US. Of note is the fact that the US Army lauded TORVICE as a successful US–Australian collaboration to four-star dignitaries and at the 2018 Pacific Operational S&T Conference.

JPO staff with an F-35 at Andrews Air Force Base, USA.

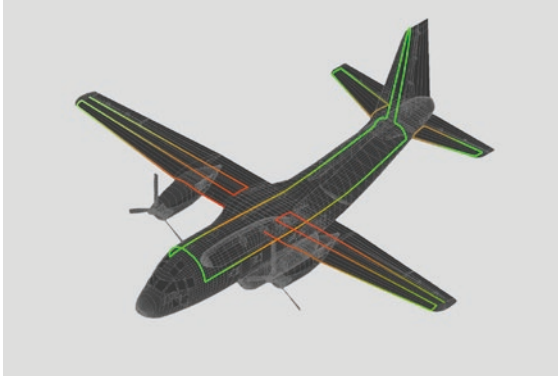
SUCCESSFUL COOPERATIVE PROGRAM PERSONNEL ATTACHMENT

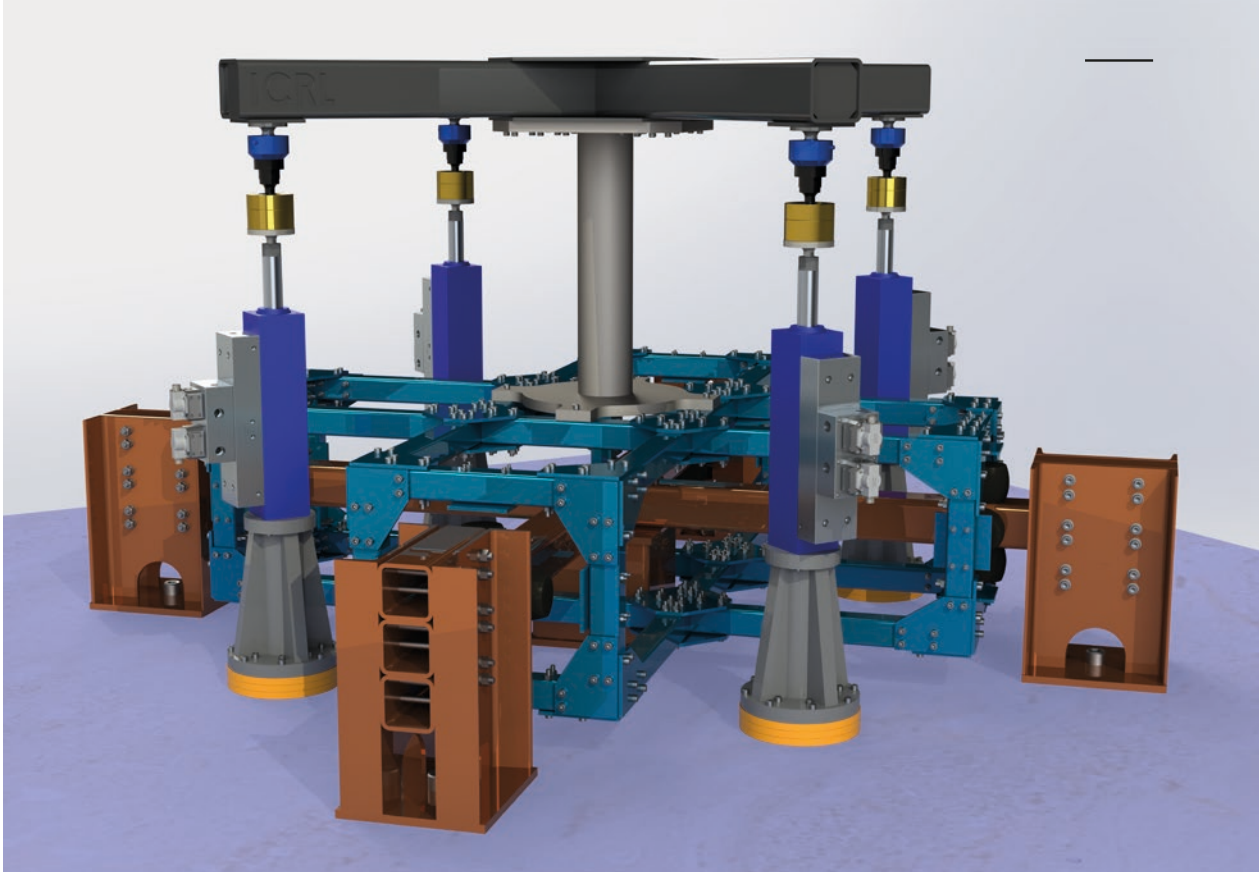
Continuing a long-standing relationship with the F-35 Lightning II Joint Program Office, a DST staff member, Paul Marsden, was embedded in the Prognostics and Health Management team, working alongside US government and partner nations on this international collaborative program. While on post, Marsden created a computer program that reads raw F-35 data and decodes it into a format suitable for detailed analysis. This capability, now being used to support rapid responses to in-house incident investigations, is predicted to save over $US33 million of direct costs for the life of the program by reducing the reliance on the original equipment manufacturer. In addition, this software will enable independent efficiency improvement and knowledge discovery analyses that are expected to provide further substantial savings. The benefits of these analyses will help Australia's F-35A program to be more affordable and sustainable. Marsden subsequently received the US Department of Defense Medal for Exceptional Public Service.

JOINT US–AUSTRALIAN RESEARCH PROGRAM IN ADVANCED STRUCTURAL MONITORING

In June 2018, the US and Australia embarked on a four-year bilateral research program on advanced structural monitoring. The project arrangement enables researchers in the US Naval Research Laboratory to work with their aerospace counterparts in DST to investigate and transition into service some advanced fibre optic sensing technologies for integrated structural performance and health monitoring.

Technologies and data developed under this joint project will be used by DST for the certification and fleet through-life support of the ADF's C-27J transport aircraft.





HELICOPTER ADVANCED FATIGUE TEST

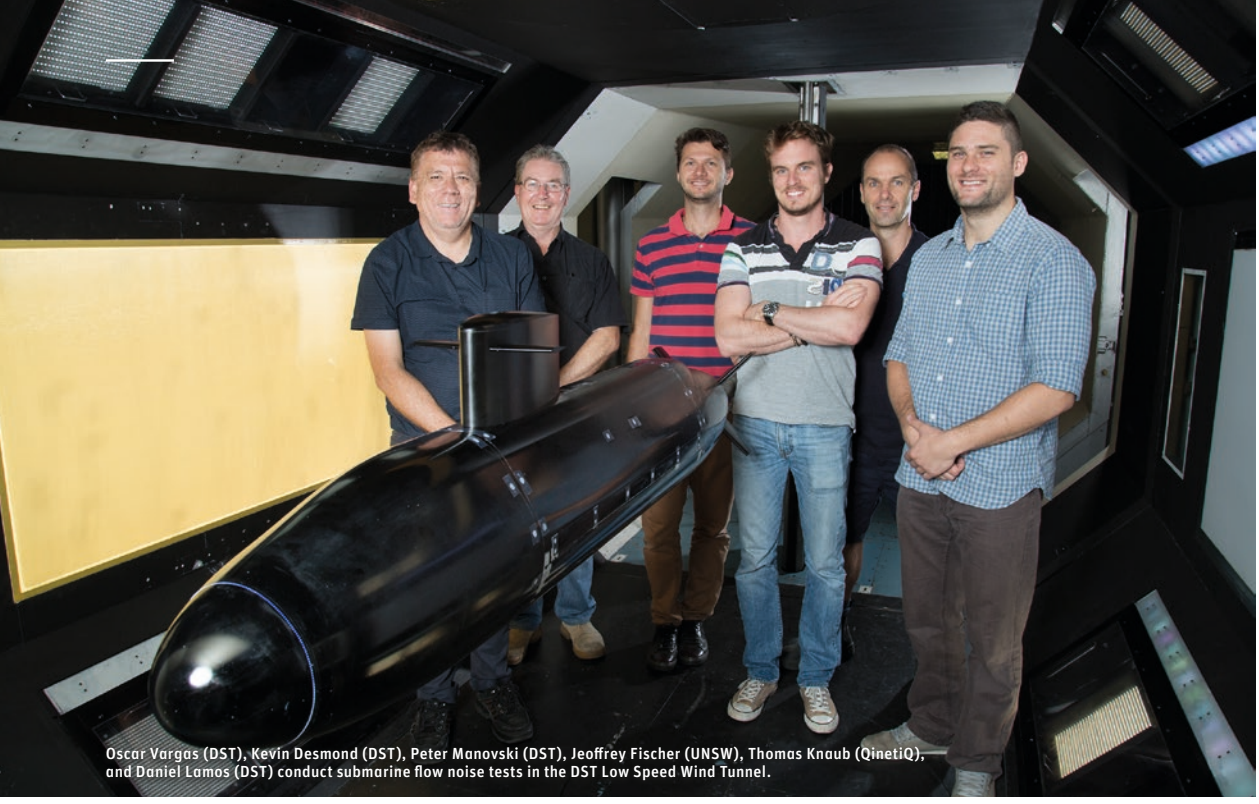
With the delivery of a US Navy MH-60 Romeo helicopter to DST in March 2018, work officially began on the joint DST and US Naval Air Systems Command Helicopter Advanced Fatigue Test-Technology Demonstrator project. This project aims to mature the technologies required to make full-scale helicopter airframe durability testing a viable option for fleet sustainment managers.

While full-scale durability tests are routinely conducted for fixed-wing aircraft, the complex high-frequency flight loading required for helicopter tests has been particularly difficult to replicate in-laboratory.

DST's three-degree-of-freedom dynamic demonstrator test rig is being used to make the application of the complex loading required a reality.

This helicopter durability test technology has the potential to change the way that helicopters are certified and that in-service structural integrity is managed. Should the project prove successful, the US Navy is considering a full-scale durability test of the MH-60R helicopter as part of their Service Life Assessment and Extension program.

Chief of Aerospace Division Dong Yang Wu (right) with Shane Fairweather, US First Assistant Secretary Helicopter Systems Division at the opening of the fatigue test project.



Oscar Vargas (DST), Kevin Desmond (DST), Peter Manovski (DST), Jeoffrey Fischer (UNSW), Thomas Knaub (QinetiQ), and Daniel Lamos (DST) conduct submarine flow noise tests in the DST Low Speed Wind Tunnel.

INTERNATIONAL PARTNERING FOR HYDRODYNAMICS STUDY

Throughout 2017–18, DST experts developed and tested new advanced flow-diagnostic tools capable of measuring the hydrodynamic performance, manoeuvrability and acoustic signatures of modern submarine geometries.

The work represents the culmination of several years of targeted fundamental research, during which, DST has partnered with the Acquisition Technology and Logistics Agency in Japan, the Swedish Defence Research Agency, the US Naval Surface Warfare Center (Carderock Division) and the University of New South Wales.

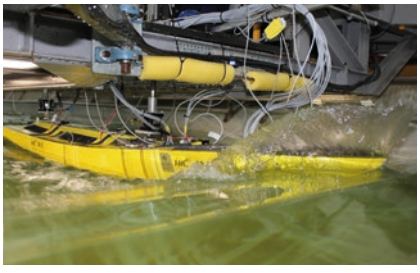
DST's Low Speed Wind Tunnel together with its HPC system and the Australian Maritime College's hydrodynamic testing facilities constitute state-of-the-art S&T research resources that Defence can access to assist its acquisition of submarines under the SEA 1000 Future Submarine program.

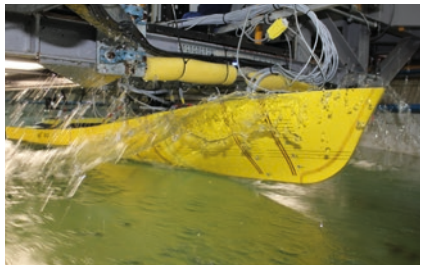
NATO MISSILE COUNTERMEASURES TRIAL

In May 2018, members of the Australian Airborne Countermeasures Team, comprising personnel from the Joint EW Support Unit and DST, attended Trial SALT III in Sweden – a NATO-run exercise to test electronic warfare (EW) threat warning and countermeasures against infra-red (IR)-guided anti-aircraft missiles.

During the trial, 52 IR-guided missiles were fired at a number of missile warning systems (MWS), some of which were countermeasure-enabled, in order to understand and improve MWS capabilities and to study the effectiveness of directed IR countermeasure (DIRCM) technologies being developed in Europe. DIRCM is a jamming system consisting of a wideband IR laser and IR tracker, mounted on a directional turret, with the turret initially being directed towards the missile threat by a MWS device.

Australia's involvement in the trial included extensive modelling of the effects of the DIRCM technologies to provide the necessary trial safety footprint. The Australian team also collected data on the performance of missile warning systems and DIRCM technologies, which are key elements in the EW self-protection systems installed on ADF aircraft. DST's efforts to understand and improve their performance have high importance for ADF operations.





NAVAL SLAMMING LOAD ANALYSIS AND PREDICTION

DST has participated in a research program called the Slamming Load Analysis and Prediction Joint Industry Project, which was undertaken with the Maritime Research Institute and the Defence Materiel Organisation in the Netherlands, Defence Research and Development Canada and the US Coast Guard. The program is mainly concerned with developing techniques for mapping hydrodynamic loads. Under the program, a collaborative project with the Australian Maritime College is investigating the seakeeping behaviour of a generic patrol boat under a variety of operating conditions, including various forward speeds, wave heights and wave periods.

ACHIEVING HIGHER ACTIVE PROTECTION CAPABILITIES FOR LAND VEHICLES

Under the Collaborative Land Active Self Protection Program, DST and the UK's Dstl have been investigating the use of active protection systems on land vehicles. The UK and Australian teams conducted trials and jointly produced capabilities for modelling, simulation and experimentation to inform the development of protection systems in today's battlespace against evolving threats.

The work has produced results that have been used to advise and shape major acquisition programs in both countries, including LAND 400 in Australia.

Further joint trials are scheduled for October 2018 to focus on measuring a soft-kill active protection system while also planning valuable signature and terminal effects measurements.

In November 2017, the Collaborative Land Active Self Protection Program team received a joint award presented by Australia's Chief Defence Scientist and the Chief Scientific Adviser for the UK Ministry Of Defence.

TTCP WPN Group Meeting DST May 2018

INTERNATIONAL WORKSHOPS AND MEETINGS

Workshops and meetings with overseas partners are an essential part of maintaining the momentum on research collaboration.

During the year, the following events were conducted:

- The TTCP Cyber Strategic Challenge in September 2017 successfully demonstrated new concepts in trustworthy systems, mission assurance and situational awareness, and 'electromagnetic cyber' – the conduct of cyber operations employing the electromagnetic spectrum.
- The 7th annual Australia Red Teaming Workshop in conjunction with the International CHIMERA Sympsium was hosted by DST in Adelaide during April 2018.
- The 47th annual meeting of TTCP Weapons Systems Group was hosted by DST in Edinburgh and Brisbane during May 2018 to discuss the operation of weapon technologies and future weapon system capabilities.
- The 2nd Australian–US Submarine Tactical Advancements for the Next Generation Workshop, was hosted by DST in June 2018 at HMAS *Stirling* to explore how command situational awareness can be improved through better data fusion, information flow and the incorporation of new technologies, resulting in innovative concepts that will inform decisions about investments in the Future Submarine research progam.
- The 3rd Australia, New Zealand and Pacific Workshop on Biofouling Control for Sustainable Shipping was organised by DST in September 2017 to discuss current developments impacting biofouling control.
- The 2nd Intelligence Mission Data Futures Symposium was hosted by DST in Canberra in March 2018, with intelligence representatives from UK, USA and Australia discussing the value of information that makes warfighting systems smart.
- The 2018 Joint Pre-Deployment Operational Analysis Course was facilitated by DST and attended by participants from India, Sweden and the UK to learn about the effective application of OA skills to support military operations.

OUTREACH AND ENGAGEMENT

DST plays a significant role in promoting science, technology, engineering and mathematics (STEM) as career opportunities by participating in outreach activities.

SUPPORTING STEM

DST participated in the Science Alive exhibition which attracted more than 30,000 visitors across three days, including 5,700 students and more than 100 teachers on the first day and over 24,000 general public attending over the weekend.

In further community educational ventures, DST staff gave talks and demonstrations to school students throughout the year. Another DST staff member ran a stargazing event at Canterbury Public School as part of ABC TV's Stargazing Live venture, which broke the world record for most people stargazing across multiple venues at the same time. DST Sydney hosted the annual scientist-in-schools STEM activity in November 2017.

High school students from Alexandria Park Community School and All Saints Grammar Belmore attended workshops and activities at the DST Sydney facility. Among the highlights of the STEM activities for 2017–18 was a visit to Fleet Base East at Garden Island Sydney where students inspected the dry dock capability and attended the Maritime Heritage Museum.

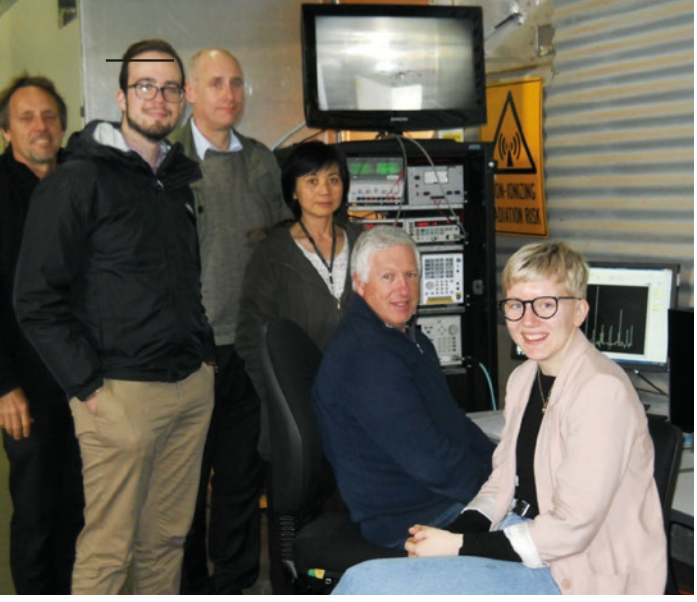
PROMOTING STEM IN THE FIELD OF AUTONOMOUS ROBOTICS

As a Gold Sponsor of the UAV Challenge and through its membership on the technical rules committee, DST sought to ensure that these open competitions challenge participants to solve problems directly relevant to the achievement of resilient autonomous system capabilties.

The challenge was to develop algorithms that enhanced intelligent avoidance behaviour while still dealing with the multi-objective problem of finding and retrieving a medical sample from a remote location.

This year, DST added an extra degree of difficulty by injecting simulated threats such as birds, other aircraft and even threat UAVs into the airspace that teams had to navigate.

DST has offered to take up any promising approaches emerging from the challenge for further development in collaboration with their originators.



YOUNG SCIENTISTS INVESTIGATE UAV VULNERABILITIES

To nurture the development of tertiary-level STEM talent in Adelaide, DST personnel mounted a research project for honours students requiring them to investigate the vulnerability of a UAV to electromagnetic influences.

The tasks set for the project were to model a commercial-off-the-shelf inertial measurement unit for a quadcopter and characterise and then model the susceptibility of this to electromagnetic interference.

The students participated in numerous laboratory tests and were responsible for developing the simulation models, validating the models and using the models in their investigation.

The outcome of this project will contribute to research programs in directed energy weapons and counter-UAV technologies.

