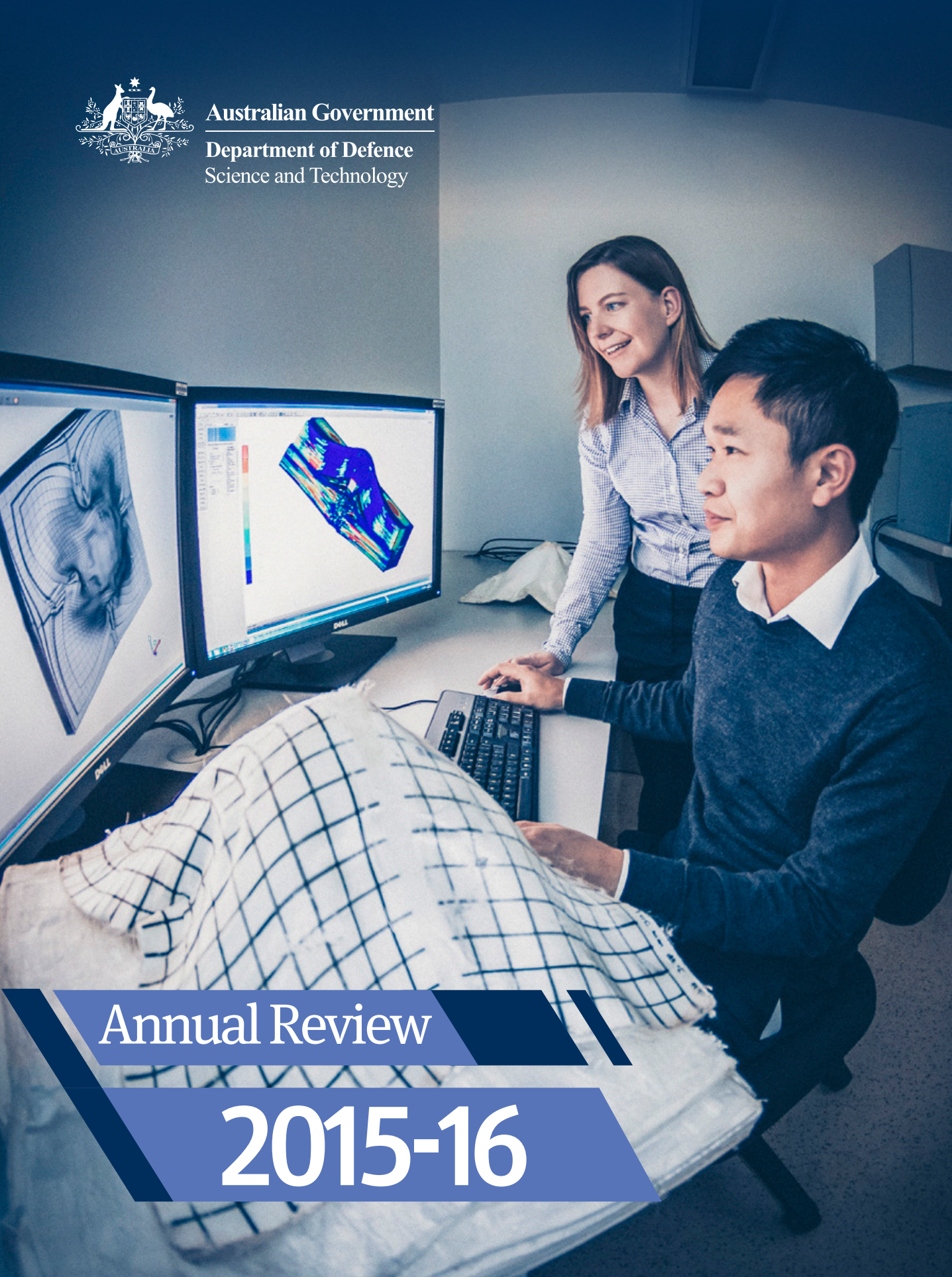




Australian Government
Department of Defence
Science and Technology



Annual Review

2015-16



Australian Government

Department of Defence
Science and Technology

Annual Review 2015-16



Melissa Laws uses a variety of techniques to synthesise, purify and characterise compounds used in chemical and biological defence research.