PARTNERSHIPS WEEK

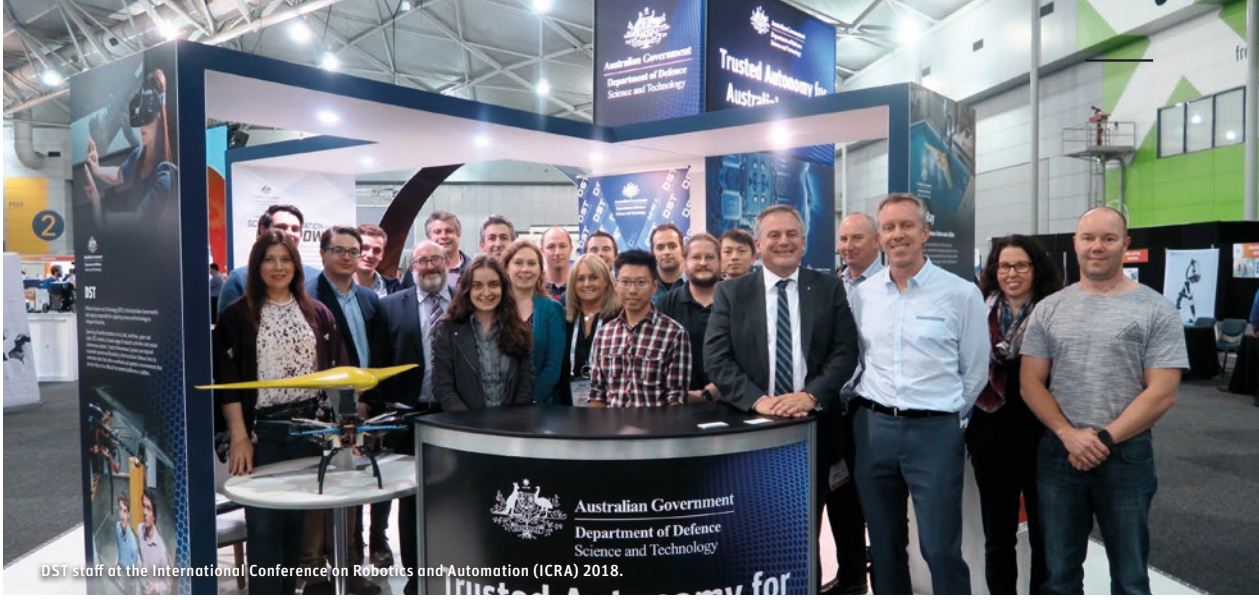
The third DST Partnerships Week was held at DST's Edinburgh site in August 2017, and served to strengthen the organisation's external engagements by cementing long-term relationships and starting conversations with potential new partners.

It included two days of activities for invited partners from the ADF, research agencies, academia and industry, and one day for the STEM community.

Partnerships Week 2017 went to plan and was very well received by participants, with the informal feedback gathered being highly favourable while the formal feedback obtained via an online form was also overwhelmingly positive.

Partnerships Week 2017:

- Showed the defence community that DST is still 'open for business', with a focus now on future development, innovation and partnerships
- Fostered broader connections with ADF partners, industry, academia, government and the education sector through the attendance of 345 people from these organisations – an increase of 20 percent over the previous year
- Presented opportunities at the Technology PitchFest for attendees to take up licensing opportunities
- Strengthened existing partnerships, with three new collaborations signed
- Increased DST's profile through the use of social media for the event.



DST staff at the International Conference on Robotics and Automation (ICRA) 2018.

AWARENESS AND REPUTATION

DST attracts strategic partnerships and productive collaborations on the strength of its world-class reputation and positive image in the marketplace.

Public affairs activities continued to play a key role during the year in communicating the value of defence science. The Next Generation Technologies Fund was a particular focus as new programs were successfully inaugurated, such as the Grand Challenge for countering improvised threats, the first Defence Cooperative Research Centre for Trusted Autonomous Systems, the expanded university research networks in South Australia and New South Wales, the Small Business Innovation Research for Defence initiative, the spin-out of Silentium Defence as a start-up, and the partnership with the US Department of Defense's Multi University Research Initiative, enabling Australian universities to collaborate with US universities on defence projects of interest to both countries. These programs were promoted in the media, on online channels and through speaking engagements.

DST maintained its strong participation in high-profile events to highlight Defence technologies and collaboration opportunities. These events included the ADM Congress, 2017 Pacific Maritime Exposition, Science Meets Parliament, STEM in Defence Summit, Research Innovation Summit, CIVSEC 2018 and the International Conference on Robotics & Automation.

During the year, independent publishers Faircount Media Group produced a flagship publication dedicated to defence science and technology, called DST Outlook, which was very well received by industry, prompting an updated version to be produced in 2019.

Defence scientists continued to be recognised by external organisations for innovation and the excellence of their scientific work. DST proactively competes for prestigious science and innovation awards to benchmark its work against other contenders.

At the CIVSEC 2018 event, Tony Lau, Alex Skvortsov, Branko Ristic, Ralph Gailis and Peter Dawson received two innovation awards for developing a disease forecasting capability.

In April 2018, the Institution of Radio and Electronics Engineers of Engineers Australia selected Brian Ferguson for the 2017 Special David Robinson Award named after Australia's world renowned expert in ultrasound technology.

The BAE Systems Chairman's award for developing an innovative aircraft corrosion management system was presented to the DST team of Geoff Hugo, Darren Gerrard, Chris Loader, Grant McAdam and Aaron Sudholz.

Vanessa Pickerd was given an early career award by the Defence Materials Technology Centre for her excellent contribution to one of their projects involving life-of-type evaluations of Navy frigates.

The Chief Defence Scientist kept up a high tempo of public speaking engagements, encouraging industry and universities to partner and prosper.

4

INVESTING IN OUR PEOPLE, OUR ASSETS, OUR SUCCESS

VALUING OUR PEOPLE

DST places high priority on nurturing career development to ensure personnel achieve their full potential as researchers and future leaders, and deliver outstanding scientific support to Defence. A range of initiatives to promote talent, diversity and career development is yielding results.

STAFF LEARNING AND DEVELOPMENT

As part of DST's commitment to fostering ongoing learning and development for all staff, several targeted learning and development programs were designed and delivered during 2017–18. These aimed to provide DST's workforce with the skills required to deliver the S&T outcomes that Defence and national security clients will need in years to come.

FIVE participants.

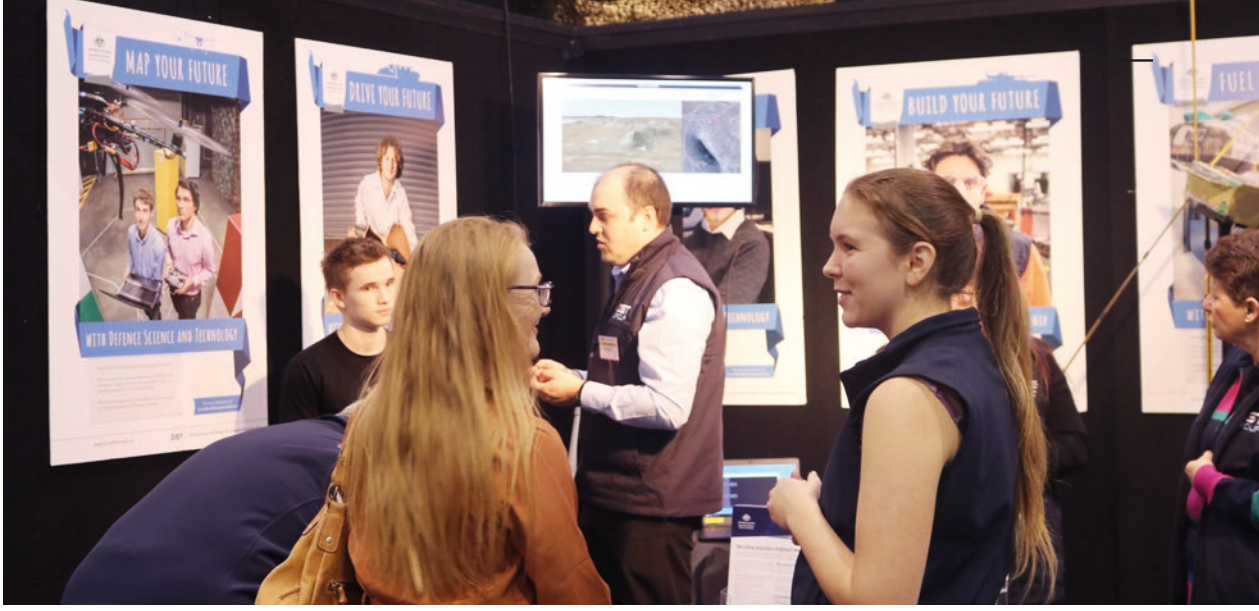
A new Next Generation Leadership Program for all S&T5 staff, called the FIVE Program, was offered during the first half of 2018. Constituting an essential developmental step for all future leaders, FIVE focused on enhancing strategic awareness, building and maintaining partnerships within and external to DST, instilling professionalism and scientific excellence, and embedding One Defence leadership behaviours. A total of 460 staff participated in this program across 28 targeted seminars. All staff had the opportunity to engage directly with the Chief Defence Scientist to discuss their research in the context of DST's strategic initiatives and its future S&T priorities.

The twelve-month Science Leadership Development Program provided challenging experiential leadership development for 20 senior staff. In addition, DST continued to partner with the University of Melbourne to deliver the Graduate Program in Scientific Leadership, which is targeted at staff near to the mid-point of their scientific careers. This innovative program, integrated into DST's business activities, offers diverse action learning opportunities and gives participants unique access to DST's senior leaders as well as military and academic partners. Both of these programs are serving to provide staff with the broad skill sets they will need to take on leadership roles at DST.

In addition to fostering leadership skills development, DST is committed to ensuring staff have opportunities to gain higher-level skills in various S&T qualifications. Currently, 24 staff are enrolled in the S&T Education Program and are working towards a Masters qualification, with a further 34 staff currently working towards a PhD.

DST also established a series of initiatives to promote mentoring within DST. A Divisional Mentoring Champion Network was established to support and encourage divisional staff to develop mentoring relationships. A one-on-one mentoring program, meanwhile, has been pairing staff with suitable mentors, and mentoring skills workshops have been offered across the organisation. A Mentoring Circles for Women Program was taken up by a diverse group of 25 women in a year-long venture of personal and leadership development.

DST conducted two induction programs for new employees, including cadets, students and some Defence employees.



RECRUITMENT AND TALENT PIPELINE

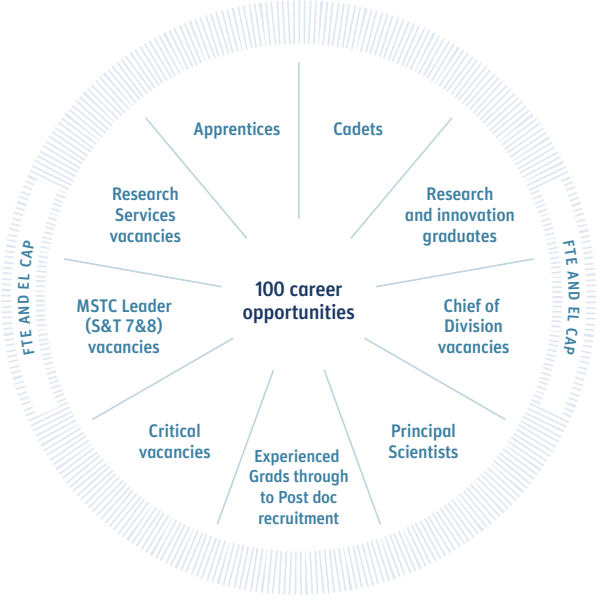
In 2017–18, one of DST's key priorities was recruiting to its staffing targets and ensuring there were strong pathways to transition students from placement programs into employment.

The current focus of the DST Recruitment Plan is continuing to build capability in key discipline areas at the entry and early career level to ensure DST is able to deliver S&T capability enhancements to Defence and national security agencies now and into the future.

Key features of the DST Recruitment Plan include:

- Recruiting for 150 critical vacancies with a focus on growing the foundation classifications. DST established the inaugural Early Career Researcher and Post-doctorate programs, providing a flexible and dynamic approach to targeting and recruiting early career scientists and research engineers.
- Six cadets graduated from the DST STEM Cadetship Program and entered into employment positions, while an additional 28 cadets were recruited, bringing the total of STEM cadets on the program in 2017–18 to 35.
- The inaugural five research and innovation graduates completed the Defence Graduate Program and transitioned into ongoing employment positions, with a further eight graduates undertaking the program in 2018.
- DST currently has six apprentices working in its specialised engineering services area, and two Indigenous Australians were recruited as electronics apprentices.
- DST completed another round of its 100 Career Opportunities for enabling S&T staff at the S&T5&6 levels to move through the organisation, with opportunities also offered under the DST Broadbanding program.
- Following finalisation of the Chief of Division recruitment in 2017, work was undertaken to stabilise the leadership cohort responsible for MSTCs. A number of these positions have been filled, with the remainder expected to be filled in 2018.

DST RECRUITMENT PLAN 2018

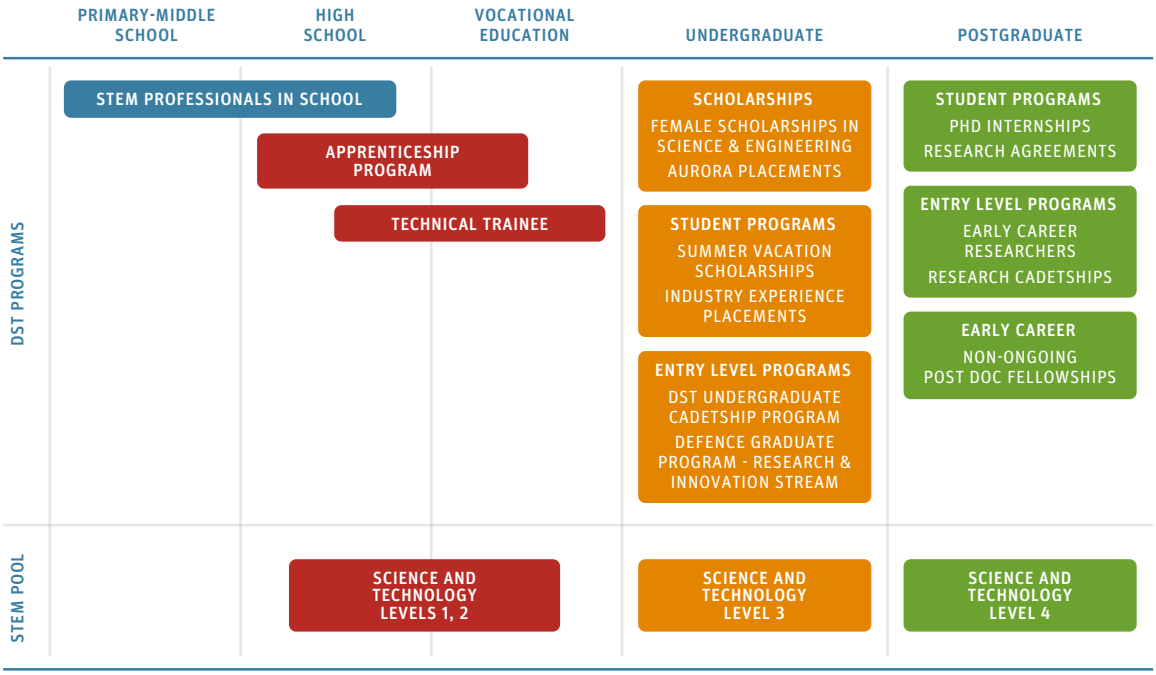


AMSI agreement signing at Pacific 2017: CDS Alex Zelinsky, AMSI intern Mahrita Harahap, and AMSI Director Geoff Prince.

ENTRY LEVEL FRAMEWORK

With a focus on entry and early career recruitment, the DST Entry Level Framework was developed in 2017. This outlines how DST will grow its talent pipeline through initiatives that provide a transition from school and university into the workforce. One of the new initiatives under the framework was the establishment of a four-year partnership with Australian Postdoctoral Research to place up to 100 PhD interns in DST over four years. This provides a great opportunity for some of Australia's brightest PhDs to undertake three- to five-month projects to build their research skills while contributing to Defence capability.

DST ENTRY LEVEL FRAMEWORK



INCLUSION AND DIVERSITY

DST is committed to working as a fair and inclusive organisation, and in 2017, the DST Inclusion and Diversity statement was launched. Key activities and achievements in the inclusion and diversity portfolio during 2017–18 included:

- Continuing to develop DST's bronze-level application for the SAGE Athena SWAN program. Bronze-level certification recognises that an institution has demonstrated a good understanding of the current status of gender equity, and is positioned well to implement interventions to address inequities.
- The Chief Defence Scientist continued his participation in the STEM Male Champions for Change working group, and DST continued to benchmark and provide examples of good practice for consideration more broadly across this group.
- DST's Gender Equity Working Group was a finalist in the Australian Public Service Diversity and Gender Equality Awards 2017. The Gender Equity category recognises staff, agencies, departments and networks that have made significant progress or contribution towards addressing gender inequality in the Australian Public Service.
- In line with the Defence target of 2.7 percent Indigenous representation in the workforce, DST has undertaken 26 recruitment ventures as affirmative actions since January 2018. With a focus on entry-level pathways to S&T careers, DST has welcomed the commencement of two Indigenous apprentices and one cadet in 2017–18.
- Mr Peter Lambert was appointed as a Defence and DST Indigenous Champion.
- To assist in building the Indigenous STEM talent pipeline, DST partnered with the Aurora Education Foundation. This partnership supports high-performing Indigenous STEM students completing post-graduate courses at prestigious universities overseas. Aurora also helps promote career opportunities available at DST and in the STEM industry more broadly.
- DST's Indigenous Engagement Program was closed in April 2018, and is to be renewed by the end of the calendar year in line with the Defence Reconciliation Action Plan and DST's Strategic Plan.
- Successful events and activities were held at DST sites across Australia to celebrate the International Day of People with a Disability. DST also appointed its inaugural Disability Champion, Dr Peter Shoubridge.
- Other DST chiefs have been appointed as Defence champions. Dr Dong Yang Wu was appointed a Cultural and Linguistic Diversity Champion and Dr Lynn Booth was appointed a Mental Health Champion.

PATHWAY TO CHANGE INSIGHTS SURVEY

In July 2017, DST ran its fourth Pathways to Change Insights Survey, attaining a high 85 percent staff participation rate.

This provided the DST Leadership Team with feedback on the organisation's performance, assessed the impact of the 2012–17 DST Strategic Plan and sought views on what employees thought needed to be incorporated into the next DST Strategic Plan.

The results of the survey indicated improvements since 2015 in teamwork and collaboration, client outcomes, and creativity and innovation – areas critical to an innovative culture. There were also increases registered in personal commitment to achieving the DST Strategic Plan and diversity with equal opportunity and fair treatment for all.

One of the areas that staff considered could be further improved is leadership and managing change. Resources and facilities were also seen to require additional attention.

HIGH ACHIEVERS

Secretary of Defence Greg Moriarty, Ms Zenka Mathys and Chief Defence Scientist Dr Alex Zelinsky.

2017 MINISTER'S AWARD FOR ACHIEVEMENT IN DEFENCE SCIENCE

Zenka Mathys

For her work in improving fire safety for Navy ships, submarines and crew. Zenka's work involved extensive collaborations with Navy and international partners to develop a new standard for the testing of materials used in fire resistance and structural protection of deployed craft. Zenka was also involved in the investigation of fires on board HMAS *Bundaberg* and HMAS *Waller*, leading to the implementation of an integrated survivability research program.