DST
GROUP

Science and Technology for Safeguarding Australia

Abbreviations and Acronyms

ABCANZ	Australia Britain Canada New Zealand	HF	High Frequency
ADF	Australian Defence Force	ICT	Information and Communications Technology
ASRAAM	Advanced Short Range Air-to-Air Missile	IED	Improvised Explosive Device
CAD	Chief Aerospace Division	IM&T	Information Management and Technology
CASG	Capability Acquisition and Sustainment Group	ISR	Intelligence Surveillance and Reconnaissance
CEWD	Chief Cyber & Electronic Warfare Division	JORN	Jindalee Operational Radar Network
CJOAD	Chief Joint and Operations Analysis Division	JSF	Joint Strike Fighter
CLD	Chief Land Division	JTF	Joint Task Force
CMD	Chief Maritime Division	LHD	Landing Helicopter Dock
CNSID	Chief National Security & ISR Division	MRI	Magnetic Resonance Imaging
CRSD	Chief Research Services Division	MSTC	Major Science and Technology Capability
CSPED	Chief Science Partnerships & Engagement Division	NATO	North Atlantic Treaty Organization
CSSPD	Chief Science Strategy & Program Division	RAN	Royal Australian Navy
CWCSD	Chief Weapons & Combat Systems Division	NRL	Naval Research Laboratory
CBD	Chemical and Biological Defence	OSC	Operations Support Centre
CBRN	Chemical, Biological, Radiological and Nuclear	PAA	Project Analysis and Advice
CBRnfx	Chemical, Biological, Radiological & Nuclear Effects	R&D	Research and Development
CDS	Chief Defence Scientist	RAAF	Royal Australian Air Force
CIED	Counter Improvised Explosive Device	RF	Radio Frequency
CSIRO	Commonwealth Scientific and Industrial Research Organisation	RMIT	Royal Melbourne Institute of Technology
CTD	Capability and Technology Demonstrator	SAGE	Science in Australia Gender Equity
Defence	The Defence Organisation, including the Department of Defence and the Australian Defence Force	S&T	Science and Technology
DSI	Defence Science Institute	SCT	Specialised Coatings Technology
Dstl	Defence Science and Technology Laboratory (UK)	SMEs	Small and Medium Enterprises
DST Group	Defence Science and Technology Group	SRI	Strategic Research Initiative
EO	Electro-Optical	STC	Science and Technology Capability
		STEM	Science, Technology, Engineering and Mathematics
		STEMM	Science, Technology, Engineering, Mathematics and Medicine
		TPO	Technology Partnerships Office
		TTCP	The Technical Cooperation Program
		UAV	Uninhabited Aerial Vehicle

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Front cover
 Long Nguyen and Tania Holmes using computer simulation to study new armour materials.

Back cover
 Garland Hu and Natalie Olsen working on the development of the Buccaneer CubeSat. This mission is being progressed in partnership with UNSW Canberra and will launch in 2017.

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Overview from the Chief Defence Scientist



We concluded the 2015-16 year by meeting Defence expectations, thanks to the contributions of all our staff and research partners.

2015-16 was another momentous year for defence science and technology.

We successfully addressed the five recommendations from the First Principles Review that applied to DST Group. These included articulating the value we deliver to Defence, disbanding the DSTO Advisory Board, strengthening partnerships with industry and academia, realigning research priorities with future force requirements and rationalising our top leadership structure. These recommendations have now been actioned and completed.

The Australian National Audit Office review of research activities was also completed during the year, making only one recommendation to improve our Management Information System. This recommendation has also been actioned.

The release of the Defence White Paper in March 2016 marked a new era for the future advancement of Defence capability. The White Paper explicitly recognised the critical role of science and technology in delivering the ADF's capability edge. As a result, the government committed \$1.9 billion in funding for science and innovation activities, including \$730 million for a Next Generation Technologies Fund to be managed by DST Group over the next ten years. This was part of a sweeping reform to bring the fragmented Defence innovation programs into a unified innovation ecosystem.

The \$730 million Next Generation Technologies Fund represents the first-ever investment on this scale to develop future game-changing capabilities with the specific involvement of industry and academia. The opportunities afforded by this level of investment are enormous for Defence as well as the Australian research and innovation sector in the foreseeable future. These opportunities have the potential to significantly transform Defence capability outcomes through multi-disciplinary collaboration and strategic partnerships across institutional and national boundaries.

We are in the third year of implementing the 5-year Defence Science & Technology Strategic Plan. We were delighted to have the Minister for Defence, Senator Payne endorse the 2016 update of the plan. Most importantly, it was tremendous to see us making significant progress with our ten strategic initiatives. Our progress on implementation is highlighted in this Annual Review.

During the year, DST Group continued to externally benchmark its Major Science and Technology Capabilities. Nearly half these capabilities have now been externally reviewed and 37 groups/areas to date have been rated as meeting world benchmark standards. These results underline a true commitment by DST Group staff to continuous improvement in achieving world-class scientific excellence.

Science excellence must be accompanied with a focus on delivering outcomes for Defence. Our science teams have successfully re-engaged with our Defence clients and partners. We measure our engagement results through client surveys. Our survey results have continued to improve and this is reflected in our client satisfaction with 92% of Defence respondents being satisfied with our performance. We will continue to seek to deliver better results for our Defence clients.

Performance matters most when scientists are delivering capability solutions to the Australian Defence Force. Among the practical solutions provided during the year was the extension of the carriage life of the rocket motors in the Advanced Short-Range Air-to-Air Missile allowing the F/A-18 aircraft to continue operations in the Middle East, resolving issues with the integration of the missile warning system in the ADF's new helicopters, exploring novel fuel and energy technologies to reduce the weight carried by soldiers, developing a passive radar system for situational awareness without being detected, and implementing electronic countermeasures against improvised explosive devices (IED).

The Redwing suite of counter-IED products, developed by DST Group in collaboration with industry and the Australian Military Sales Office, was recognised for its inventiveness with a Public Sector innovation award from the Institute of Public Administration Australia. More than 100,000 of the light-weight, low-cost devices have been supplied to Afghanistan. The Redwing force protection systems illustrate DST Group's ability to respond to urgent operational needs not only with agility but with ingenuity.

Fostering innovation is a key strategic initiative in DST Group and for the first time a dedicated Innovation Day was set aside to engage the entire organisation in activities focused on innovation. The enthusiastic response from staff generated more than 100 new ideas of which the most promising have been selected for further development and implementation.

The high tempo of external engagements was maintained during the year with the successful staging of the second Partnerships Week which attracted nearly 400 industry and university visitors to our Melbourne laboratory. Our program of pitching technologies at defence industry events such as the Future Land Force Conference was also continued while two more strategic alliances were signed

with defence primes. These activities have resulted in greater industry collaboration and increased take-up of our technologies for further development or commercialisation.

The Defence White Paper placed a high priority on international engagement as a means of positioning Australia to protect its security and prosperity based on regional stability and a rules-based global order. In this respect DST Group strengthened its growing science and technology relationships with Singapore, Japan and South Korea while forging new links with Indonesia and India. The relationship with our traditional 5-eyes allies - USA, UK, Canada and New Zealand - continued to play a strong part in addressing shared capability challenges through closer cooperation in joint research activities that are focused on outcomes. Many of these activities are carried out under The Technical Cooperation Program which held the 51st Meeting of its Principals in Sydney this year. Australia is taking a leading role in research activities related to cyber, autonomous systems and contested urban environments, all deemed strategic challenges by the Principals of The Technical Cooperation Program.

We made good progress during the year in improving diversity, career development for staff and supporting activities for the advancement of science, technology, engineering and mathematics. We sponsored 51 scholarships, cadetships and research placements while our indigenous intake now represents one per cent of the total workforce in DST Group. During the year, we also joined the Science in Australia Gender Equity (SAGE) program of the Athena Scientific Women's Academic Network as part of our commitment to improving our practices in recruitment, retention and promotion of women.

We concluded the 2015-16 year by meeting Defence expectations, thanks to the contributions of all our staff and research partners. While scientific and technical achievement is the centrepiece of our business, this work could not be accomplished without our wonderful support staff. With the science and technology commitments in the Defence White Paper we have a new opportunity to make a tangible and far-reaching difference to the Australian Defence Force of the future. I am confident DST Group will deliver on this mission in partnership with industry and academia.

A handwritten signature in blue ink, appearing to read 'A. Zelinsky'.

Dr Alex Zelinsky
Chief Defence Scientist

Major highlights

First Principles Review recommendations completed

Recommendations relating to DST Group in the First Principles Review report were addressed in full and closed off.

Major Science and Technology Capabilities benchmarked

The external benchmarking of the Major Science and Technology Capabilities continued, with a further 9 completed in 2015-16. The reviews identified 18 areas of capability that were rated as meeting world benchmark standards. This brings to 18 the number of MSTCs that have been reviewed since the introduction of the program.

Priorities for science and innovation in Defence White Paper

The 2016 Defence White Paper recognised the role of science and technology in developing Defence capability and assigned responsibility to DST Group for leading the \$730 million Next Generation Technologies Fund to deliver game-changing capabilities in collaboration with industry and academia.

Improvised Explosive Device (IED) countermeasure

DST Group developed the Huckleberry IED countermeasure capability in response to an urgent operational need posed by a new IED threat to ADF soldiers and vehicles in theatres of operation.

Innovation award for Redwing products

The Redwing suite of counter-IED products, developed by DST Group in collaboration with the Capability Acquisition & Sustainment Group, Defence's CIED Task Force and defence industry, received the inaugural innovation award from the Institute of Public Administration Australia.

ASRAAM flight hour carriage extension

Experiments conducted by DST Group enabled the extension of the air carriage limits of the ASRAAM rocket motor to accommodate the additional flying hours required to effectively prosecute air operations in Operation OKRA in the Middle East.



L-R Tim Heenan, Darryn Smart, Katherine Thatcher, Rex Russell, the winners of the inaugural Public Sector Innovation Award from the Institute of Public Sector Administration Australia (IPAA).

Major highlights

Countering surface-to-air missile threats to Navy helicopters

DST Group performed detailed simulations in its Integrated Hardware-in-the-Loop Facility to quantify the vulnerability of Navy helicopters to surface-to-air missiles launched from small surface vessels, which resulted in changes being made to the tactical guidance offered to helicopter crews.

New fatigue damage algorithm for RAAF's F/A-18 aircraft

A new algorithm developed by DST Group for calculating accrued fatigue damage in F/A-18 airframes found that the consumed life of some aircraft is lower than previously thought, meaning that fatigue is now not likely to limit some operations or lead to premature aircraft retirement.

Support to the Future Submarine Competitive Evaluation Process

Extensive analysis was provided to support the Competitive Evaluation Process used to select the international partner for the design and build of the next generation of Australia's submarines.

Cyber security review

DST Group assisted a cyber security review conducted by the Department of the Prime Minister and Cabinet particularly by offering valuable advice on ICT supply chain security, with this work facilitating the development of the Australian Government's Cyber Security Strategy.