Chief Defence Scientist Dr Alex Zelinsky and Dr Janis Cocking

2017 PUBLIC SERVICE MEDAL

Dr Janis Cocking

For outstanding service in the field of defence science and technology while driving the strategic innovation agenda for DST and strengthening Australian defence expertise and research infrastructure through international collaboration.

US SECRETARY OF DEFENSE AWARD

Marcus McDonald

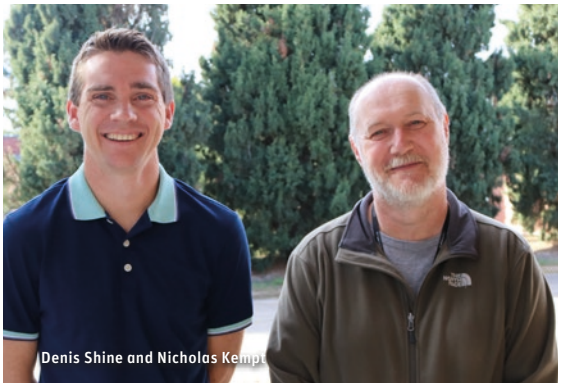
For exceptional public service as Australia's representative as a ground test engineer assigned to the Lightning II Joint Program Office Airframe team from December 2013 to December 2016, playing an integral role in improving the full-scale durability test plans and displaying personal initiative in implementing an improved fatigue analysis methodology.

James Waldie (BAE Systems) and Geoff Hugo (DST)

BAE SYSTEMS CHAIRMAN'S AWARD

Geoff Hugo, Darren Gerrard, Chris Loader, Grant McAdam, Aaron Sudholz

Recipients of the Business Leader Award 2017 in the category, Innovating for Success, awarded for their work developing corrosion management systems for aircraft, including the global F-35 JSF fleet.



Denis Shine and Nicholas Kempt

US MILITARY OPERATIONS RESEARCH SOCIETY, DAVID RIST PRIZE

Denis Shine and Nicholas Kempt

For the outstanding quality of their paper on operations research titled *A Multi-Method Analysis of Future Australian Army Watercraft Capability in Combat*.

Chief Defence Scientist Dr Alex Zelinsky, Dr Brian Ferguson, and Chief of Navy, Vice Admiral Timothy Barrett, AO, CSC, RAN

2017 DEFENCE SECRETARY GOLD COMMENDATION

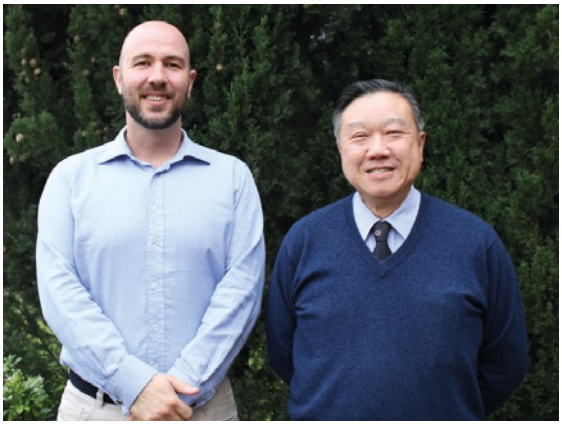
Brian Ferguson

For advancing Defence capability through acoustic and sonar innovations.

2017 SPECIAL DAVID ROBINSON AWARD FROM ENGINEERS AUSTRALIA

Brian Ferguson

For contributions to radio and electronics engineering.



CIVSEC INNOVATION AWARDS

Tony Lau, Alex Skvortsov, Branko Ristic, Ralph Gailis, Peter Dawson

With University of Melbourne for developing two infectious-disease forecasting software products called EpiFX and EpiDefence. CIVSEC 2018 Innovation Award for Disaster Relief, Emergency Management and Humanitarian Services, and the CIVSEC 2018 National Innovation Award for Civil Security.

2017 SABO INTERNATIONAL BALLISTICS SYMPOSIUM

Huon Bornstein

For Best Paper (*Effect of Blast Mitigation from Multiple Fluid Containers* by Eric Yang and Huon Bornstein)

Senator David Fawcett, Vanessa Pickerd and DMTC CEO Mark Hodge.

DMTC EARLY CAREER AWARD

Vanessa Pickerd

In recognition of her efforts above and beyond those of other personnel on a Defence Materials Technology Centre project to investigate and enhance life-of-type evaluations of Navy frigates.

Neil Gordon, Samuel Davey, Matthew Stead, Ian Holland and David Liebing.

MH370 AWARD

Neil Gordon, Samuel Davey, David Liebing and Ian Holland

Awarded by the Australian Transport Safety Bureau to the DST Team that assisted the search for missing Malaysian Airlines MH370 flight in 2014.

AUSTRALIA–UK DEFENCE SCIENCE AND TECHNOLOGY AWARD

Rob Baker, Mark Mckenzie, Kym Meaney, Josh Mitchell, Jonathan Boan and George Katselis (DST recipients)

For contribution to the joint Active Protection Systems S&T Team, developing an understanding of the threats to land forces associated with modern anti-tank guided weapons and rocket-propelled grenades, and developing protection technology for safely and effectively defeating these threats.

CRS Peter Lambert, Acting Deputy Secretary Defence People Richard Oliver, Ajith Bandara and former VCDF Ray Griggs.

DEFENCE SAFETY AWARD 2018

Ajith Bandara

Silver Award for implementing a regulatory governance framework in DST's chemical biological and radiation laboratories.

NATO SCIENTIFIC ACHIEVEMENT AWARD

Dr Anthony Cramp

Joint recipient of a NATO Scientific Achievement Award as a part of the Modelling and Simulation as a Service Working Group (MSG)-136 Team, which investigated, proposed and evaluated standards, agreements, architectures, implementations and cost-benefit analysis of modelling and simulation.

DEFENCE OPERATIONS RESEARCH SYMPOSIUM, GUS SCHAEFER AWARD

Steve Rowling

For Best Paper on maritime capability analysis on barrier patrols against an evasive adversary.


Samuel Sedgman (right) receiving his award.

Julia Piotto.

AIR WARFARE CENTRE COMMANDER'S AWARDS

Samuel Sedgman

For his outstanding contribution as an operational research specialist, providing invaluable support to 88 Squadron.

Julia Piotto

For her outstanding contribution to the establishment of the AWC's OA capability.

DST ACHIEVEMENT AWARDS 2017

OUTSTANDING CONTRIBUTION TO COLLABORATIVE PARTNERSHIPS

HPRNet team

LAND DIVISION

Nick Beagley, Dan Billing, Ross Coad, David Crone, Nick Fitzgerald, Mike Harris, Bevan McDonald, Mark Novakovic, Mark Patterson, Robert Peile, Tom Radtke, Corey Shillabeer.

In recognition of the HPRnet team's drive and creativity that has brought about the development and implementation of an innovative approach to partnering between DST and Australian universities. HPRnet effectively demonstrates the feasibility of attracting excellent teams from across Australia to jointly invest in a multi-year research program and to work together as a broader community focused on addressing the current and emerging challenges of military human performance.

OUTSTANDING CONTRIBUTION TO DEFENCE OUTCOMES

Distributed Mission Training Team

CROSS DIVISIONAL

Christopher Best, Christopher Francis, Dawei Jia, Benjamin Rice, Ronan McInerney, Simon Hosking, Joshua Chalmers, Julian Vince, Michael Skinner, Bradley Wolfgang, Christopher Shanahan, Brad MacPherson, Will Oliver, Blair Wyatt, Mike Spataro, James Fraser, Graeme Simpkin, John Yildiz, Simon Tartaggia, David Craven, Jessica Parker, John Fulton, Roy Thomson, Ian Kerton, Steve Kent, Maria Vukovic, Tim Fagan, Peter Ross, Adam Malcontenti-Wilson, Andrew Robbie.

In recognition of work done to transition key research in distributed mission training into a RAAF capability for use in Exercise Black Skies, the Coalition Virtual Flag exercise and the Joint Air Warfare Battle Laboratory, and in development of the Virtual Wedgetail.

SCIENCE AND ENGINEERING EXCELLENCE

Songsri Sirianunpiboon

CYBER AND ELECTRONIC WARFARE DIVISION

In recognition of significant advancements made in the field of theoretical signal processing with EW intercept applications, including the development of novel multi-channel, passive sensor techniques for detecting and characterising modern RF signals.

TECHNICAL EXCELLENCE

Julia Freeman

LAND DIVISION

In recognition of her dedication and determination to deliver and maintain the Environmental Test Facility and Vapour System Test for assessing the integration of chemical, biological, radiological and nuclear individual protective ensembles.

OUTSTANDING COMMUNICATION OF SCIENCE AND TECHNOLOGY

Olivia Samardzic

CYBER AND ELECTRONIC WARFARE DIVISION

In recognition of her outstanding and extensive contribution to the communication of S&T in various educational organisations. Olivia's work in communicating science has inspired a great number of people, mostly secondary school students, and her efforts to address gender inequity in science are noteworthy.

File photo.

Zoltan Bacskai

CYBER AND ELECTRONIC WARFARE DIVISION

In recognition of his high-level voluntary contributions to teaching and mentoring younger Australians through mathematics enrichment program activities, fostering a love of learning in STEM subject areas in all ages of students.

OUTSTANDING CORPORATE CONTRIBUTION

Peter Anderson with CDS (left) and Sir Angus Houston (right).

Peter Anderson

WEAPONS AND COMBAT SYSTEMS DIVISION

In recognition of his outstanding contribution to delivering positive and meaningful changes to DST as part of the T1 Fostering Innovation Strategic Initiative.

OUTSTANDING EARLY CAREER ACHIEVER

Bryan Clarke

MARITIME DIVISION

In recognition of the pivotal contribution he has made to collaborative autonomy research and development, in particular, the successful demonstration of interoperability and adaptive mission re-planning for submerged vehicles sourced from several international allies.

AUSTRALIA DAY MEDALLIONS


Regina Blyth, Cheryl Smith-Gander, Jimmy Hafesjee and Daniel Billing.

Vladimir Perejogin

In recognition of his outstanding contribution to the field of hyper-temporal imaging and in his leadership of the international trial, Soaring Sparkler, at Woomera in June 2016.

Daniel Billing

In recognition of the dedication, leadership and significant personal effort he has applied over the past thirteen years to develop physical employment standards for all the Defence services by establishing an innovative and world-leading methodology.

Jimmy Hafesjee

In recognition of his team leadership over an extensive career to deliver quality communications about DST's most successful projects, people and achievements.

Regina Blyth

In recognition of her personal contribution on a weekly basis as a DST volunteer for CSIRO's STEM Professionals in Schools Program.

Cheryl Smith-Gander

In recongition of her outstanding involvement in the strategic partnership between the Royal Australian Navy and the US Navy for the co-development of the tactical and weapon control system fitted to all submarines of both countries.

Costantino Melino

In recognition of his outstanding contribution to maritime electronic warfare over a distinguished 40-year career with DST, with his tireless efforts benefiting Navy through enhanced maritime platform survivability against the anti-ship missile threat.

TTCP AWARDS 2017

Electronic Warfare Systems Group, Geolocation Team

Dr Darren Bachmann, Mr Robert Baker, Mr Nikica Budimir, Mr Alistair Coles, Mr Daniel Dinow, Mrs Karen Donaldson, Mr Anthony Douglas, Dr Sam Drake, Mr Jean-Pierre Gibard, Dr Damian Hall, Dr Hatem Hmam, Mr Wayne Howie, Dr Keith Mason, Mr Peter McDougall, Mr Chris Pitcher, Mr Hayden Plunkett, Mr Michael Shanahan, Mr. Ralph Sienicki, Ms Elizabeth Smith, Mr Marcus Varcoe.

For their outstanding work on developing specialised geolocation algorithms for use on a variety of platforms, which have been successfully transitioned to support electronic warfare capabilities in a US Naval Air Systems Command program.

Maritime Technical Panel 3 Team

Dr Thong Nguyen, Dr Jeffrey Tweedale and Dr Kingsley Fletcher.

For their significant contribution toward improving decision-making and response planning in maritime integrated air and missile defence operations.

Maritime Technical Panel 13 Team

Dr David Battle, Mr Neil Tavener and Dr Weizhen Zhou.

For improving the performance and survivability of unmanned maritime systems through the development, testing and demonstration of autonomy for mine countermeasures.

Weapons Action Group 27, High Speed Weapons Team

Edward Dawson, Kelvin Halsey and Joanne Luscombe, Rodney Brown, Linda Mockridge, Vanessa Pickerd, Dale Quinn, Bill Woods.

In recognition of the significant efforts they applied through collaborations with partner nations to understand the design and performance of high-speed cruise missiles and their capabilities to meet future capability needs, and to evaluate the capability of current and potential threat systems.

Weapons Technical Panel Team 4

Mr Federico Lorenzin, Mr David Conser, Mr Carl Mouser, Mr Trevor Mills, Mr Chris Rider.

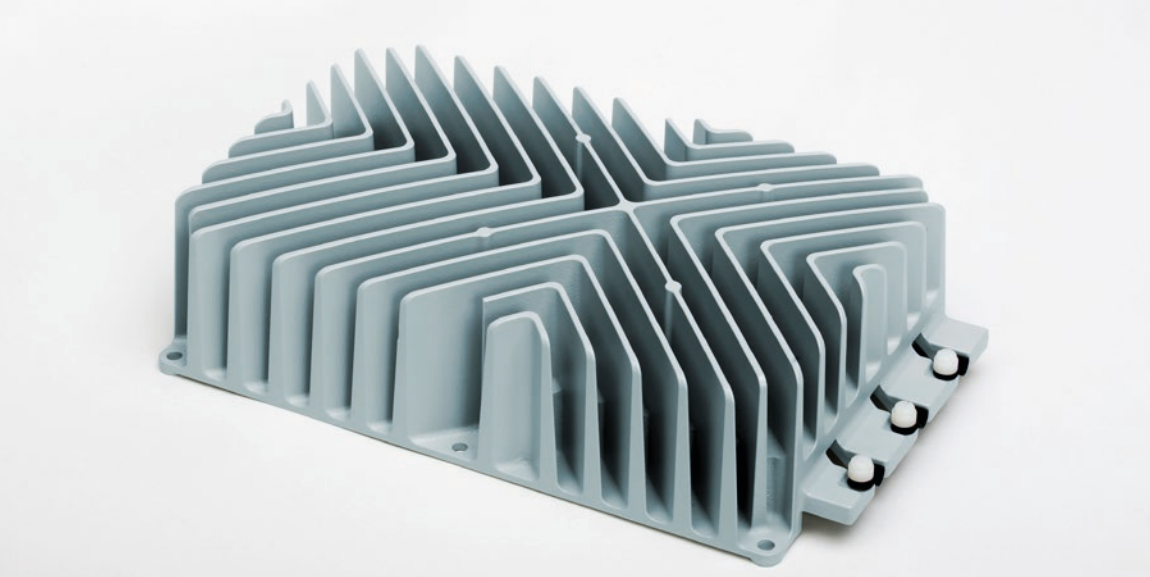
For investigations into vibratory loading in solid rocket motors, which involved assessing the effects of vibrations on missiles carried by aircraft by studying the mechanisms through which damage occurs.

Dr Olivia Samardzic

For her leadership in the area of electro-optical sensing and countermeasures.

INVESTING IN ORGANISATIONAL ENABLERS

DST invests in specialised services and innovative solutions that underpin its operational R&D capability.



An engineered part of the Silvershield system.

ENGINEERING AND MANUFACTURING CAPABILITIES

DST further developed its advanced manufacturing capabilities by acquiring new equipment for machining, turning and bending that will facilitate the delivery of technically complex and high-risk items in a timely manner. With new equipment now installed at DST's Edinburgh and Fishermans Bend sites, this will enable improvements to be made in manufacturing capability, productivity and work throughput in support of DST's S&T program.

Also augmenting these manufacturing capabilities, DST has maintained its collaborations with industry partners such as the Australian National Fabrication Facility and has updated its partnering agreement with QinetiQ Australia.

A major fabrication activity DST undertook during 2017–18 was its assistance to the Redwing team to transition the design of its counter-IED Silvershield device into production. It was supported in this project by industry partner L3 Micreo.

Another major venture undertaken was the design, manufacture and commissioning into service of a model of the JSF aircraft to be used in stores studies in DST's Transonic Wind Tunnel. This proved to be a complex design, engineering and manufacturing project that required novel design work, comprehensive engineering analysis and a tightly controlled manufacturing effort to produce the model to the specifications set.

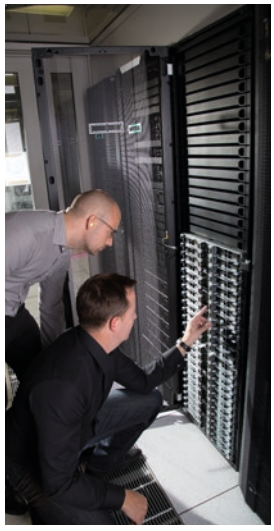
HIGH PERFORMANCE COMPUTING (HPC)

Over recent years, Defence and DST have invested heavily in, and enhanced, DST's research ICT infrastructure. Most notably, the 2016 Defence White Paper and Integrated Investment Program allocated $107 million for the acquisition of a centralised secure HPC capability that will significantly benefit many areas of Defence and national security work.

For DST, this capability constitutes a strategic enabler for S&T innovation, design development and the sustainment of national security capabilities. For ADF purposes, it will facilitate increases in mission insights, enhance force survivability, improve the likelihood of operational success and reduce risks in force design and acquisition. For national security agencies, it will vitally assist their work on various government-agreed research priorities as well as operational requests for support in areas such as cyber, biometrics, illicit behaviour pattern recognition and border security.

After the early release of capital funding in 2017–18, DST successfully tendered out and acquired a small-scale pilot high-performance computer, which was installed at DST Fishermans Bend. Delivered in May 2018, this has enabled DST researchers to gain experience in the use of a centralised secure HPC capability. In addition, the pilot equipment is being used to de-risk the acquisition of a larger scalable HPC capability by allowing DST to gain essential experience for delivering a robust, secure and reliable computational science service to DST researchers.

In September 2018, DST will seek Australian Government approval to acquire the scalable centralised large-scale secure HPC capability, which will then enable advanced R&D, modelling and experimentation to be conducted througout Defence. The new HPC capability will be housed in a purpose-built centre at DST Edinburgh with readiness for full operating capability by 2020.



SCIENTIFIC COMPUTING AND RESEARCH SOFTWARE DEVELOPMENT

During the year, DST also targeted internal research ICT investment to significantly transform its scientific computing and research software development environments. These developments have included the provision of an in-house cloud-like computing infrastructure as well as research software development platforms and tools on its research networks.

The new environments will significantly improve computing performance while reducing the time and effort required by DST researchers to establish their own individual environments for development, testing and establishing new projects. They allow for economies of scale in both resourcing and maintenance effort, and offer scalability, meaning that researchers can use as much or as little as they need during a research project life cycle.

The new science research computing environment will also feature Windows and Linux virtual desktops as well as self-service Windows and Linux server operating systems. The software development environment centrally hosts a suite of Atlassian products – Bitbucket, Confluence, Bamboo, FishEye, JIRA Software and Crucible – that will enable programming best practices to improve efficiency, maximise collaboration and the reuse and sharing of computer code.

Focused on the needs of researchers, these new environments will provide on-demand access to modern, agile and high-powered computing and research programming resources.

Video conferencing facilities in The Hub.

RESEARCH INFORMATION

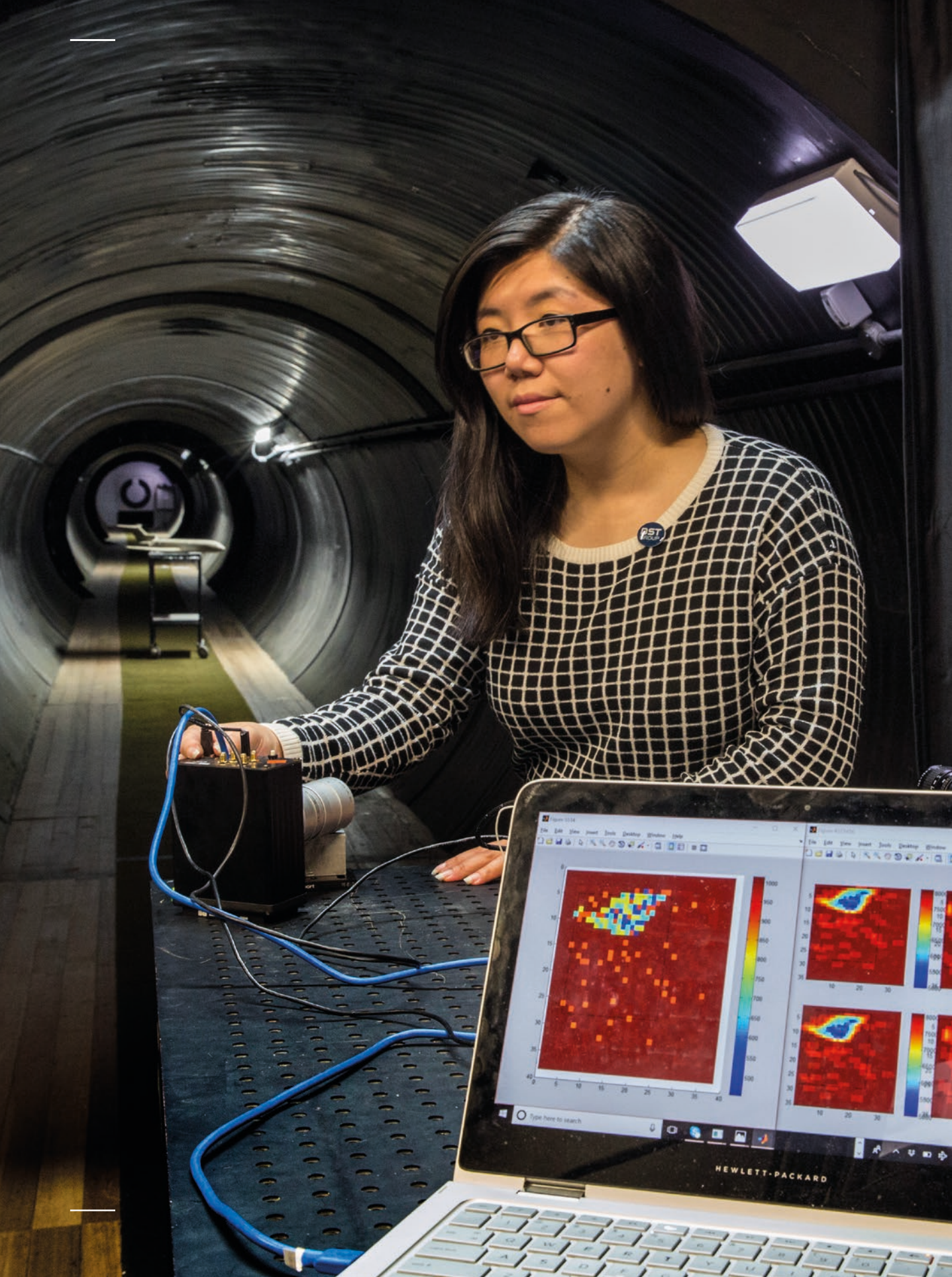
DST undertook a transformation of its Research Information Services (previously the DST Library) to expand the digital services on offer, providing better support to staff in their laboratories by combining a digital focus with in-person embedded professional and collaborative support.

The change facilitates closer partnering between librarians and divisional staff, delivering support and services directly into research environments to more immediately satisfy the dynamic, complex information and intelligence needs of research personnel.

The digital transformation has also enabled DST to rationalise and consolidate the print collections into a single storage unit, reducing space requirements as well as making room for DST's new collaboration Hubs. Designed to facilitate collaborative work activities, these are flexible multi-purpose areas that can be reconfigured as small spaces, large group spaces and quiet spaces, and they have ready access to 3D printing and visualisation technologies.

RESEARCH SAFETY

One of DST's corporate policies is to ensure zero harm occurs in its workplaces. As an organisation that is mindful of safety, DST hosted a forum in November 2017 called the Community of Practice, which was attended by a number of like-minded research organisations including CSIRO, ANSTO, ARPANSA, BOM, Monash University, National Measurements Institute, RMIT and Comcare. This forum looked into the key safety challenges facing research organisations, and provided opportunities for networking and information sharing.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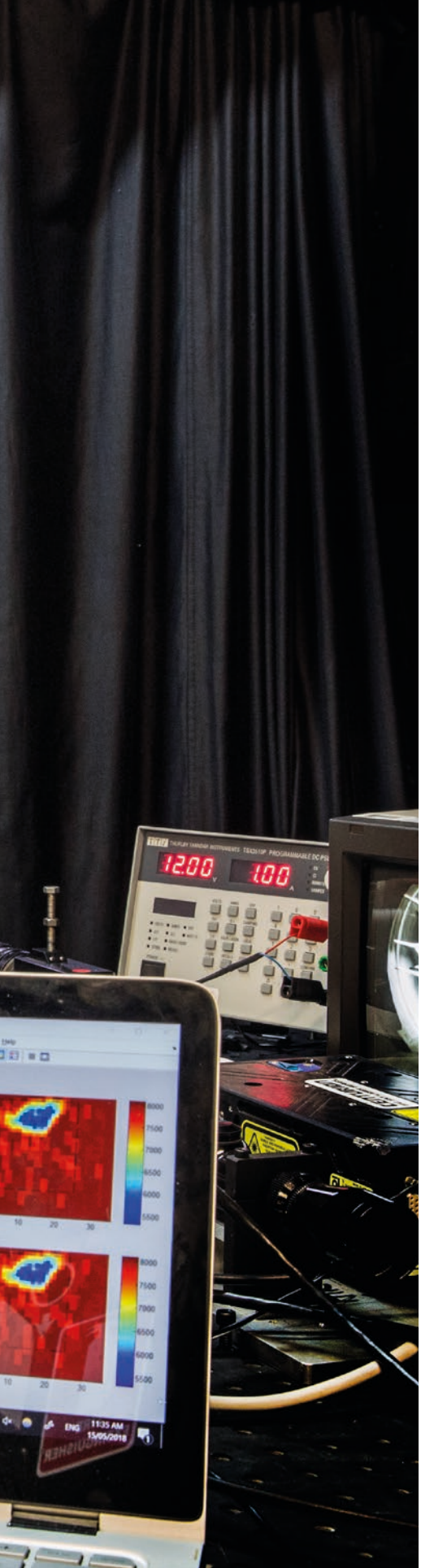


5

EMERGING FUTURES

SHAPE OF THINGS TO COME

EMERGING TECHNOLOGIES FOR TRANSFORMING DEFENCE CAPABILITIES

DST actively partners with industry, academia and allied defence research agencies on horizon-scanning and foresighting studies to identify future opportunities and potential game-changing technology areas that will impact Defence in the long term. These studies are intended to minimise disruption for Defence, as well as ensure Defence will have access to military disruptive technologies that provide strategic advantage.

Two S&T areas of note in this regard are those of materials development and manufacturing, and human biotechnologies. Both were explored in the series of Emerging and Disruptive Technologies Assessment Symposiums run by DST as part of the Next Generation Technologies Fund.

EDTAS panel members.

MATERIALS DEVELOPMENT AND MANUFACTURING

Advances in materials and manufacturing will have a profound effect on Defence and national security over the coming decades. The quest to produce structures that are lighter, stronger and more durable is driving the development of new metals and alloys.

Cheaper lower energy production and manufacturing techniques will enable the increased use of specialised materials such as titanium and carbon fibre. Other specialised materials such as amorphous metals and superalloys with special magnetic properties and high-temperature resistance will open up new product development opportunities. The advent of metals with specific degradation qualities and deformation characteristics will also enable novel developments in aerospace and biotechnology previously considered unfeasible.

Meanwhile, advances in manufacturing techniques, such as 3D printing, will be vital too for the development of new technologies while enabling greater manufacturing efficiencies with lower waste. The use of additive and hybrid manufacturing processes along with novel materials has the potential to deliver highly customised and intricate designs that could even incorporate embedded electronics and sensors.

The application of additive manufacturing technology will also have important ramifications for Defence capability acquisition. Defence and Australian industry may, for example, apply novel manufacturing techniques in collaborative ventures for the rapid design and manufacture of next-generation weapons, combat vehicles and other equipment. The ability to make small batches or just one-off products at low cost could revolutionise how Defence acquires assets, allowing iterative improvements from one purchase unit to the next.

HUMAN BIOTECHNOLOGIES

Disruptive S&T advances are seen as likely to emerge in two areas of the human biotechnology field; one being measurement capabilities for checking the health status of personnel before, during and after service, and the other being body modifications for improved health and bodily performance.

In the area of measurement capability development, one of the goals of HPRNet research being undertaken by DST, Army and their university partners is to identify 'combat genes' that will enable physical training programs for personnel to be optimised so that they can build up the strength and resilience they need for their roles without injury.

In the area of human modification, the use of drugs, therapies and prosthetics has already achieved significant improvements in medical treatment outcomes and human performance. Within the next 20 years, the application of genomics and bioinformatics, however, may deliver personally targeted approaches to treating illness with far greater effectiveness and fewer side-effects, and possibly also prophylactic therapies that ensure a person never even becomes unwell!

One new biotechnology involves threading single DNA strands through extremely tiny pores in a membrane called nanopores. With the possible therapeutic uses including cellular repair, nanotechnology applications like this may provide new ways of treating disease and effecting significant increases in human lifespans.

In metabolic and genetic engineering, the development of Clustered Regularly Interspaced Short Palindromic Repeats gene-editing technology, paired with insights gained from enhanced monitoring systems, will allow its use as a molecular 'scalpel', enabling medical interventions to be conducted at the molecular level within cells. The technology also looks likely to valuably assist gene therapy work by enabling the remediation of damaged stem cells extracted from a patient's blood or bone marrow, which, once corrected, can then be infused back into the patient to cure a genetic disease.

Within the next 20 years, neural enhancement, either through wearable or implanted technology may have game-changing impacts on human sensory capabilities and could also enhance the function of the brain itself. Coupled with advances in communication and processing power, the technology may facilitate higher levels of machine interactions with personnel remotely.

One form of this neural enhancement technology has been designed to help military personnel overcome memory deficits incurred as a result of service. It similarly may be applied in treating broader problems of confabulation or memory disturbance incurred as a result of cognitive degeneration or diseases such as dementia.

Given the rapid advances being made towards realising these technological possibilities and those in other fields, one certainty known now is that the capability tool set available to Defence will look very different in decades to come.

STRATEGIC WARGAMING FOR FUTURE FORCE DESIGN

DST has created wargaming tools for the exploration and assessment of options for the design of a modern defence force at the strategic level. The HEADSTART Matrix Game 2017 was developed in order to explore the effects of an attempted intervention in, and stabilisation of, a small nation in South East Asia in 2035. Its purpose was to assist the development of possible future force designs for the ADF by examining what effects the ADF may encounter or need to employ in 2035.

The wargame was run in two phases. The first phase involved a set of Plausible Futures Workshops to develop rich descriptions of a range of alternative futures and to construct scenarios for wargaming. In the second phase, matrix-style wargames explored possible future military effects to thereby inform the development of future operating concepts and force design.

MIRAGE SIGNATURE ASSESSMENT CAPABILITY

DST researchers have been working with Army, CASG and the Land Test and Evaluation Agency to develop improved signature evaluation methods and new signature control materials. As part of this work, DST developed a new approach to visible platform signature evaluation through the use of a software tool called Mirage that evaluates the detectability of platforms depicted in photos or CGI simulations.

The capability to generate and assess simulated images enables DST to deliver visible signature evaluations for vehicles in a range of operationally relevant environments without having to conduct exhaustive field trials. Mirage was used to produce an exploratory analysis assessment of the visible signatures of the two combat reconnaissance vehicles that were being considered for acquisition.

INTEGRATED REACTIVE TOURNIQUET

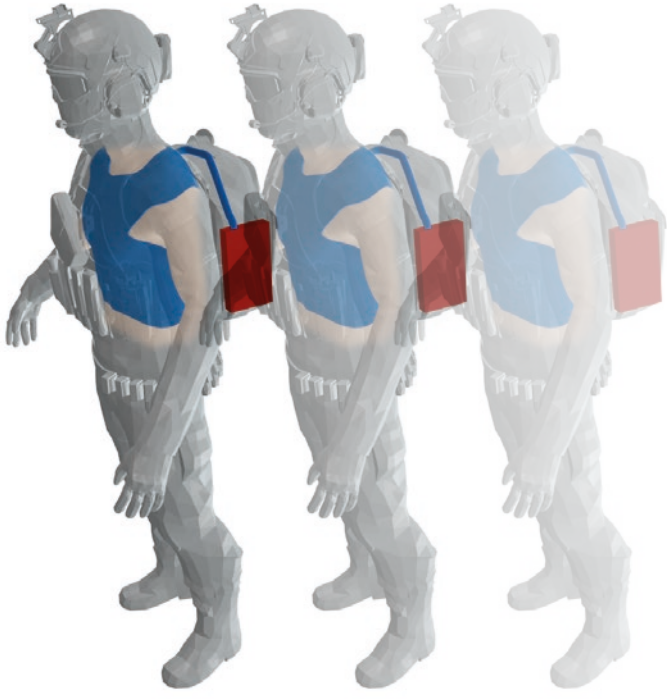
DST is developing a reactive tourniquet technology based on the use of shape-memory woollen fibres that are integrated into the fabric of combat uniforms. If a penetrative injury is sustained, the shape-memory fibres are activated and tighten, constricting the affected area within seconds. This technology offers significant advantages over existing tourniquet solutions.

PASSIVE COOLING SYSTEM FOR SOLDIERS

CSIRO and DST are collaborating to develop a metabolic cooling vest based on flexible heat pipe technology.

This technology has a self-perpetuating cyclical mode of operation, in which heat is absorbed at a hot surface by a liquid that evaporates, and the vapour created then flows through a closed pipe system to a cold surface where it condenses, giving off the heat energy. Heat pipe technology, thus, can transfer heat without the need of an external power input.

The passive cooling system developed to date has achieved 400 watts of cooling power, which is comparable to, if not better than, the cooling capablities of commercially available systems that require power, and moreover, are bulky, heavy and restrictive. The first version of this novel system is expected to be ready for trials in June 2019.



EXOSKELETON DEVELOPMENT

The quest to develop a wearable exoskeleton to enhance soldiers' strength and stamina began more than a hundred years ago. Among the many approaches that have emerged, these have usually involved rigid supports attached to the wearer's legs, often powered by an external motive force. The innovative Operational Exoskeleton (OX) developed by DST and its partners, is instead a passive exoskeleton design based on the use of Bowden cables, which facilitate the transfer of force via a steel wire cable moving inside a flexible steel casing.

Funded by an Australian Army Minor's program and in collaboration with industry and Victoria University, DST has produced three OX prototypes for studies to determine how such an exoskeleton might benefit a dismounted soldier carrying backpack loads of up to 35 kilograms. OX is simple in design and construction compared to typical load-carriage exoskeletons. Consequently, it is inexpensive to produce and relatively light, weighing less than five kilograms, and since its cable lengths are adjustable, OX can also be readily transferred from one wearer to another.

OX has undergone a process of iterative development through testing undertaken with the support of Army personnel from the 7th Royal Artillery Regiment and the School of Artillery. Testing to date has confirmed that the use of OX does offset the strain of load carriage. Further development efforts will focus on accommodating a broader range of body shapes and sizes.

The work done so far has already attracted significant interest from Australia's TTCP allies.


TANK B
WORK IN PROGRES

6

APPENDICIES

APPENDIX A: PUBLIC RELEASE SCIENCE AND TECHNOLOGY REPORTS

Title	Author/s	Report No.
The Operationalisation of Agent Transparency and Evidence for Its Impact on Key Human-Autonomy Teaming Variables	Adella Bhaskara	DST-Group-TR-3413
Bubble Cloud Generation by an Airgun: Laboratory experiments and modelling	Alexei Kouzoubov and Shane Wood	DST-Group-TR-3379
Pressure Signatures Of Underwater Moving Objects: MATLAB Graphical User Interface Guide	Alice von Trojan	DST-Group-TN-1612
Anthropometric Manikins for the Design and Evaluation of Soldier Equipment	Alistair Furnell	DST-Group-TN-1716
Flow Visualisation Around a Hemispherical Protuberance in the DST Group Water Tunnel	André Franck Bauer, Jesse McCarthy and Matteo Giacobello	DST-Group-TR-3482
Refinement of Out of Circularity and Thickness measurements of a Cylinder for Finite Element Analysis	BP Phelps	DST-Group-TN-1521
Development of a Fast Lumped Parameter Interior Ballistic Model for the Investigation of Novel Grain Geometry Performance	Bryce Dolman	DST-Group-TN-1655
Twitter Users as Information Spreaders: A Comprehensive Literature Review	Caitlin McCurrie and Lucia Falzon	DST-Group-TR-3401
Evaluation of a Distributed Fibre Optic Strain Sensing System for Full-Scale Fatigue Testing	Claire Davis, Meg Knowles and Geoff Swanton	DST-Group-TR-3452
Methods of Designing and Feeding Carbon Fibre Reinforced Plastic Slotted Waveguide Antenna Arrays	D Gray, K J Nicholson, PJ Callus and Kamran Ghorbani	DST-Group-TR-3424
Benchmarking the AMC Cavitation Tunnel for Hydrodynamic Measurements on Submarine Models with CFD Determined Blockage Corrections	Daniel Butler, David B Clarke, Chris L Ellis, Paul Brandner, Mohammed Kandoussi	DST-Group-TR-3358
Hydrodynamic Measurements on the Joubert Hull in the AMC Cavitation Tunnel	David B Clarke, Daniel Butler, Chris L Ellis, Paul A Brandner	DST-Group-TR-3359
High Range Resolution Backscatter Sounder Ionograms	David J Netherway, Michael J Whitington and Robert S Gardiner-Garden	DST-Group-TR-3477
Gauge: A Software Framework for User Interface Evaluation	Derek Weber and Aaron Ceglar	DST-Group-TN-1667
An Investigation into the Possibility of Numerical Ephemeris Extension for GPS	Don Koks	DST-Group-RR-0443
A Guide to the DST Airglow Database	Anne Unewisse and Mr Andrew Cool	DST-Group-GD-0978
Radar Detection of Helicopters at low SNR using Time-Frequency Transforms	Duong Duc Nguyen, Si Tran Nguyen Nguyen, Rocco Melino, Sandun Kodituwakku and Hai-Tan Tran	DST-Group-TR-3481
The Janus C++ Library – An Interface Class for DAVE-ML Compliant XML-Based Flight Model Datasets	Geoff Brian and Shane Hill	DST-Group-TN-1658
Exploring Automation of Dull Administration in Logistics and Fleet Management: A Pilot Study on Prototyping and Proof-of-Concept Development	Guy Edward Gallasch, Nicholas Brealey and Leong Yen	DST-Group-GD-0974
Preliminary Extinguishment and Burnback Resistance Assessment of Fluorinated Firefighting Foams and a Non-Fluorinated Foam	Ian Burch and Grant Gamble	DST-Group-TR-3387