Innovation Day

The first-ever Innovation Day was organised across the organisation for staff to focus on fostering innovation. The exercise resulted in over 100 new ideas, the most promising of which are being developed further for implementation.

Partnerships and engagement still going strong

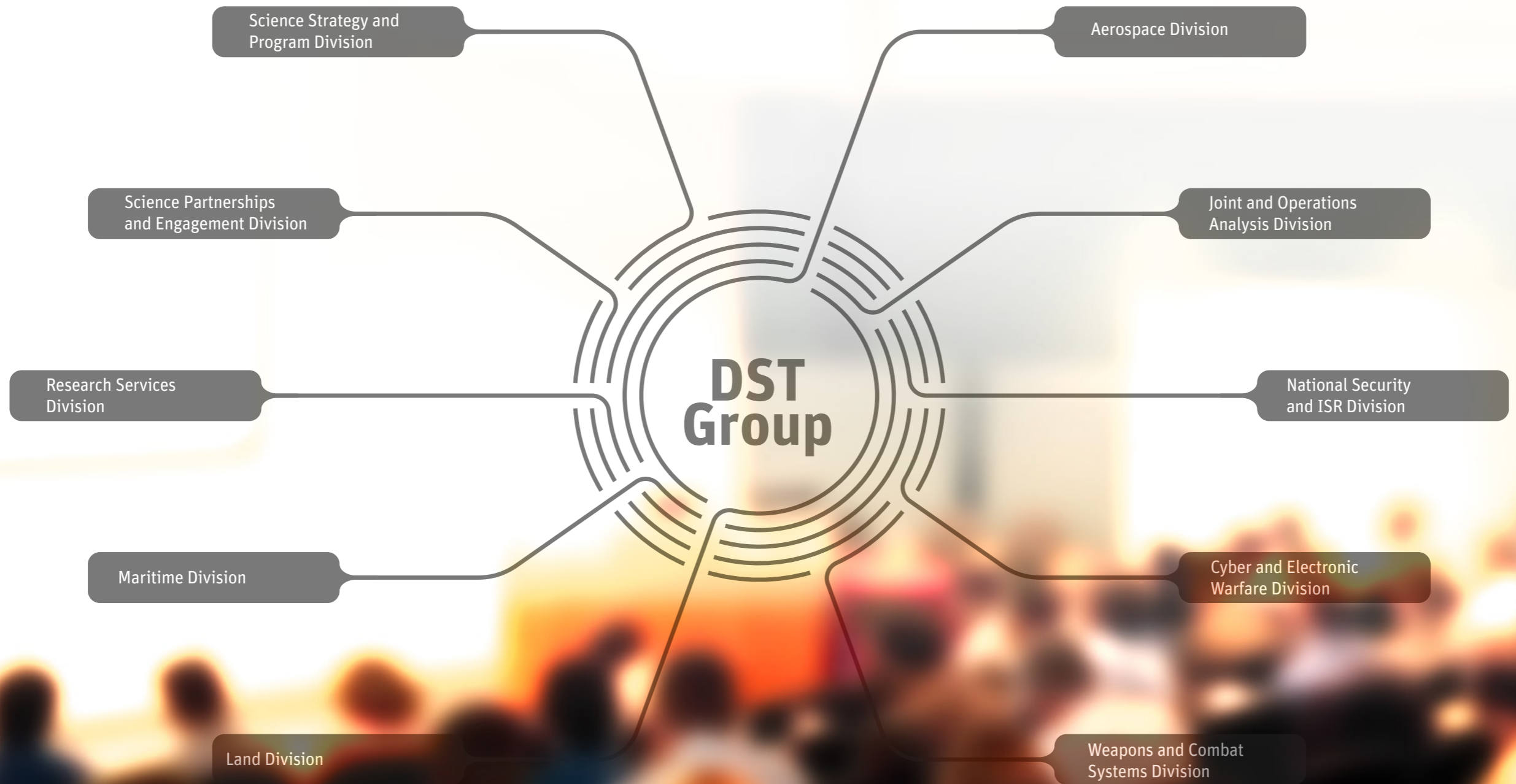
The second Partnerships Week in the Melbourne laboratory built on the success of the inaugural 2015 event in Adelaide with nearly 400 visitors attending. DST Group now has 14 strategic industry alliances in place and defence science partnerships with 30 Australian universities.



Audience at the launch of Partnerships Week in Melbourne.



One of the workshops on Innovation Day.



SECTION 1

OUR ORGANISATION

About us

DST Group 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 Group had a budget of \$470 million for the 2015-16 year and employed 2,200 staff, predominantly scientists, engineers, IT specialists and technicians.

DST Group staff are located in nearly every state and territory in Australia. Internationally, the Group 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 Group personnel operate in the Middle East, providing direct support to Australian military operations.

Our purpose

DST Group provides the Australian Government with scientific advice and innovative technologies to meet Australia's defence and national security challenges.

Its core roles are focused on supporting Australian troops on operations, 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 the challenges of the future.