Title	Author/s	Report No.
What is Non-Traditional Sensing?	Jayson Priest, Timothy Priest and Angela Consoli	DST-Group-TR-3400
A History of Java's Progress to a Field Programmable Gate Array	Jeffrey W Tweedale	DST-Group-TN-1723
Calibration of the DST Group Research Wind Tunnel Pressure Rings	Jesse McCarthy	DST-Group-TN-1728
Technology Impact of Autonomous and Automated Systems on Land Force Logistics – A Qualitative Assessment of Systems in Distribution and Material Handling Task	Ksenia Ivanova, Stephen Baker, and Guy Edward Gallasch	DST-Group-TN-1651
An Evidential Network Approach Applied to Threat Evaluation in Above Water Warfare	Lloyd Hammond	DST-Group-TR-3449
C-27J FEM Version 3.0 Enhancement and Verification	Michael Opie and Damion Hadcroft	DST-Group-TN-1686
C-27J NASTRAN Global Finite Element Model User Manual C-27J_GFEM_DSTG-v3.0	Michael Opie, Damion Hadcroft	DST-Group-TN-1700
Current Position of Equipped Anthropometric Data Research for the Australian Warfighter and Future Areas of Work – December 2016	Ms Sheena Davis	DST-Group-GD-0987
Convex Relaxation Methods: A Review and Application to Sparse Radar Imaging of Rotating Targets	Ngoc Hung Nguyen, Kutluyıl Do˘gan¸cay, Paul Berry, and Hai-Tan Tran	DST-Group-RR-0444
New paths from sensor to shooter: How 'digitization' can change the formability and topology of information flows in systems that acquire and prosecute targets	Patrick Chisan Hew	DST-Group-TR-3417
Asymptotic distribution of rewards accumulated by alternating renewal processes	Patrick Chisan Hew	DST-Group-TN-1631
An intermittent sensor versus a target that emits glimpses as a homogenous poisson process	Patrick Chisan Hew	DST-Group-TN-1765
Covert Channels Over Network Traffic: Methods, Metrics and Mitigations	Patrick Prendergast	DST-Group-TN-1695
Potential Performance Criteria for Combat Ration Packs – Colour	Paul Capela and Jeanine De Diana	DST-Group-TN-1693
Australian Defence Force Anthropometry: A Summary of Historic Surveys	Peter Blanchonette	DST-Group-GD-0968
Cornercube Retroreflectors for Satellite Laser Ranging: Characterisation Analysis	Philip CL Stephenson	DST-Group-TR-3392
An Azimuth Elevation Survey of DST Group Edinburgh 71 Labs platform	Rob Earl and Ant Perry	DST-Group-TN-1690
A Parametric Model of the Ionospheric Electron Density Profile for JORN	Robert Gardiner-Garden, Andrew Heitmann & Brett Northey	DST-Group-TN-1722
Automatic Helicopter Blade Flash Signal Separation Using Sparse Signal Optimisation	Si Tran Nguyen Nguyen, Rocco Melino, Hai-Tan Tran and Sandun Kodituwakku	DST-Group-RR-0442
An Initial Program Integration and Interoperability Assessment Methodology	Stephen Cook and Mark Unewisse	DST-Group-TR-3399
A Review of Machine Learning in Software Vulnerability Research	Tamas Abraham and Olivier de Vel	DST-Group-GD-0979
Adversarial Machine Learning for Cyber-Security NGTF Project Scoping Study	Tamas Abraham, Olivier de Vel, and Paul Montague	DST-Group-GD-0988
Quality Evaluation of Dried Soup Mix Packaging	Tracey McLaughin	DST-Group-TN-1696
Field Evaluation of In-Service and Prototype MA CRP	Tracey McLaughlin, Jeanine De Diana, Sean Bulmer and Angus Pike	DST-Group-TR-3453
F-111C Lower Wing Skin Bonded Composite Repair Post Service Proof Load Testing	AB Harman and AN Rider	DST-Group-TR-3310
Study of Dynamic Momentum Transfer to a Target Loaded by a Buried Charge	AD Resnyansky, SA Weckert, and M Rausch	DST-Group-TR-3448

APPENDIX B: PAPERS DELIVERED OR PUBLISHED EXTERNALLY JULY 2017–JUNE 2018

Title	Author/s	Publication
Foundations of trusted autonomy: An introduction	Abbass H. A., Scholz J. and Reid D. J. (2018)	Springer International Publishing.
Effects of Lumbar Spine Assemblies and Body-Borne Equipment Mass on Anthropomorphic Test Device Responses During Drop Tests	Aggromito D., Jaffrey M., Chhor A., Chen B. and Yan W. (2017)	Journal Of Biomechanical Engineering 139 (10).
Optimising the multiplicative AF model parameters for AA7075 cyclic plasticity and fatigue simulation	Agius D., Kajtaz M., Kourousis K. I., Wallbrink C. and Hu W. (2018)	Aircraft Engineering & Aerospace Technology 90 (2): pp. 251–260.
On the utilisation of nonlinear plasticity models in military aircraft fatigue estimation: A preliminary comparison	Agius D., Kajtaz M., Kourousis K. I., Wallbrink C., Hu W. and Wang C. H. (2017)	Aerospace Science and Technology 71: pp. 25–29.
Cyclic plasticity and microstructure of as-built SLM Ti-6Al-4V: The effect of build orientation	Agius D., Kourousis K. I., Song T. and Wallbrink C. (2017)	Materials Science and Engineering A 701: pp. 85–100.
Cyclic Elastoplastic Performance of Aluminum 7075-T6 Under Strain- and Stress-Controlled Loading	Agius D., Kourousis K. I. and Wallbrink C. (2017)	Journal of Materials Engineering and Performance 26 (12): pp. 5769–5780.
A review of the as-built SLM Ti-6Al-4V mechanical properties towards achieving fatigue resistant designs	Agius D., Kourousis K. I. and Wallbrink C. (2018)	Metals 8 (1).
Addendum to Cyclic plasticity and microstructure of as-built SLM Ti-6Al-4V: The effect of build orientation [Mater. Sci. Eng. A 701 (2017) 85–100]	Agius D., Kourousis K. I., Wallbrink C. and Song T. (2018).	Materials Science & Engineering: A 712: pp. 394–396.
Performance Analysis of High Throughput Satellite Systems with Optical Feeder Links	Ahmad I., Nguyen K. D. and Letzepis N. (2018)	Institute of Electrical and Electronics Engineers Inc.
On the Hopping Loss in MIMO Decode-and-Forward Cooperative Relaying	Ahmad I., Nguyen K. D., Letzepis N. and Pollok A. (2018)	IEEE Transactions on Communications 66 (1): pp. 54–63.
The Cognitive Fitness Framework: A Roadmap for Systematic, Evidence-based Mental Skills Training and Performance Enhancement	Aidman E. V. (2017)	Journal of Science and Medicine in Sport 20S (2017), p. S50.
Team diversity enhances performance under extreme conditions: Why are mixed-gender teams a winning combination?	Aidman E. V. (2017)	Journal of Science and Medicine in Sport 20S (2017), pp. S72–S74.

Title	Author/s	Publication
Synchronized drowsiness monitoring and simulated driving performance data under 50-hr sleep deprivation: a double-blind placebo-controlled caffeine intervention	Aidman E., Johnson K., Hoggan B., Fidock J., Paech G. M., Della Vedova C., Pajcin M., Grant C., Kamimori G., Mitchelson E. and Banks S. (2018)	Data in Brief 19, pp. 1335–1340.
Caffeine protects cognitive performance under sleep deprivation beyond promoting alertness	Aidman E., Balin M., Jackson S., Johnson K., Paech G. M., Pajcin M., Grant C., Kamimori G., Fidock J., Della Vedova C. and Banks S. (2018)	Paper accepted at 2018 Frontiers of Neuroscience Conference: Augmentation of Brain Function.
Collective performance enhancement frontiers Part 2: The role of team diversity and interactional competence	Aidman E. and Sengelman J. (2017, November)	Keynote presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Caffeine reduces the impact of drowsiness on driving errors	Aidman E., Johnson K., Mitchelson E., Fidock J., Paech G. M., Grant C., Banks S., Vedova C. D., Pajcin M., Kamimori G. and Hoggan B. L. (2018)	Transportation Research Part F: Traffic Psychology and Behaviour 54: pp. 236–247.
Simultaneous tracking of cardiorespiratory signals for multiple persons using a machine vision system with noise artifact removal	Al-Naji A. and Chahl J. (2017)	IEEE Journal of Translational Engineering in Health and Medicine 5.
Detection of Cardiopulmonary Activity and Related Abnormal Events Using Microsoft Kinect Sensor	Al-Naji A. and Chahl J. (2018)	Sensors (Basel, Switzerland) 18 (3).
Detection of cardiopulmonary activity and related abnormal events using microsoft kinect sensor	Al-Naji A. and Chahl J. (2018)	Sensors (Basel, Switzerland) 18 (3).
Remote Optical Cardiopulmonary Signal Extraction with Noise Artifact Removal, Multiple Subject Detection Long-Distance	Al-Naji A. and Chahl J. (2018)	IEEE Access 6: pp. 11573–11595.
Remote sensing of physiological signs using a machine vision system	Al-Naji A., Gibson K. and Chahl J. (2017)	Journal Of Medical Engineering & Technology 41 (5): pp. 396–405.
An efficient motion magnification system for real-time applications	Al-Naji A., Lee S. H. and Chahl J. (2018)	Machine Vision and Applications 29 (4): pp. 585–600.
Monitoring of Cardiorespiratory Signal: Principles of Remote Measurements and Review of Methods	Al-Naji A., Lee S. H., Chahl J. and Gibson K. (2017)	IEEE Access 5: pp. 15776–15790.
Remote monitoring of cardiorespiratory signals from a hovering unmanned aerial vehicle	Al-Naji A., Perera A. G. and Chahl J. (2017)	Biomedical Engineering Online 16 (1): pp. 101–101.
Complex socio-organisational phenomena and ill-defined problem spaces: A multi-method approach to the rescue	Ali I., Zuparic M., MacLeod I., La P. and Yue Y. (2017)	Journal of the Operational Research Society 68 (8): pp. 919–934.
Rapid System Vulnerability Assessment Using Fault Trees with System Location Attribution	Aksu S. (2017)	Pacific International Maritime Conference 3–5 October 2017, Sydney, Australia.
Non-myopic sensor scheduling for multistatic sonobuoy fields	Angley D., Ristic B., Suvorova S., Moran B., Fletcher F., Gaetjens H. and Simakov S. (2017)	IET Radar, Sonar & Navigation 11 (12): pp. 1770–1775.

Title	Author/s	Publication
A Novel Batch Bayesian WIV Estimator for Three-Dimensional TMA Using Bearing and Elevation Measurements	Badriasl L., Arulampalam S. and Finn A. (2018)	IEEE Transactions on Signal Processing 66 (4): pp. 1023–1036.
Caffeine reduces the degrading impact of drowsiness on cognitive performance: a randomised placebo-controlled study	Balin M., Jackson S., Johnson K., Paech G. M., Pajcin M., Grant C., Kamimori G., Lavalle C., Banks S. and Aidman E. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Measured fatigue crack growth increments versus predictions for small cracks in 7XXX aluminium alloys	Barter S., Burchill M. and Jones M. (2017)	International Journal of Fatigue 105: pp. 144–159.
Corporate portfolio management in the public sector	Baskarada S. and Hanlon B. (2018)	Journal of Management Development 37 (4): pp. 333–340.
Strategic management of multi-business portfolios in the public sector	Baškarada S. and Hanlon B. (2017)	Journal of Advances in Management Research 14 (4): p. 466.
Investigation of a conformal amplifier embedded in an aerospace composite structure	Baum T. C., Ghorbani K., Ziolkowski R. W. and Nicholson K. J. (2017)	Institute of Electrical and Electronics Engineers Inc.
Void Probabilities and Cauchy/Schwarz Divergence for Generalized Labeled Multi-Bernoulli Models	Beard M., Vo B.-T., Vo B.-N. and Arulampalam S. (2017)	IEEE Transactions on Signal Processing 65 (19): pp. 5047–5061.
The Structure of Chariklo's Rings from Stellar Occultations	Bérard D., Sicardy B., Desmars J., Meza E., Leiva R., Kervella P., Lecacheux J., Camargo J. I. B., Braga-Ribas F., Benedetti-Rossi G., Vieira-Martins R., Ortiz J. L., Duffard R., Morales N., Santos-Sanz P., Rizos J. L., Colas F., Maquet L., Vachier F., Gomez-Júnior A. R., Assafin M., Dauvergne J. L., Renner S., Monard B., Sickafoose A. A., Breytenbach H., Genade A., Beisker W., Bath K. L., Bode H. J., Witt C. D., Schoenau P., Prager R., Backes M., Ivanov V. D., Brillant S., Selman F., Herrera C., Jehin E., Gillon M., Manfroid J., Pollock J., Tancredi G., Roland S., Salvo R., Vanzi L., Herald D., Gault D., Kerr S., Pavlov H., Barry M. A., Broughton J., Loader B., Pennell A., Bradshaw J., Dunham D., Newman J., Horvat R., Giles D., Davis L., Paton R. A., Hwill K. M., Cole A., Cool A., Lade B., Maybour D., Jaquiery P. D., Dumas C., Carraro G., Monaco L., Maury A., Peyrot A., Teng-Chuen-Yu J. P., Richichi A., Irawati P., Colazo C., Melia R., Spagnotto J., Blain A., Alonso S., Román A. and Maestre J. L. (2017)	Astronomical Journal 154 (4).
Understanding anthropometric characteristics associated with performance in manual lifting tasks	Beck B., Middleton K. J., Billing D. C., Caldwell J. N. and Carstairs G. L. (2017)	Journal of Strength and Conditioning Research.
First Detection of Two Near-Earth Asteroids With a Southern Hemisphere Planetary Radar System	Benson C., Boyce R., Reynolds J., Edwards P. G., Philips C. J., Stevens J. B., Stacy N. J. S., Benner L. A. M., Giorgini J. D., Jao J. S., Martinez G., Slade M. A., Teitelbaum L. P., Anabtawi A., Kahan D., Oudrhiri K., Lazio T. J. W., Baines G. and Kruzins E. (2017)	Radio Science 52 (11): pp. 1344–1351.

Title	Author/s	Publication
The development and analyses of several Gram-negative arsenic biosensors using a synthetic biology approach	Bereza-Malcolm L., Aracic S., Franks A. E. and Mann G. (2018)	Sensors and Actuators, B: Chemical 256: pp. 117–125.
Functional characterization of Gram-negative bacteria from different genera as multiplex cadmium biosensors	Bereza-Malcolm L., Aracic S., Kannan R., Franks A. E. and Mann G. (2017)	Biosensors and Bioelectronics 94: pp. 380–387.
International Congress on Soldiers' Physical Performance 2017: Research priorities across the service members operational lifecycle	Billing D. C. and Drain J. R. (2017)	Journal of Science and Medicine in Sport 20: pp. S1–S3.
Non-coherent radar detection probability in compound sea clutter with correlated speckle	Bocquet S., Zuk J. and Rosenberg L. (2018)	2018 IEEE Radar Conference (RadarConf18), Place of Publication: Piscataway, NJ, USA; Oklahoma City, OK, USA. Country of Publication: USA., IEEE.
Physical Mechanisms for Near-Field Blast Mitigation with Fluid Containers	Bornstein H., Ryan S. and Mouritz A.P. (2017)	In: Explosive Blast Response of Composites, eds. A.P. Mouritz and Y.D.S. Rajapakse, Elsevier, Woodhead Publishing/Elsevier, pp. 345–374.
Blast mitigation with fluid Containers: Effect of mitigant type	Bornstein H., Ryan S. and A Mouritz. P. (2018)	International Journal of Impact Engineering 113: pp. 106–117.
Experimental Study for Transmitter Imperfections in DVB-T Based Passive Radar	Bournaka G., Ummenhofer M., Cristallini D., Palmer J. and Summers A. (2018)	IEEE Transactions on Aerospace & Electronic Systems 54 (3): pp. 1341–1354.
Numerical Investigation of Vortex Ring Ground Plane Interactions	Bourne K., Wahono S. and Ooi A. (2017)	Journal of Fluids Engineering, Transactions of the ASME 139 (7).
Competitive influence maximization and enhancement of synchronization in populations of non-identical Kuramoto oscillators	Brede M., Stella M. and Kalloniatis A. C. (2018)	Scientific Reports 8 (1): pp. 702–702.
Integrated Survivability Analysis of Naval Platforms in High Threat Environments	Brett J., Gamble G., Reid R., Smith S., Woolley A. and Yiannakopoulos G. (2017)	Pacific International Maritime Conference 3–5 October 2017. Sydney, Australia.
A Study of Bubble Collapse Pressure Pulse Waves from Small Scale Explosions near the Water Surface	Brett J. M. and Krelle A. (2017)	Journal of Sound and Vibration, 2017 (submitted).
Properties of rehydrated freeze-dried rice as a function of processing treatments	Bui L. T. T., Coad R. A. and Stanley R. A. (2018)	LWT – Food Science & Technology 91: pp. 143–150.
Microstructurally small fatigue crack growth rates in aluminium alloys for developing improved predictive models	Burchill M., Barter S., Chan L. H. and Jones M. (2018)	EDP Sciences.
Exploring the cognitive performance of dismounted combatants using augmented night vision systems	Cahill L., Price T. and Dummin R. (2018).	Paper presented at 9th International Conference on Applied Human Factors and Ergonomics, Orlando, FL.
Detection of salient targets in 360° images is better with VR head-mounted displays than flat screen displays	Camilleri D., Whitney S. J., Fidock J. J. T. and Cahill L. (2017)	Proceedings of the Australasian Simulation Congress 2017 held in Sydney, Australia: Simulation Australasia.