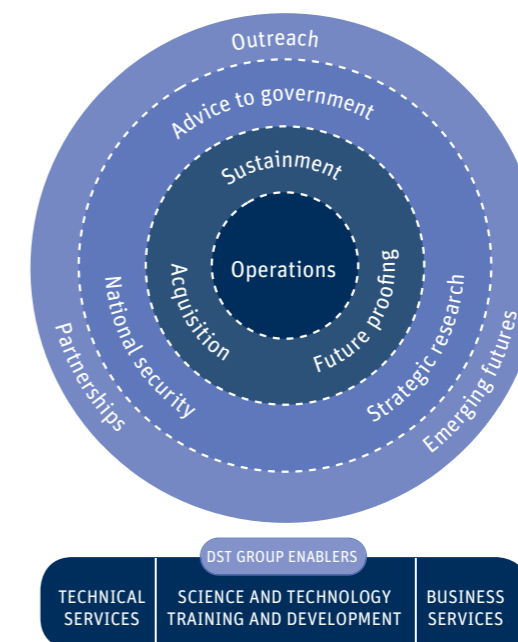
DST Group has a role in providing expert, impartial advice to government on defence and national security matters, as well as coordinating the delivery of whole-of government science and technology support for national security.

As a science and technology organisation, DST Group conducts strategic research to identify high-impact areas for Defence and monitor emerging technologies to assess their potential impact on Defence capability.

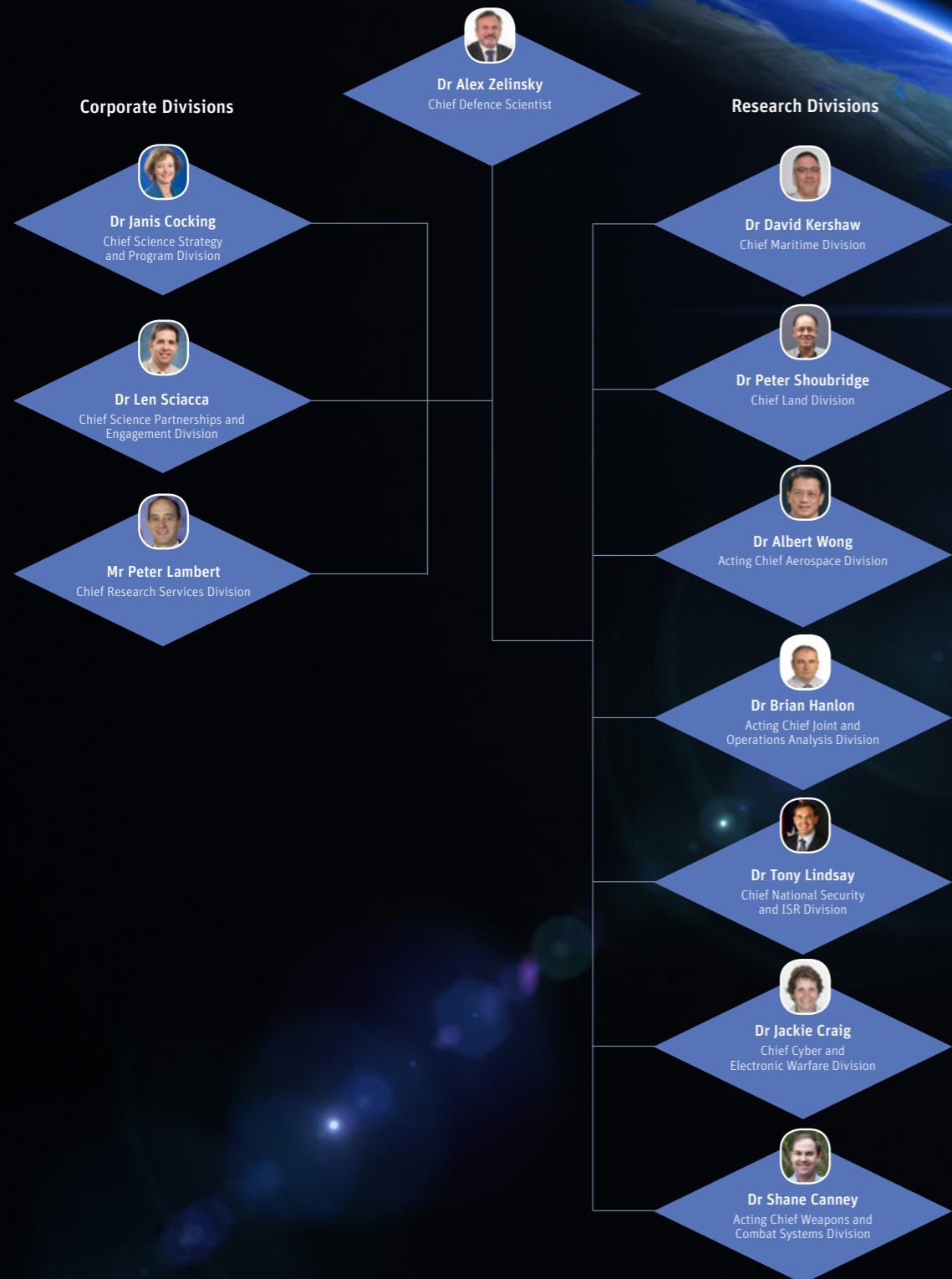
Underlying all of its activities is an increased emphasis on external engagement and collaboration. This includes taking a stronger role in knowledge and innovation integration, strengthened through partnerships with industry and academia.

Our roles

ROLE	DESCRIPTION
CORE	
Operations	Supporting operational capability with science and technology 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 science and technology to enhance whole-of-government national security.
Strategic research	Conducting research into high-impact areas for future Defence capability.
SUPPORTING	
Emerging futures	Scanning the environment to gain an understanding of emerging science and technology threats and opportunities.
Partnerships	Enhancing its 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 2016



Vision, Purpose, People and Values

Vision

DST Group aims to be a world leader in defence science and technology – indispensable in supporting and transforming Australia’s defence and national security.

Purpose

DST Group is a national leader in safeguarding Australia by delivering valued scientific advice and innovative technology solutions for Defence and national security.

People

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

Values

DST Group 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 be proud of, 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.

Implementation of the Strategic Plan

Implementation of the Strategic Plan 2013-18 continued during the year with significant progress recorded for each of the strategic initiatives.

Science and Technology Excellence (D1 Strategic Initiative)

Technical benchmarking

The benchmarking of DST Group's Major Science and Technology Capabilities (MSTC), commenced in 2014-15, was continued in 2015-16. All 39 MSTCs completed a second round of internal benchmarking and a further nine were externally reviewed. Half of DST Group's major capabilities have now been externally reviewed.

The second round of internal benchmarking showed a modest improvement across all dimensions in comparison with the previous year. The biggest gains were in internal engagement as well as the promotion of scientific excellence and client impact.

Of the MSTCs externally reviewed in 2015-16, all but one received an overall favourable assessment. The remaining MSTC was assessed as tenable. The areas of client impact and client satisfaction were assessed as 'best practice'. The reviewers found 18 world-benchmark capabilities.

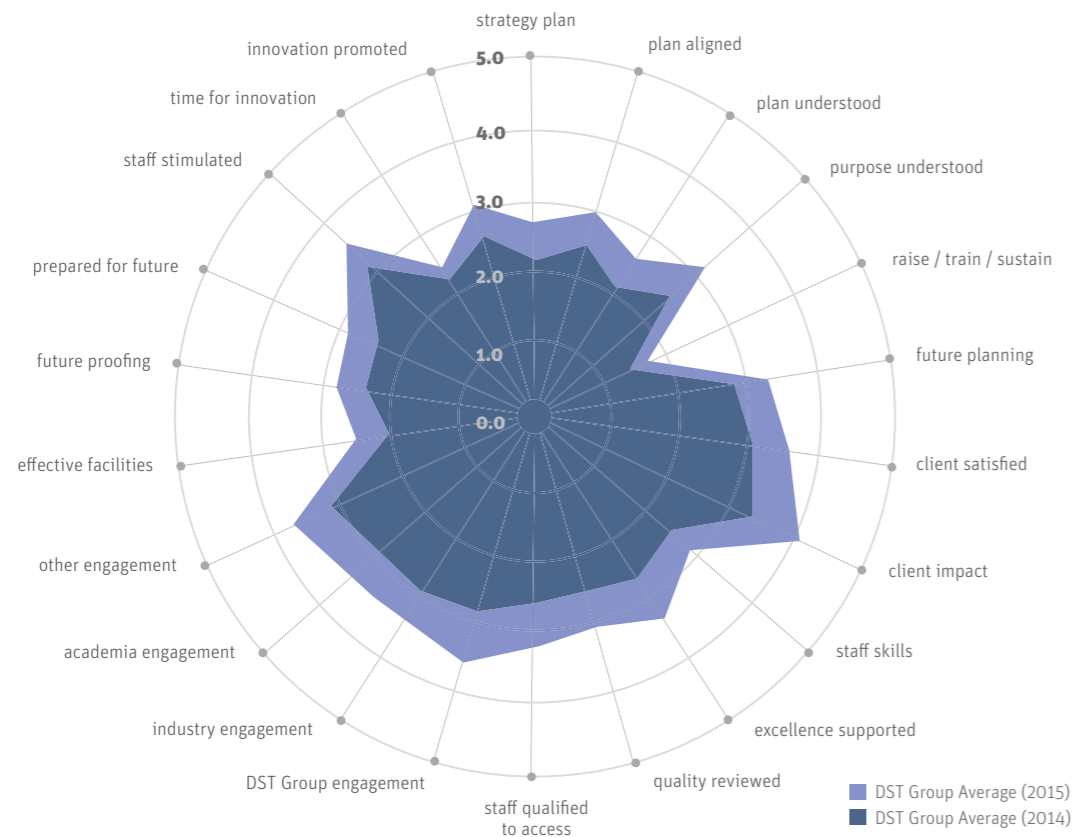


Figure 1: Outcomes of reviews of DST Group's MSTC performances for the 2015-16 year compared to 2014-15.

The MSTC-on-a-page approach has been developed to aid internal and external understanding of our capabilities and to assist discussions with partners and stakeholders on potential areas of future work. It records the goal, impact and engagement aspects of each MSTC and will be available in both hard copy and PowerPoint formats.

Non Acoustic Signature Management

Goal
To enhance the survivability and operational warfighting capability and to reduce the cost of ownership of ADF platforms through the use of materials science and technology.