Title	Author/s	Publication
Delivering Healthy Food Choice: A Dual-Process Model Enquiry	Carins J. E., Rundle-Thiele S. R. and Parkinson J. E. (2017)	Social Marketing Quarterly 23 (3): pp. 266–283.
A method for developing organisation-wide manual handling based physical employment standards in a military context	Carstairs G. L., Ham D. J., Savage R. J., Best S. A., Beck B. and Billing D. C. (2018)	Journal Of Science And Medicine In Sport.
Corrosion Inhibition of HY80 With La(4OHCin)3 & Imidazolinium-4OHC	Catubig R. A., Somers A. E., Neil W. C., McAdam G., Forsyth M. and Yunis R.	Corrosion and Prevention 2017.
Climatological model of over-the-horizon radar (CMOR)	Cervera M. A., Francis D. B. and Frazer G. J. (2017)	Institute of Electrical and Electronics Engineers Inc.
Freejet testing of the HIFiRE 7 scramjet flowpath at Mach 7.5	Chan W. Y. K., Razzaqi S. A., Turner J. C., Suraweera M. V. and Smar M. K. (2018)	Journal of Propulsion and Power 34 (4): pp. 844–853.
Enhanced detection and classification of mine-like objects using situational awareness and deep learning	Chapple P., Dell T. and Bongiorno D.	Underwater Acoustics Conference & Exhibition (UACE2017), 2017.
Optimizing the Balance Between Task Automation and Human Manual Control in Simulated Submarine Track Management	Chen S. I., Visser T. A. W., Loft S. and Huf S. (2017)	Journal of Experimental Psychology: Applied 23 (3): pp. 240–262.
Physics of Explosive loading of Structures	Cimpoeru S., Ritzel D. and Brett J. (2017)	In: A Review of Integrated Survivability Assessment for Naval Vessels (U), Editors Adrian Mouritz and Yapa D.S. Rajapakse, Elsevier 2017 ISBN.
Blast Physics and Vehicle Response	Cimpoeru S. J., Phillips P. and Ritzel D.V. (2017)	In: Military Injury Biomechanics: The Cause and Prevention of Impact Injuries, eds. M. F. Franklyn and P. V. S. Lee, CRC Press/Taylor & Francis Group, pp. 19–34.
Blast Physics and Loading of Structures in the Near-Field	Cimpoeru S.J. and Ritzel D. V. (2017)	Keynote Lecture, 6th International Conference on Design and Analysis of Protective Structures, eds. Guoxing Lu, Jian Zhao and Xiao-Ling Zhao, Melbourne, Australia, 30 Nov–1 Dec 2017.
Physics of Explosive Loading of Structures	Cimpoeru S. J., Ritzel D.V. and Brett J.M. (2017)	In: Explosive Blast Response of Composites, eds. A.P. Mouritz and Y.D.S. Rajapakse, Woodhead Publishing/Elsevier, pp. 1–22.
Enhancing tactical information assessment using an agent-based cognitive architecture	Consoli A. (2018)	Springer Science and Business Media Deutschland GmbH.
A SoS Approach for Engineering Capability Programs	Cook S. C. and Unewisse M. H. (2017)	INCOSE International Symposium 27 (1): pp. 15–29.
The development of retrogression and re-aging to manage environmental degradation in Australian defence force aircraft	Crawford B. R., Shekhter A. and Loader C. (2018)	Materials Performance and Characterization 7 (1): pp. 139–159.
Armour Steels	Crouch I. G., Cimpoeru S. J., Li H. and Shanmugam D. (2017)	In: The Science of Armour Materials, ed. I. G. Crouch, Woodhead Publishing/Elsevier, pp. 55–115.

Title	Author/s	Publication
How Statistical Signal Processing Was Used to Define the MH370 Search Zone	Davey S., Gordon N., Holland I., Rutten M. and Williams J. (2017)	IEEE Potentials 36 (6): pp. 32–37.
Whipping Analysis of a Submerged Free-Free Cylinder	De Candia S., Flockhart C. and Cannon S. M. (2017)	9th Australasian Congress on Applied Mechanics (ACAM9), 27–29 November 2017.
The Whipping Response of a Submerged Free-Free Cylinder Due to Underwater Explosions	De Candia S., Ojeda R., Reid W. D., Ratcliffe M. and Binns J. (2017)	International Maritime Conference – Pacific 2017, Sydney, October 2017.
Window RF Shielding Film Using Printed FSS	Dewani, A. A., O'Keefe S. G., Thiel D. V. and Galehdar A. (2018)	IEEE Transactions on Antennas and Propagation 66 (2): pp. 790–796.
Effect of Stand-off on the Blast Mitigation Using Water-Filled Containers	Di Placido S., Bornstein H., Ryan S., Orifici A. and Mouritz A. (2017)	6th International Conference on Design and Analysis of Protective Structures, eds. Guoxing Lu, Jian Zhao and Xiao-Ling Zhao, Melbourne, Australia, 30 Nov–1 Dec 2017.
The Pandolf equation under-predicts the metabolic rate of contemporary military load carriage	Drain J. R., Aisbett B., Lewis M. and Billing D. C. (2017)	Journal of Science and Medicine in Sport 20 (Suppl 4): pp. S104–S108.
Hormonal response patterns are differentially influenced by physical conditioning programs during basic military training	Drain J. R., Groeller H., Burley S. D. and Nindl B. C. (2017)	Journal of Science and Medicine in Sport 20: pp. S98–S103.
Determining the behavioural dose-response relationship of marine mammals to airgun noise and source proximity	Dunlop R. A., Noad M. J., Cato D. H., McCauley R. D., Scott-Hayward L., Kniest E., Slade R. and Paton D. (2017)	Journal of Experimental Biology 220 (16): pp. 2878–2886.
The behavioural response of migrating humpback whales to a full seismic airgun array	Dunlop R. A., Noad M. J., McCauley R. D., Kniest E., Slade R., Paton D. and Cato D. H. (2017)	Proceedings of the Royal Society B: Biological Sciences 284 (1869).
Acoustic emission characteristics of a single cylinder diesel generator at various loads and with a failing injector	Dykas B. and J. Harris (2017)	Mechanical Systems and Signal Processing 93: pp. 397–414.
An Artificial Neural Network Based Constitutive Model for Predicting the Response of a High-Strength Steel	Edgerton M. and Ryan S. (2017)	International Symposium on Ballistics, Long Beach, California, 9–13 September 2017.
Light Alloys	Edwards D. P. and Crouch I. G. (2017)	In: The Science of Armour Materials, ed. I. G. Crouch, Woodhead Publishing/Elsevier, pp. 117–166.
Adiabatic Shear bands in 2024-T351 Aluminium	Edwards N. J., Cimpoeru S. J., Ruan D. and Lu G. (2017)	6th International Conference on Design and Analysis of Protective Structures, eds. Guoxing Lu, Jian Zhao and Xiao-Ling Zhao, Melbourne, Australia, 30 Nov–1 Dec 2017.
Mechanical and microstructural properties of 2024-T351 aluminium using a hat-shaped specimen at high strain rates	Edwards N. J., Ruan D., Lu G., Song W., Cimpoeru S. J. and Herzig N. (2018)	Materials Science and Engineering A 720: pp. 203–213.
Representation and analysis of twitter activity: A dynamic network perspective	Falzon L., Dunn J. and McCurrie C. (2017)	Association for Computing Machinery Inc.

Title	Author/s	Publication
A reconfigurable wideband streaming channeliser for RF sensing applications: A multiple GPU-based implementation	Faulkner S., Elton S. D., Lamahewa T. A. and Roberts D. (2018)	Institute of Electrical and Electronics Engineers Inc.
Linearly-growing reductions of Karp's 21 NP-complete problems	Filar J. A., Haythorpe M. and Taylor R. (2018)	Numerical Algebra, Control and Optimization 8 (1): pp. 1–16.
The effect of motor task precision on pupil diameter	Fletcher K., Neal A. and Yeo G. (2017)	Applied Ergonomics 65: pp. 309–315.
General Dynamics of Single Frequency Solid-State Lasers in the Saturated Regime	Foster S. (2018)	IEEE Journal of Quantum Electronics 54 (2).
Distributed feedback fiber laser strain sensor technology	Foster S. B., Cranch G. A., Harrison J., Tikhomirov A. E. and Miller G. A. (2017)	Journal of Lightwave Technology 35 (16): pp. 3514–3530.
Performance prediction for design of a network of skywave over-the-horizon radars	Francis D. B., Cervera M. A. and Frazer G. J. (2017)	IEEE Aerospace and Electronic Systems Magazine 32 (12): pp. 18–28.
Radar sensitivity budget analysis for a network of skywave over-the-horizon radars	Francis D. B., Cervera M. A. and Frazeri G. J. (2017)	Institute of Electrical and Electronics Engineers Inc.
Simulating the effect of degraded wireless communications on emergent behavior	Fraser B., Hunjet R. and Szabo C. (2018)	Institute of Electrical and Electronics Engineers Inc.
Magnet-responsive, superhydrophobic fabrics from waterborne, fluoride-free coatings	Fu S., Zhou H., Wang H., Zhao Y., Niu H., Lin T., Ding J., Liu S. and Rutledge G. C. (2018)	RSC Advances 8 (2): pp. 717–723.
Histogram-PMHT for fluctuating target models	Gaetjens H. X., Davey S. J., Arulampalam S., Fletcher F. K. and Lim C. C. (2017)	IET Radar, Sonar and Navigation 11 (8): pp. 1292–1301.
Magnetorheological technology for fabricating tunable solid electrolyte with enhanced conductivity and mechanical property	Gangrou P., Yu G., Jie D., Caiyun W., Wallace G. G. and Weihua L. (2018)	Smart Materials and Structures 27 (3): p. 035022.
High power cryogenic Ho:YAG laser	Ganija M., Veitch P., Munch J., Hemming A., Simakov N., Boyd K. and Haub J. (2017)	Optics Express 25 (25): pp. 31889–31894.
End of injection process in a single-hole diesel injector	Ghiji M., Goldsworthy L., Brandner P. A., Garaniya V. and Hield P. (2018)	Atomization and Sprays 28 (1): pp. 23–45.
Numerical simulation and reduced-order aerodynamic modeling of a lambda wing configuration	Ghoreyshi M., Lofthouse A. J., Jirásek A., Cummings R. M. and Young M. E. (2018)	Journal of Aircraft 55 (2): pp. 549–570.
A review of recent developments in the understanding of transonic shock buffet	Giannelis N. F., Vio G. A. and Levinski O. (2017)	Progress in Aerospace Sciences 92: pp. 39–84.
The Effect Of Caffeine On Glucose Metabolism, Self-reported Hunger And Mood State During Extended Wakefulness	Grant C. L., Coates A. M., Dorrian J., Paech G. M., Pajcin M., Della Vedova C., Johnson K., Kamimori G. H., Fidock J., Aidman E. and Banks S. (2018)	Sleep 41 (suppl. 1) pp. A84–A85.
The impact of caffeine consumption during 50 hr of extended wakefulness on glucose metabolism, self-reported hunger and mood state	Grant C. L., Coates A. M., Dorrian J., Paech G. M., Pajcin M., Della Vedova C., Johnson K., Kamimori G. H., Fidock J., Aidman E. and Banks S. (2018)	Journal of Sleep Research.

Title	Author/s	Publication
Numerical Sensitivity Study of Ballistic Impact on UHMWPE Composite	Grunwald C., Lassig T., van der Werff H., Heisserer U., Nguyen L. and Riedel W. (2017)	6th International Conference on Design and Analysis of Protective Structures, eds. Guoxing Lu, Jian Zhao and Xiao-Ling Zhao, Melbourne, Australia, 30 Nov–1 Dec 2017.
Identification of very small open reading frames in the genomes of Holmes Jungle virus, Ord River virus, and Wongabel virus of the genus Hapavirus, family Rhabdoviridae	Gubala A., McAllister J., Mitchell I., Gauci P., Skvortsov A., Walsh S., Weir R., Davis S., Melville L., Bulach D. and Boyle D. (2017)	Evolutionary Bioinformatics 13.
Many encephalitis cases still a medical mystery	Gubala A. and Warrilow D. (2018)	Australian And New Zealand Journal Of Public Health 42 (1): pp. 106–107.
Can cyberloafing and internet addiction affect organizational information security?	Hadlington L. and Parsons K. (2017)	Cyberpsychology, Behavior, and Social Networking 20 (9): pp. 567–571.
A novel hybrid population balance-Brownian dynamics method for simulating the dynamics of polymer-bridged colloidal latex particle suspensions	Hajizadeh E., Yu S., Wang S. and Larson R. G. (2018)	Journal of Rheology 62 (1): pp. 235–247.
Optimum sparse array beamforming for general rank signal models	Hamza S. A., Amin M. G. and Fabrizio G.	2018 IEEE Radar Conference (RadarConf18), Place of Publication: Piscataway, NJ, USA; Oklahoma City, OK, USA. Country of Publication: USA, IEEE.
Separation of O/X Polarization Modes on Oblique Ionospheric Soundings	Harris T. J., Cervera M. A., Pederick L. H. and Quinn A. D. (2017)	Radio Science 52 (12): pp. 1522–1533.
A Robust Automatic Ionospheric O/X Mode Separation Technique for Vertical Incidence Sounders	Harris T. J. and Pederick L. H. (2017)	Radio Science 52 (12): pp. 1534–1543.
Observations and modeling of traveling ionospheric disturbance signatures from an Australian network of oblique angle-of-arrival sounders	Heitmann A. J., Cervera M. A., Holdsworth D. A., Ward B. D., Gardiner-Garden R. S., Mackinnon A. D. and Reid I. M. (2017)	Institute of Electrical and Electronics Engineers Inc.
Structural strength and laminate optimization of self-twisting composite hydrofoils using a Genetic Algorithm	Herath M. T., Prusty B. G., Phillips A. W. and St. John N. (2017)	Composite Structures 176: pp. 359–378.
Modeling of ductile failure in high strength steel	Herzig N., Abdel-Malek S., Meyer L.W. and Cimpoeru S. J. (2017)	DYMAT 23rd Technical Meeting, Trondheim, Norway, 12–14 Sept. 2017, Proceedia Engineering, Vol. 197, 2017, pp. 285–293.
Making Virtual Sense: Display Type and Narrative Medium Influence Sensemaking in Virtual Environments. Intersections in Simulation and Gaming	Hibbard S. J., Whitney S. J., Carter L., Fidock J. J. T., Temby P., Thiele L., Naweed A., Wardaszko M., Leigh E. and Meijer S.	21st Annual Simulation Technology and Training Conference, SimTecT 2016 and 47th International Simulation and Gaming Association Conference, ISAGA, held as part of the First Australasian Simulation Congress, ASC 201 Melbourne, Victoria, Australia. Place of Publication: Cham, Switzerland; Country of Publication: Switzerland. Springer International Publishing.
How effective are psychological resilience training interventions? A synthesis of the evidence	Hoggan B. (2018, November)	Abstract accepted for presentation at 2018 Human Factors and Ergonomics Society of Australia (HFESA) Conference. 26–28 November, Perth, WA.

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Enhancing Collective Training in the Australian Army: Insights from the Team Training Literature	Hoggan B. and Temby P. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
MH370 burst frequency offset analysis and implications on descent rate at end of flight	Holland I. D. (2018)	IEEE Aerospace and Electronic Systems Magazine 33 (2): pp. 24–33.
The deceleration of a spherical projectile passing through porcine organs at laboratory temperature (16 °C) and core body temperature (37 °C)	Humphrey C., Henneberg M., J. Kumaratilake and Wachsberger C. (2018)	Journal of Forensic and Legal Medicine 53: pp. 46–50.
Effects of Re-heating Tissue Samples to Core Body Temperature on High-Velocity Ballistic Projectile-tissue Interactions	Humphrey C., Henneberg M., Kumaratilake J., Wachsberger C. and Maiden N. (2017)	Journal of Forensic Sciences 62 (6): pp. 1466–1471.
The maximum evaporative potential of constant wear immersion suits influences the risk of excessive heat strain for helicopter aircrew	Hunt A. P. (2018)	PLoS ONE 13 (5).
Thermoluminescence emission from quartz at 480 nm as a high-dose radiation marker	Hunter P. G., Spooner N. A. and Smith B. W. (2018)	Radiation Measurements.
Ultrasonic detection and sizing of compressed cracks in glass- and carbon-fibre reinforced plastic composites	Ibrahim M. E., Smith R. A. and Wang C. H. (2017)	NDT & E International 92: pp. 111–121.
Nondestructive inspection of fatigue crack propagation beneath supersonic particle deposition coatings during fatigue testing	Ibrahim M. E. and Zhuang W. Z. L. (2017)	International Journal of Fatigue 102: pp. 149–157.
Addressing Future Challenges for Defence Acquisition: A Methodological Perspective on Military Contextualisation of Emerging Technologies	Ivanova K. and Elsawah S. (2018)	SETE 2018, 29 Apr–02 May 2018, Sydney, Australia (Conference Proceedings).
Navigator attributes impact driver performance and adaptability in a simulated driving task	Jackson S. A., Kleitman S. and Aidman E. V. (2017, June)	Paper presented at the 2017 Singapore Conference of Applied Psychology.
Intellectual spring cleaning: it's time for a military Do Not Read list; and some sources that should be on that list	Jackson A. P., Zweibelson B. and Simonds W. (2018)	Defence Studies 18 (2): pp. 131–146.
Acute short-term sleep deprivation does not affect metacognitive monitoring captured by confidence ratings: a systematic literature review	Jackson S. A., Martin G. D., Aidman E. and Kleitman S. (2018)	Metacognition and Learning 13 (1): pp. 39–56.
Effect of sulphate-reducing bacteria on the microbiologically influenced corrosion of ten different metals using constant test conditions	Javed M. A., Neil W. C., McAdam G. and Wade S. A. (2017)	International Biodeterioration and Biodegradation 125: pp. 73–85.
Studies Of The Microbiologically Influenced Corrosion Of Stainless Steel Alloys By Sulphate Reducing Bacteria	Javed M. A., Neil W. C., McAdam G. and Wade S.A.	Corrosion and Prevention 2017.

Title	Author/s	Publication
Microbiologically Influenced Corrosion of Copper and its Alloys – A Review	Javed M., Neil W., McAdam G. and Wade S.	Corrosion and Materials, 42 (4), pp. 89–93, 2017.
An imaging flow cytometry method to assess ricin trafficking in A549 human lung epithelial cells	Jenner D., Chong D., Walker N. and Green A. C. (2018)	Methods (San Diego, Calif.) 134–135: pp. 41–49.
A Study of the Effects on Transmission Loss of Modelled Water Column Variations within an Area off the East Australian Coast	Jones A., Zinoviev A. and Greening M. (2017)	Acoustics Australia 45 (2): pp. 343–351.
Enhancement of Battlespace Information Management Systems for Coalition Networks using C2 Agility Design Concepts	Judd G. and Chan, K (2018)	Proceedings of the 22nd International Command and Control Research and Technology Symposium. Los Angeles, California: CCRP, Nov 2017.
Eigenstructure assignment for the position regulation of a fully-actuated marine craft	Kazantzidou C., Perez T. and Valentinis F. (2017)	IFAC–PapersOnLine 50 (1): pp. 12398–12403.
Resilient Cognition and Military Decision Making	Keegan R. J., Martin K., Rattray B., Robinson S., Pyne D. and Aidman E. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Down selection of climatic data for infrared signature modelling	Kermonde I. L., Drost F. and Borg R. A. J. (2018)	SPIE.
Using Shakespeare's Sotto Voce to Determine True Identity From Text	Kernot D., Bossomaier T. and Bradbury R. (2018)	Frontiers In Psychology 9: pp. 289–289.
Residual opening of hydraulic fractures created using the channel fracturing technique	Khanna A., Luong H., Kotousov A., Nguyen G. D. and Rose L. R. F. (2017)	International Journal of Rock Mechanics and Mining Sciences 100: pp. 124–137.
Six-DOF simulations of an underwater vehicle undergoing straight line and steady turning manoeuvres	Kim H., Ranmuthugala D., Leong Z. Q. and Chin C. (2018)	Ocean Engineering 150: pp. 102–112.
Research Update: Hybrid energy devices combining nanogenerators and energy storage systems for self-charging capability	Kim J., Lee J. H., Lee J., Yamauchi Y., Kim J. H. and Choi C. H. (2017)	APL Materials 5 (7).
HIFiRE-1 and -5 Flight and Ground Tests	Kimmel R. L., Adamczak D., Borg M. P., Jewell J. S., Juliano T. J., Stanfield S. and Berger K.	2018 AIAA Aerospace Sciences Meeting. Place of Publication: Reston, VA, USA; Kissimmee, FL, USA. Country of Publication: USA. American Institute of Aeronautics and Astronautics.
Dynamic Scenario-based Cognitive Assessment: Preliminary Findings and Implications	Kleitman S., Blanchard M., Jackson S., Rizvandi N., Nalivaiko E. and Aidman E. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Comparison of Corrosion in Different Paint Defects, Material and Orientation Following Prohesion Salt Fog Testing	Knight S., Sudholz A., Jacob S. and Waldie J.	Corrosion and Prevention 2017.
Tri-orthogonal polarization diversity reception for non-geosynchronous satellite orbit ionospheric channels	Lawrence N. P., Hansen H. J. and Abbott D. (2018)	International Journal of Satellite Communications and Networking 36 (1): pp. 44–65.