Impact

Platform Survivability: Partnering with industry to design, manufacture and install radar absorbing material on ships, submarines and aircraft to reduce the RCS of platforms to radar detection.

Safety: Leading the evaluation of chromate free primers for aircraft, including F35, and new isocyanate free navy topcoat has led to a safer workplace for platform sustainment.

Operational Capability: Design and application of Radar Absorbing Materials to the "surfboard" on 4 FFH's to significantly improve communication performance.

Platform Acquisition: The provision of S&T advice on signatures and management technologies for SEA 1000, SEA 5000, LAND 400, LAND 121, AIR 6000 has ensured enhanced survivability and regional superiority.

Cost of Ownership: New anti-foul and durable coatings on ship hull, superstructure and propellers has reduced RAN fuel consumption, in water cleaning and maintenance costs.

S&T Excellence

Three year publication record
52 DST Technical Reports
39 DST Client Reports
24 Journal Publications
61 Conference Papers

Peer Recognition

- 2 ARC reviewers
- Editor J. Computer Networks
- ONR Coatings Program reviewer

Awards

- Ministers Award for Defence Science 2013 (Dr Andrew Amiet)
- NATO STO Excellence award 2014
- Surface Coatings Association of Australia Lou Cash Memorial award 2016
- Engineers Australia Excellence Award for Innovative R&D 2016
- DST Awards: Outstanding early career achievement 2014, 2016, Outstanding contribution to defence 2015, Technical Excellence Award 2016

Electromagnetic Signature Control



Specialised Coating Technology



Environmental Signatures and Protective Systems



Corrosion Sciences



PARTNERSHIPS & OUTREACH

<p>Universities Swinburne University of Technology, Deakin University University of Wollongong, La Trobe University University of South Australia RMIT, University of Melbourne, Flinders University</p>	<p>Industry Mackay Industries BAE Systems Australian Submarine Corporation PPG, Akzo Nobel, Jotun, DEFT, Protec, Axalta, RUAG MacTaggart Scott Dow Chemicals</p>	<p>Government National Marine Science Committee NT & WA Departments of Fisheries Australian Institute of Marine Science</p>	<p>International TTCP- MAT, AER and MAR Groups NATO - SET Panel NRL, ARL (US) DSTL (UK) TNO, MARI, Phillips Lighting (NL) WTD 52 (Germany) Atlas Elektronik (UK) Lockheed Martin (US)</p>
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Example of DST Group's MSTC-on-a-page approach.

Externally Assessed World-Leading Capabilities

(from eight MSTCs reviewed between January and June 2016)

World benchmark capability	Where world benchmark capability resides	Description
Cavitation Research Test Facility	Hydroacoustics Science and Technology Capability (STC) in Acoustic Signature Management MSTC	The Cavitation Research Test facility is a state-of-the-art facility utilised by many nations, and the conduct of world-class research was evidenced by the collaborative publications issued and a presence at international hydroacoustic conferences.
Computational fluid dynamics (CFD) cluster	Hydroacoustics STC in Acoustic Signature Management MSTC	The CFD group has a dedicated computational facility and it works in well with the focus on computational solutions. The people (both DST Group and academics) who work on this have created a hub of excellence. The cluster size is a world benchmark.
Composite prototyping	Acoustic Material Systems STC in Acoustic Signature Management MSTC	The rapid prototyping ability of composite structures and the understanding and ability to shape and change ideas in support of the acoustic materials research was very impressive.
Target echo strength research	Acoustic Signature Control STC in Acoustic Signature Management MSTC	The target echo strength research was world-class, evidenced by strong international collaboration and deliberate allocation of research components across all participating nations.
AUSRAT tool	Acoustic Signature Control STC in Acoustic Signature Management MSTC	The Australian signature assessment tool (AUSRAT) is critical to SEA1000 development and its ability to be incrementally refined to Australian defence requirements as the submarine design matures.
Health & Usage Monitoring Systems (HUMS)	Vehicle Dynamics and Diagnostics STC in Aircraft Health and Sustainment MSTC	Recognised by US Department of Defense medal and thus of international significance.
Thermography	Airframe Diagnostic Systems STC in Aircraft Health and Sustainment MSTC	Citations and Lockheed Martin assessment.
Fibre optic acoustic array sensors	Active Sonar STC in Sonar Technology and Systems MSTC	Feedback from many clients and stakeholders (including the University of Adelaide) indicates a world benchmark capability in fibre optic acoustic array sensors. It will likely change the direction of major projects and result in enhanced capability for ADF. DST Group's work is backed by open literature publication and patents and has had a major influence on clients, industry and the direction of external research.
Multi-static sonobuoy research	Sonar Processing & Performance Analysis STC in Sonar Technology and Systems MSTC	The research in multi-static sonobuoy concepts, a collaboration between DST Group and academia, is rated by Professor Moran of RMIT as a world benchmark. The only equivalent work is being performed by the Space and Naval Warfare Systems Command, which has significantly greater resources.
Aerosol science	Integrated Personnel Protection STC in Land Personnel Protection MSTC	The aerosol research work is world-class based on publications and facilities including international recognition.