Title	Author/s	Publication
The application of subjective job task analysis techniques in physically demanding occupations: Evidence for the presence of self-serving bias	Lee-Bates B., Billing D. C., Caputi P., Carstairs G. L., Linnane D. and Middleton K. (2017)	Ergonomics 60 (9): pp. 1240–1249.
The application of subjective job task analysis techniques in physically demanding occupations: evidence for the presence of self-serving bias	Lee-Bates B., Caputi P., Middleton K., Billing D. C., Carstairs G. L. and Linnane D. (2017)	Ergonomics 60 (9): pp. 1240–1249.
Size and Shape of Chariklo from Multi-epoch Stellar Occultations	Leiva R., Sicardy B., Desmars J., Bérard D., Meza E., Kervella P., Camargo J. I. B., Benedetti-Rossi G., Vieira-Martins R., Braga-Ribas F., Morgado B. E., Ortiz J. L., Duffard R., Morales N., Lellouch E., Snodgrass C., Gomes-Junior A. R., Assafin M., Colas F., Maquet L., De Witt C., Schoenau P., Bath K. L., Bode H. J., Sickafoose A. A., Breytenbach H., Dauvergne J. L., Cool A., Lade B., Kerr S. and Herald D. (2017)	Astronomical Journal 154 (4).
Longitudinal development of flow-separation lines on slender bodies in translation	Lee S. K. (2018)	Journal of Fluid Mechanics 837: pp. 627–639.
Integrating a hip belt with body armour reduces the magnitude and changes the location of shoulder pressure and perceived discomfort in soldiers	Lenton G. K., Doyle T. L. A., Saxby D. J., Billing D., Higgs J. and Lloyd D. G. (2018)	Ergonomics 61 (4): pp. 566–575.
Primarily hip-borne load carriage does not alter biomechanical risk factors for overuse injuries in soldiers	Lenton G. K., Saxby D. J., Lloyd D. G., Higgs J., Doyle T. L. A. and Billing D. (2018)	Journal of Science and Medicine in Sport.
A fractional fourier domain approach for multiple target localization using the time-of-arrival	Leong P. H., Lamahewa T. A. and Abhayapala T. D. (2018)	Institute of Electrical and Electronics Engineers Inc.
A finite block length achievability bound for low probability of detection communication	Letzepis N. (2018)	arXiv.
Spatial-based topic modelling using Wikidata knowledge base	Lim K. H., Karunasekera S., Harwood A. and Falzon L. (2018)	Institute of Electrical and Electronics Engineers Inc.
A novel simulation environment for cognitive human factors engineering research	Lim Y., Gardi A., Ramasamy S., Kistan T., Sabatini R., Vince J. and Pongracic H. (2017)	Institute of Electrical and Electronics Engineers Inc.
Detecting and Preventing Cyber Insider Threats: A Survey	Liu L., De Vel O., Qing-Long H., Jun Z. and Yang X.	IEEE Communications Surveys & Tutorials 20 (2): pp. 1397–1417.
A data-driven attack against support vectors of SVM	Liu S., Zhang J., Xiang Y., Zhou W., Wangt Y. and De Vel O. (2018)	Association for Computing Machinery, Inc.
A Service-based Approach to Force Design, Integration and Analysis	Lowe D. (2017)	INCOSE International Symposium 27 (1): pp. 1506–1519.
Passive detection of BPSK radar signals with unknown parameters using multi-sensor arrays	Ly P. Q. C., Sirianunpiboon S. and Elton S. D. (2018)	Institute of Electrical and Electronics Engineers Inc.

Title	Author/s	Publication
Some fractographic contributions to understanding fatigue crack growth	Lynch S. (2017)	International Journal of Fatigue 104: pp. 12–26.
Cognitive Implications of HMIs for Tele-operation and Supervisory Control of Robotic Ground Vehicles	Ma-Wyatt A., Johnstone D., Fidock J. and Hill S. (2018)	IEEE Computer Society.
Identification of slam events experienced by a high-speed craft	Magoga T., Aksus S., Cannon S., Ojeda R. and Thomas G. (2017)	Ocean Engineering 140: pp. 309–321.
Three-Dimensional Tracking of an Aircraft Using Two-Dimensional Radars	Mallick M., Arulampalam S., Yan Y. and Ru J. (2018)	IEEE Transactions on Aerospace and Electronic Systems 54 (2): pp. 585–600.
Long-range modulating retroreflector communications	Manning S., Mudge K., Grant K., Clare B., Arnold J. P., Biggs C. and Cowley W. G. (2018)	Institute of Electrical and Electronics Engineers Inc.
Inference in the wild: A framework for human situation assessment and a case study of air combat	McAnally K., Davey C., White D., Stimson M., Mascaro S. and Korb K. (2018)	Cognitive Science.
Metacognitive monitoring and control in visual change detection: Implications for situation awareness and cognitive control	McAnally K. I., Best C. and Morris A. P. (2017)	PLoS ONE 12 (9).
Developing an Underwater Sound Recorder: The Long and Short (Time) of It	McCauley R. D., Thomas F., Parsons M. J. G., Erbe C., Cato D. H., Duncan A. J., Gavrilov A. N., Parnum I. M. and Salgado-Kent C. P. (2017)	Acoustics Australia 45 (2): pp. 301–311.
Experimental response of high strength steels to localised blast loading	McDonald B., Bornstein H., Langdon G. S., Curry R., Daliri A. and Orifici A. C. (2018)	International Journal of Impact Engineering 115: pp. 106–119.
Deformation and Rupture of Armour Grade Steel Under Localised Blast Loading	McDonald B., Bornstein H., Langdon G., Curry R. and Orifici A. (2017)	DYMAT 23rd Technical Meeting, Trondheim, Norway, 12–14 Sept. 2017, Proceedia Engineering, Vol. 197, 2017, pp. 13–22.
Quantification of Mechanisms for Blast Mitigation with Water-Filled Containers	Bornstein H., Ryan S. and Mouritz A. P. (2017)	30th International Symposium on Ballistics, Long Beach, California, 9–13 September 2017.
Effects of a brief training intervention on Situation Awareness in a Simulated Military Task	McNaughton A., Whitney S. J., Temby P. and Sarris A. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Message Passing Algorithms for Scalable Multitarget Tracking	Meyer F., Win M. Z., Kropfreiter T., Hlawatsch F., Williams J. L., Lau R. and Braca P. (2018)	Proceedings of the IEEE 106 (2): pp. 121–259.
Implication of changing loading conditions on structural health monitoring utilising guided waves	Mohabuth M., Kotousov A., Ng C. T. and Rose L. R. F. (2018)	Smart Materials and Structures 27 (2).
Verification of an airframe fatigue life monitoring system using ex-service structure	Molent L. and Mau V. (2018)	Engineering Failure Analysis 83: pp. 207–219.
Using the lead crack concept and fractal geometry for fatigue lifing of metallic structural components	Molent L., Spagnoli A., Carpinteri A. and Jones R. (2017)	International Journal of Fatigue 102: pp. 214–220.

Title	Author/s	Publication
A methodology to support early stage off-the-shelf naval vessel acquisitions	Morris B. A., Cannon S. M. and Cook S. C. (2018)	Transactions of the Royal Institution of Naval Architects Part A: International Journal of Maritime Engineering 160: pp. 21–39.
A Model-Based Method for Design Option Evaluation of Off-the-Shelf Naval Platforms	Morris B. A. and Cook S. C. (2017)	INCOSE International Symposium 27 (1): pp. 688–703.
Epidemic forecasts as a tool for public health: interpretation and (re)calibration	Moss R., Fielding J. E., Franklin L. J., Stephens N., McVernon J., Dawson P. and McCaw J. M. (2018)	Australian And New Zealand Journal of Public Health 42 (1): pp. 69–76.
A UAS Testbed for the Flight Demonstration of Structural Health Monitoring Systems	Moss S. D., Davis C. E., van der Velden S., Jung G., Smithard J., Rosalie C., Norman P., Knowles M. L., Galea S. C., Dang P. and Rajic N. (2017)	Procedia Engineering 188: p. 456.
Consensus paper on testing and evaluation of military exoskeletons for the dismounted combatant	Mudie K. L., Begg R. K., Boynton A. C., Crowell H. P., LaFiandra M. E., Karakolis T., O'Donovan M. P., Kanagaki G. B. and Billing D. C. (2018)	Journal of Science and Medicine in Sport.
Corrosion Onset Detection Sensor	Muscat R. F. and Wilson A. R. (2017)	IEEE Sensors Journal 17 (24): pp. 8424–8430.
A skeleton-free kinect system for body mass index assessment using deep neural networks	Nahavandi D., Abobakr A., Haggag H., Hossny M., Nahavandi S. and Filippidis D. (2017)	Institute of Electrical and Electronics Engineers Inc.
Human-Automation Interaction in Self-Organizing Sociotechnical Systems	Naikar N. (2018)	Journal of Cognitive Engineering and Decision Making 12 (1): pp. 62–66.
Biomarker predictors of cognitive fitness: Comparing acoustic startle paradigm with dynamic simulation-embedded assessment	Nalivaiko E., Kleitman S., Walker R., Jackson S., Blanchard M., MacDougall H., Zalewska K. and Aidman E. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Habituation of acoustic startle: A new biomarker of psychological resilience	Nalivaiko E., Walker R. and Aidman E. (2017)	Journal of Science and Medicine in Sport 20S (2017), pp. S50–S52.
Radio Gaga? Intra-team communication of Australian Rules Football umpires – effect of radio communication on content, structure and frequency	Neville T. J., Salmon P. M. and Read G. J. M. (2018)	Ergonomics 61 (2): pp. 313–328.
Ultralow-Profile and Flush-Mounted Monopolar Antennas Integrated Into a Metallic Cavity	Nghia N.-T., Pinapati S. P., Hall D., Piotrowski A. and Fumeaux C. (2018)	IEEE Antennas and Wireless Propagation Letters 17: pp. 86–89.
A dual-band dual-pattern frequency-reconfigurable antenna	Nguyen-Trong N., Fumeaux C. and Hall L. (2017)	Microwave and Optical Technology Letters 59 (11): pp. 2710–2715.
Pattern synthesis of stub-loaded half-mode substrate-integrated leaky-wave antenna	Nguyen-Trong N., Fumeaux C. and Hall L. T. (2017)	Institute of Electrical and Electronics Engineers Inc.
A Frequency-Reconfigurable Dual-Band Low-Profile Monopolar Antenna	Nguyen-Trong N., Fumeaux C. and Piotrowski A. (2017)	IEEE Transactions on Antennas and Propagation 65 (7): pp. 3336–3343.
An image focusing method for sparsity-driven radar imaging of rotating targets	Nguyen N. H., Doğançay K., Tran H. T. and Berry P. (2018)	Sensors (Switzerland) 18 (6).

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Wavelet-Based Sparse Representation for Helicopter Main Rotor Blade Radar Backscatter Signal Separation	Nguyen S. T. N., Kodituwakku S., Melino R. and Tran H.-T. (2017)	IEEE Transactions on Aerospace & Electronic Systems 53 (6): pp. 2936–2949.
Aircrew manpower supply modeling under change: An agent-based discrete event simulation approach	Nguyen V., Novak A., Shokr M. and Pash K. (2018)	Institute of Electrical and Electronics Engineers Inc.
Case study of quality function deployment method in defence missions	Nicholds B., Bil C., Marzocca P., Mo J., Stimson M. and Holmes D. (2018)	American Institute of Aeronautics and Astronautics Inc.
Perspectives on resilience for military readiness and preparedness: Report of an international military physiology roundtable	Nindl B. C., Beckner M. E., Billing D. C., Drain J. R., Greeves J., Groeller H., Taylor N. A. S., Teien H. K., Marcora S., Moffitt A., Reilly T., Young A. J. and Friedl K. E. (2018)	Journal of Science and Medicine in Sport.
Coherent beam combination of four holmium amplifiers with phase control via a direct digital synthesizer chip	Oermann M. R., Carmody N., Hemming A., Rees S., Simakov N., Boyd K., Davidson A., Corena L., Stepanov D., Haub J. and Swain R. (2018)	Optics Express 26 (6): pp. 6715–6723.
Lamb wave-based detection of a controlled disbond in a lap joint	Ong W. H., Chiu W. K., Rajic N. and Rosalie C. (2018)	Structural Health Monitoring 17 (3): pp. 668–683.
Super-multiplexed fluorescence microscopy via photostability contrast	Orth A., Ghosh R. N., Wilson E. R., Doughney T., Brown H., Reineck P., Thompson J. G. and Gibson B. C. (2018)	Biomedical Optics Express 9 (7): pp. 2943–2954.
Effects of strategic early-morning caffeine gum administration on association between salivary alpha-amylase and neurobehavioural performance during 50 h of sleep deprivation	Pajcin M., White J. M., Banks S., Dorrian J., Paech G. M., Grant C. L., Johnson K., Tooley K., Aidman E., Fidock J., Kamimori G. H. and Della Vedova C. B. (2018)	Accident; Analysis And Prevention.
Receiver platform motion compensation in passive radar	Palmer J., Ummenhofer M., Summers A., Bournaka G., Palumbo S. and Cristallini D. (2017)	IET Radar, Sonar & Navigation 11 (6): pp. 922–931.
Approaching the wicked problem of obesity: an introduction to the food system compass	Parkinson J., Dubelaar C., Carins J., Holden S., Newton F. and Pescud M. (2017)	Journal of Social Marketing, 7 (4), pp. 387–404.
Enhancing Soldier Cognitive Performance Using Immersive Simulation and Perceptual-Cognitive Training Technologies	Patton D. and Temby P. (2017, October)	Paper presented at 55th Army Operations Research Symposium, 24–26 October 2017. Aberdeen Proving Ground, Maryland.
Interpreting observations of large-scale traveling ionospheric disturbances by ionospheric sounders	Pederick L. H., Cervera M. A. and Harris T. J. (2017)	Journal of Geophysical Research: Space Physics 122 (12): pp. 12556–12569.
Human motion analysis from UAV video	Perera A. G., Law Y. W., Al-Naji A. and Chahl J. (2018)	International Journal of Intelligent Unmanned Systems 6 (2): pp. 69–92.
Integration of a wideband low-profile monopolar antenna onto curved metallic surfaces	Pinapati S. P., Nguyen-Trong N., Fumeaux C. and A Piotrowski. (2017)	Institute of Electrical and Electronics Engineers Inc.
Polarimetric Calibration of Circularly Polarized Synthetic Aperture Radar Data	Pincus P., Preiss M., Goh A. S. and Gray D. (2017)	IEEE Transactions on Geoscience and Remote Sensing 55 (12): pp. 6824–6839.

Title	Author/s	Publication
Non-Periodic Translation Symmetry Detection Using Global Self Similarity	Pontecorvo C. and Redding N. J. (2017)	Institute of Electrical and Electronics Engineers Inc.
Towards a scalable ultrasensitive optomechanical magnetometer	Prakash V., Li B., Forstner S., Bowen W., Bulla D., Forster S. and Rubinsztein-Dunlop H. (2017)	Institute of Electrical and Electronics Engineers Inc.
Using the SoSE Principles Framework	Pratt J. M. and Cook S. C. (2017)	INCOSE International Symposium 27 (1): pp. 1–14.
An investigation of noise performance in optical lock-in thermography	Rajic N. and Antolis C. (2017)	Infrared Physics and Technology 87: pp. 1–10.
Suitability of a radical based method for assessment of jet fuel antioxidant capacity and projected storage stability	Rawson P. M., Stansfield C. -A., Creek J., Webster R. L. and Evans D. J. (2017)	Fuel 199: pp. 497–503.
Deriving Constitutive Model Parameters From Anvil-on-Rod Experiments Using Artificial Neural Networks	Ryan S., Edgerton M., McDonald B., Thaler S. and Nguyen L. (2017)	International Symposium on Ballistics, Long Beach, California, 9–13 September 2017.
An autonomy interrogative	Reid D. J. (2018)	Springer International Publishing.
Book Chapter Experimental Techniques and Testing of Lightweight Naval Structures against Primary Weapons Effects	Reid W., Mathys Z., Pickerd V., Mc Carthy P., Elischer P. and Gellert Evan. (2017)	Book: Explosion Blast Response of Composites, Editors Adrian Mouritz and Yapa D. S. Rajapakse, Elsevier 2017 ISBN.
Meso-Scale Modelling of the Heat Conductivity Effect on the Shock Response of a Porous Material	Resnyansky A. D. (2018)	AIP Conference Proceedings 1979 (1): pp. 110017-1–110017-6.
Porous Materials under Shock Loading as a Two-Phase Mixture: The Effect of the Interstitial Air	Resnyansky A. D. (2018)	Journal of Fluids Engineering, Transactions of the ASME 140 (5).
The Taylor Cylinder Response of PC and PMMA	Resnyansky A. D., Bourne N. K. and Brown E. N. (2018)	AIP Conference Proceedings 1979 (1): pp. 070026-1–070026-6.
Gas Gun Ballistic Testing of Moving Pre-stressed Targets	Resnyansky A. D., Parry S. L. and Weckert S. A. (2018)	AIP Conference Proceedings 1979 (1): pp. 120005-1–120005-5.
Gaussian mixture multitarget-multisensor Bernoulli tracker for multistatic sonobuoy fields	Ristic B., Angley D., Suvorova S., Moran B., Fletcher F., Gaetjens H. and Simakov S. (2017)	IET Radar, Sonar & Navigation 11 (12): pp. 1790–1797.
Autonomous exploration and mapping with RFS occupancy-grid SLAM	Ristic B. and Palmer J. L. (2018)	Entropy 20 (6).
Synchronisation under shocks: the Lévy Kuramoto model	Roberts D. and Kalloniatis A. C. (2018)	Physica D: Nonlinear Phenomena 368: pp. 10–21.
Using reciprocity to derive the far field displacements due to buried sources and scatterers	Rose L. R. F., Chiu W. K., Nadarajah N. and Vien B. S. (2017)	The Journal Of The Acoustical Society Of America 142 (5): pp. 2979–2979.

Title	Author/s	Publication
Sparse signal separation methods for target detection in sea-clutter	Rosenberg L. and Ng B.	2018 IEEE Radar Conference (RadarConf18), Place of Publication: Piscataway, NJ, USA; Oklahoma City, OK, USA. Country of Publication: USA., IEEE.
Coherent detection in medium grazing angle sea-clutter	Rosenberg L. and Watts S. (2017)	IET Radar, Sonar and Navigation 11 (9): pp. 1340–1348.
Rolling with the punches	Rundle-Thiele S. R., Carins J. E. and Stock C.	In: How to keep your research project on track: insights from when things go wrong, eds. Keith Townsend and Mark Saunders. Edward Elgar Publishing (January 26, 2018).
Cooperative Localisation of a GPS-Denied UAV in 3-Dimensional Space Using Direction of Arrival Measurements	Russell J. S., Ye M., Anderson B. D. O., Hmam H. and Sarunic P. (2017)	IFAC–PapersOnLine 50 (1): pp. 8019–8024.
Analytical Techniques and Mathematical Modelling	Ryan S. (2017)	In: The Science of Armour Materials, ed. I. G. Crouch, Woodhead Publishing/Elsevier, pp. 395–481.
A scaling law for predicting the ballistic limit of aluminium alloy targets perforated in ductile hole formation	Ryan S., Nguyen L. H., Cimpoeru S. J. and Gallardy D. (2018)	International Journal of Impact Engineering 116: pp. 34–50.
3D Meteoroid Trajectories	Sansom E. K., Jansen-Sturgeon T., Rutten M. G., Bland P. A., Devillepoix H. A. R., Howie R. M., Cox M. A., Towner M. C., Cupak M. and Hartig B. A. D. (2018)	arXiv.
Recent advances in volumetric flow measurements: High-density particle tracking ('Shake-The-Box') with Navier-Stokes regularized interpolation ('FlowFit')	Schanz D., Schröder A., Gesemann S., Huhn F., Novara M., Geisler R., Manovski P. and Depuru-Mohan K. (2018)	Springer Verlag.
Learning to shape errors with a confusion objective	Scholz J. (2018)	Springer International Publishing.
Cancelling strong Doppler shifted returns in OFDM based passive radar	Searle S., Gustainis D., Hennessy B. and Young R.	2018 IEEE Radar Conference (RadarConf18), Place of Publication: Piscataway, NJ, USA; Oklahoma City, OK, USA. Country of Publication: USA., IEEE.
Task allocation and motion control for threat-seduction decoys	Shames I., Dostovalova A., Kim J. and Hmam H. (2018)	Institute of Electrical and Electronics Engineers Inc.
Adaptive data transfer methods via policy evolution for UAV swarms	Smith P., Aleti A., Barca J. C. and Hunjed R. (2017)	Institute of Electrical and Electronics Engineers Inc.
The Acousto Ultrasonic Structural Health Monitoring Array Module (AUSAM+) for Damage Detection in Structures	Smithard J., Norman P., van der Velden S., Powlesland I., Jung G., Rajic N. and Galea S. (2017)	Procedia Engineering 188: p. 448.
An advanced multi-sensor acousto-ultrasonic atructural health monitoring system Development and aerospace demonstration	Smithard J., Rajic N., van der Velden S., Rosalie C., Galea S., Norman P., Mei H., Lin B. and Giurgiutiu V. (2017)	Materials 10 (7): p. 832.

Title	Author/s	Publication
Identification of a rhythmic firing pattern in the enteric nervous system that generates rhythmic electrical activity in smooth muscle	Spencer N. J., Hibberd T. J., Travis L., Wiklendt L., Costa M., Hu H., Brookes S. J., Wattchow D. A., Dinning P. G., Keating D. J. and Sorensen J. (2018)	The Journal of Neuroscience 38 (24): pp. 5507–5522.
Automatic Ground Truths: Projected Image Annotations for Omnidirectional Vision	Stamatescu V., Barsznica P., Kim M., Liu K. K., Meakin W., Saunders G., Brinkworth R. S. A., McKenzie M. and Wong S. C. (2017)	Institute of Electrical and Electronics Engineers Inc.
Joint probabilistic data association and smoothing applied to multiple space object tracking	Stauch J., Bessell T., Rutten M., Baldwin J., Jah M. and Hill K. (2018)	Journal of Guidance, Control, and Dynamics 41 (1): pp. 19–33.
Case study: Remote In-field Environment and Corrosion Monitoring	Sudholz A., Thanh H., Waldie J., Talevski J., Loader C. and Butler A.	Corrosion and Prevention 2017.
Assessing Commander Decision Making with a Bright Fox – What a Cunning Plan!	Temby P., Antoniades M. N., Krastev M. and Thiele L. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Enhancing Army Training and Education with the Bright Fox System	Temby P. and Thiele L. (2018)	Paper accepted for presentation at 2018 International Conference on Science & Innovation for Land Power (ICSILP), 5–6 November 2018, Adelaide, South Australia.
Understanding team resilience in the Australian Army: A qualitative study	Temby P. and Vozzo J. (2017)	Journal of Science and Medicine in Sport, Volume 20, pp. S51–S52.
On the growth of cracks from etch pits and the scatter associated with them under a miniTWIST spectrum	Tamboli,D., Barter S. and Jones R. (2018)	International Journal of Fatigue 109: pp. 10–16.
Dual estimators for clutter-map CFAR detection on non-Gaussian background	Van Cao T. T. (2017)	IEEE Computer Society.
Background nuclei measurements and implications for cavitation inception in hydrodynamic test facilities	Venning J. A., Pearce B. W., Brandner P. A. and Khoo M. T. (2018)	Experiments in Fluids 59 (4).
Preliminary Sizing Correlations for Fixed-Wing Unmanned Aerial Vehicle Characteristics	Verstraete D., Palmer J. L. and Hornung M. (2018)	Journal of Aircraft 55 (2): pp. 715–726.
Experimental and computational studies on the scattering of an edge-guidedwave by a hidden crack on a racecourse shaped hole	Vien B. S., Chiu W. K. and Francis Rose L. R. (2017)	Materials 10 (7).
Representing and reasoning about logical network topologies	Voigt S., Howard C., Philp D. and Penny C. (2018)	Springer Verlag.
Microbiologically influenced corrosion of UNS N05500 in seawater	Wade S., Ang A., Piola R. and Neil W. (2018)	Materials Performance, 57 (4), pp. 66–69.
Corrosion Testing Of Thermal Spray Metal Coatings For Marine Applications	Wade S. A., Ang A. S. M., Piola R., Neil W. C., Leigh M. W., Howse H. and Berndt C. C.	Corrosion and Prevention 2017.

Title	Author/s	Publication
Evaluation of fatigue crack propagation behaviour in Ti-6Al-4V manufactured by selective laser melting	Walker K. F., Liu Q. and Brandt M. (2017)	International Journal of Fatigue 104: pp. 302–308.
Assessment of memory cushions in aircraft seating for injury mitigation through dynamic impact test	Wang J. J. and Dal Nevo R. (2018)	Journal of the American Helicopter Society 63 (1).
Sparsity-aware DOA estimation of quasi-stationary signals using nested arrays	Wang Y., Trinkle M., Ng B. W. H. and Hashemi-Sakhtsari A. (2018)	Signal Processing 144: pp. 87–98.
A larval-settlement assay method for the gregarious serpulid polychaete, ***Galeolaria caespitosa***	Watson M. G., Scardino A. J., Zalizniak L. and Shimeta J. (2017)	Journal of Experimental Marine Biology and Ecology 496: pp. 49–55.
Use of SHPB Tests for Incorporating a Compaction Constitutive Equation within a Two-Phase Model	Weckert S. A. and Resnyansky A. D. (2018)	AIP Conference Proceedings 1979 (1): pp. 110019-1–110019-6.
Geometric mean switching constant false alarm rate detector	Weinberg G. V. (2017)	Digital Signal Processing 69: pp. 1–10.
An invariant sliding window detection process	Weinberg G. V. (2017)	IEEE Signal Processing Letters 24 (7): pp. 1093–1097.
Noncoherent Radar Detection in Correlated Pareto Distributed Clutter	Weinberg G. V. (2017)	IEEE Transactions on Aerospace & Electronic Systems 53 (5): pp. 2628–2636.
Trimmed geometric mean order statistic CFAR detector for Pareto distributed clutter	Weinberg G. V. (2017)	Signal, Image and Video Processing: pp. 1–7.
Constant false alarm rate detection in Pareto Type II clutter	Weinberg G. V., Bateman L. and Hayden P. (2017)	Digital Signal Processing: A Review Journal 68: pp. 192–198.
Development of non-coherent CFAR detection processes in Weibull background	Weinberg G. V., Bateman L. and Hayden P. (2018)	Digital Signal Processing: A Review Journal 75: pp. 96–106.
Users take the driver's seat in developing next-generation simulation requirements: An exploratory study of Virtual Reality Head-Mounted Displays	Whitney S.J., Hibbard S., Fidock J. and Thiele L. (2017)	Proceedings of the Australasian Simulation Congress 2017. Sydney, Australia: Simulation Australasia.
Driving under Load: Measuring Driver Instructor Workload on a Military Heavy Vehicle Training Course	Whitney S., Temby P. and Hoggan B. (2018)	Abstract accepted for presentation at 2018 Human Factors and Ergonomics Society of Australia (HFESA) Conference. 26–28 November, Perth, WA.
Comparing Self and Instructor Assessments of Novice Army Truck Drivers	Whitney S., Temby P. and Hoggan B. (2017, November)	Paper presented at Defence Human Sciences Symposium 2017, Adelaide, South Australia.
Multiple Scan Data Association by Convex Variational Inference	Williams J. L. and Lau R. A. (2018)	IEEE Transactions on Signal Processing 66 (8): pp. 2112–2127.

Title	Author/s	Publication
Defect pair mechanism for quartz intermediate temperature thermoluminescence bands	Williams O. M. and Spooner N. A. (2018)	Radiation Measurements 108: pp. 41–44.
Track Everything: Limiting Prior Knowledge in Online Multi-Object Recognition	Wong S. C., Kearney D., Lee I., McDonnell M. D., Stamatescu V. and Gatt A. (2017)	IEEE Transactions on Image Processing 26 (10): pp. 4669–4683.
Microbial community investigation associated with corrosion failures of submarine seawater piping	Wood J., Franks A. and Neil W.	Corrosion and Prevention 2017.
3D AOA target tracking using distributed sensors with multi-hop information sharing	Xu, S., Doğançay K. and Hmam H. (2018)	Signal Processing 144: pp. 192–200.
Effect of Blast Mitigation from Multiple Fluid Containers (2017)	Yang E. and Bornstein H. (2017)	30th International Symposium on Ballistics, Long Beach, California, 9–13 September 2017.
Medium-Scale Experiments for the Validation of Naval Platform Vulnerability Simulations	Yiannakopoulos G., Flockhart C., Brett J. M. and Reid W. D. (2017)	Maritime Division, Defence Science and Technology Group, International Maritime Conference – Pacific 2017, Sydney October 2017.
Load-dependent bend-twist coupling effects on the steady-state hydroelastic response of composite hydrofoils	Young Y. L., Garg N., Brandner P. A., Pearce B. W., Butler D., Clarke D. and Phillips A. W. (2018)	Composite Structures 189: pp. 398–418.
Collision-free path control in contest environment using circular geometric attributes	Yu H., Lim C. C., Shi P., Damp L. and Kim J. (2018)	Institute of Electrical and Electronics Engineers Inc.
Near-optimal distributed detection in balanced binary relay trees	Zhenliang Z., Chong E. K. P., Pezeshki A., Moran B. and Howard S. D. (2017)	IEEE Transactions on Control of Network Systems 4 (4): pp. 826–837.
An artificial neural network-based model for analysing the R-ratio effect on fatigue crack propagation	Zhi L., Man Z., Cao Z. and Wang W. (2018)	Institute of Electrical and Electronics Engineers Inc.
Quantifying the impact of communication on performance in multi-agent teams	Zuparic M., Jauregui V., Prokopenko M. and Yi Y. (2017)	Artificial Life and Robotics 22 (3): pp. 357–373.
Analytic solution to space-fractional Fokker-Planck equations for tempered-stable Lévy distributions with spatially linear, time-dependent drift	Zuparic M. L. and Kalloniatis A. C. (2018)	Journal of Physics A: Mathematical and Theoretical 51 (3): p. 035101.
Noise-driven current reversal and stabilization in the tilted ratchet potential subject to tempered stable Lévy noise	Zuparic M. L., Kalloniatis A. C. and Roberts D. O. (2017)	Physical Review E 96 (5).

APPENDIX C: PATENTS (PENDING OR GRANTED)

Country	Application number	Filing date	Priority date	Granted number	Type	Patent status	Granted
CARTRIDGE AND SYSTEM FOR GENERATING A PROJECTILE WITH A SELECTABLE LAUNCH VELOCITY							
Stephen Forbes, Edmond Almond, Shaun McCormack, Jeffrey Ackers, Robert Reichstein, Michael Chatwin							
Europe	12840290.6	15-Oct-12	14-Oct-11	TBC	Regional	Allowed	N/A
AERIAL DEPLOYABLE RESCUE PACKAGE – CASG							
David Cole							
Australia	2015240411	19-Oct-16	31-Mar-14	N/A	Regional	Filed	N/A
VIBRATION ENERGY HARVESTER							
Scott Moss							
UK	1207828.3	04-May-12	04-Nov-11	GB2490783	Regional	Granted	04-Oct-17
VISUAL WARNING DEVICE							
Dmitri Feklistov							
Canada	276840	16-Jul-10	17-Jul-09	276840	Regional	Granted	10-Apr-18
SINGLE PHOTON AVALANCHE DIODE							
Dennis Delic							
Australia	2016290889	22-Dec-17	08-Jul-15	N/A	Regional	Filed	N/A
Canada	2990466	02-Jan-18	08-Jul-15	N/A	Regional	Filed	N/A
Europe	16820559.9	19-Jan-18	08-Jul-15	N/A	Regional	Filed	N/A
Japan	2017-568337	26-Dec-17	08-Jul-15	N/A	Regional	Filed	N/A
Malaysia	PI2017705095	28-Dec-17	08-Jul-15	N/A	Regional	Filed	N/A
New Zealand	738738	22 Dec 17	08 Jul 15	N/A	Regional	Filed	N/A
South Korea	10-2018-7002429	25 Jan 18	08 Jul 15	N/A	Regional	Filed	N/A
USA	15/741874	02 Jan 18	08 Jul 15	N/A	Regional	Filed	N/A

Country	Application number	Filing date	Priority date	Granted number	Type	Patent status	Granted
CROSS DOMAIN DESKTOP COMPOSITOR							
Mark Beaumont, Chris North							
Australia	2016262117	09 Nov 17	11 May 15	N/A	Regional	Filed	N/A
Canada	2985129	06 Nov 17	11 May 15	N/A	Regional	Filed	N/A
Europe	16791808.5	15 Nov 17	11 May 15	N/A	Regional	Filed	N/A
Japan	2017-559114	10 Nov 17	11 May 15	N/A	Regional	Filed	N/A
New Zealand	736972	9 Nov 17	11 May 15	N/A	Regional	Filed	N/A
USA	15/572452	7 Nov 17	11 May 15	N/A	Regional	Filed	N/A
AN ACTIVE OPTICAL FIBRE							
Nikita Simakov							
Australia	2016218937	21 Aug 17	9 Feb 15	N/A	Regional	Filed	N/A
Canada	2975897	4 Aug 17	9 Feb 15	N/A	Regional	Filed	N/A
Europe	16748478.1	9 Aug 17	9 Feb 15	N/A	Regional	Filed	N/A
Japan	2017-559738	9 Aug 17	9 Feb 15	N/A	Regional	Filed	N/A
Singapore	11201706447W	8 Aug 17	9 Feb 15	N/A	Regional	Filed	N/A
South Korea	10-2017-7025023	6 Sep 17	9 Feb 15	N/A	Regional	Filed	N/A
USA	15/550012	9 Aug 17	9 Feb 15	N/A	Regional	Filed	N/A

ABBREVIATIONS AND ACRONYMS

ADF	Australian Defence Force
APS	Active Protection System
BOM	Bureau of Meteorology
CASG	Capability Acquisition and Sustainment Group
CBR	Chemical Biological Radiological
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Defence	The Defence Organisation, including the Department of Defence and the Australian Defence Force
DIN	Defence Industry Network
DIP	Defence Innovation Partnership
DSI	Defence Science Institute
Dstl	Defence Science and Technology Laboratory (UK)
DST	Defence Science and Technology Group
EDTAS	Emerging and Disruptive Technology Assessment Symposium
EW	Electronic Warfare
GEWG	Gender Equity Working Group
HF	High Frequency
ICT	Information and Communication Technology
IED	Improvised Explosive Device
ISR	Intelligence Surveillance and Reconnaissance
IR	Infrared
JSF	Joint Strike Fighter
JTF	Joint Task Force
LHD	Landing Helicopter Dock
MSTC	Major Science and Technology Capabilities
MoU	Memoradum of Understanding
NATO	North Atlantic Treaty Organization
NSSTC	National Security Science and Technology Centre
PFRA	Publicly-funded Research Agency
Navy	Royal Australian Navy
RAAF	Royal Australian Air Force
R&D	Research and Development
RF	Radio Frequency
RMIT	Royal Melbourne Institute of Technology
SAGE	Science in Australia Gender Equity
S&T	Science and Technology
SME	Small and Medium Enterprises
STC	Science and Technology Capability
STEM	Science, Technology, Engineering and Mathematics
TPO	Technology Partnerships Office
TTCP	The Technical Cooperation Program
UAV	Unmanned Aerial Vehicle
UAS	Unmanned Aerial System

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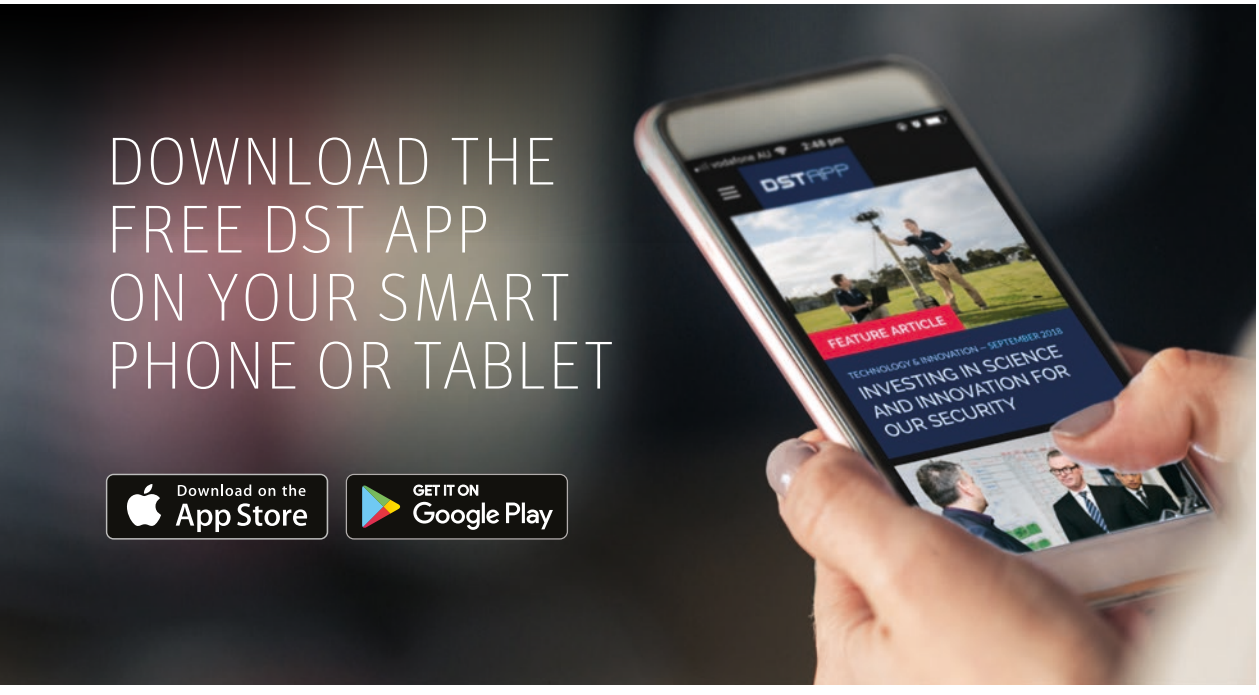


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