Externally Assessed World-Leading Capabilities

(from eight MSTCs reviewed between January and June 2016)

World benchmark capability	Where world benchmark capability resides	Description
Wargaming capability (evidenced through jSWAT capability in particular)	Land Simulation, Experimentation and Wargaming STC in Land Capability Analysis MSTC	The Joint Seminar Wargaming Adjudication Tool jSWAT is a world-best software product (within The Technical Cooperation Program (TTCP)) that has been developed over a number of years and is shared and used in TTCP nations.
Cyber and crypto mathematics research (CCMR)	Cyber and Crypto Mathematics Research STC in Cyber Assurance & Operations MSTC	Several projects in CCMR are highly commended by international partners and considered world-class.
Malware analysis research	Cyber Defence Analytics STC in Cyber Assurance & Operations MSTC	The malware analysis research area is highly valued by the intelligence community.
High-power 2-micron fibre lasers	Laser Technologies STC in Electronic Warfare Operations	The development of high-power 2-micron fibre lasers has demonstrated world-leading powers and efficiencies and innovation in design and fabrication. This is evidenced by publications in the top international journals and invited papers in the top international conferences in this field. Maintaining this world-leading capability will require significant ongoing investment in both equipment and personnel.
Electro-Optical (EO) modelling and simulation	EO Countermeasures STC in Electronic Warfare Operations	The Tactical Radar and Infrared Engagement Modelling Environment (TRIREME) package has been provided to Dstl to assist in the enhancement of the Threat Modeling Analysis Program (TMAP) models currently in development.
EO Hardware-In-the-Loop (HWIL) Facility		The EO HWIL Facility provides a world-class capability for EO Countermeasures modelling and has been adopted internationally as the standard for EO HWIL.
Optical Scattering and Reflection (OSAR)		The OSAR system has demonstrated operational performance under high jamming-to-signal ratios in Australian trials. ISAF led to collaboration with the UK and Canada.
Integrated Survivability Assessment Facility (ISAF)		
Defence laser systems	Laser Technologies STC in Electronic Warfare Operations	Development of Defence laser systems represented by LOCS Limited (UK) have demonstrated unique world-class capabilities through successful field trials and have attracted strong client interest for future investment.
Laser attention device		
Directional infrared counter measures (DIRCM) fibre laser		The rifle-mounted EAGLE technology has demonstrated an effective means for gaining attention of persons approaching checkpoints in hostile environments.
		The DIRCM fibre laser technology has been progressed to a technology level that is now being adopted by industry in support of the production of a Spanish operational capability.

Strategic Research Initiative

The Strategic Research Initiative (SRI) program was reviewed through the DST Group Investment process in December 2015. In parallel, DST Group also provided input to the 2016 Defence White Paper and the associated 2016 Defence Industry Policy Statement. The alignment of the streams of R&D in the SRI program with strategic guidance has been confirmed. The resources invested in the SRI program on trusted autonomous systems have been increased as a result of this review. The hypersonics program was externally reviewed and the DST Group Leadership Team will monitor the recommendations.

Strategic Research Investment Program	2016 Defence White Paper	
	Technology-driven transformational domain	Game-changing technology
Cyber warfare	Cyber and electronic warfare	
Bioterrorism awareness		
Future electronic warfare	Cyber and electronic warfare	
Future undersea warfare	Undersea warfare	
Hypersonics	Advanced sensors, hypersonics and directed energy capabilities	Hypersonics
Intelligence, surveillance and reconnaissance (ISR)	Integrated ISR	
Signature, materials and energy		Multidisciplinary materials science
Trusted autonomous systems		Trusted autonomous systems
Space systems	Space capabilities	
	Agile capability development	Quantum technologies
		Enhanced human performance and resilience

Science excellence

During the year, DST Group developed a definition of science and technology excellence that included metrics and characteristics and described what it means in the Defence context. The agreed elements have then been used to develop a science and technology maturity index for individuals and the characteristics exhibited by an excellent Major Science and Technology Capability.

The agreed definition states that, "Science and technology excellence within Defence is demonstrated by the highest international standards for scientific and technological innovation, rigour, original contribution and influence, while solving the most challenging and valued problems."

The rationale for achieving excellence is underlined by the fact that science and technology is valued by Defence and national security agencies for its contribution to saving lives, enhancing capabilities, reducing risk and maximising return on investment. The obligation to the nation is to preserve this contribution through an unwavering commitment to science and technology excellence.



Figure 2: The three nested layers incorporated in DST Group's approach to achieving S&T excellence.

The principles and characteristics of science and technology excellence have been defined to incorporate three nested layers, representing the individual researcher, the MSTC and the organisation as a whole. Success in achieving science and technology excellence will be governed by eight practical activities:

1. MSTCs have external quality review once every four years.
2. Every person in an MSTC will have a learning and development plan.
3. MSTC staff actively collaborate with internationally recognised research institutions.
4. The MSTC will be actively involved with defence R&D organisations.
5. MSTC staff members will present and test ideas with peers through conferences, publications, colloquia and symposiums.
6. Every STC in an MSTC will have peer-reviewed publications in high quality journals or conference proceedings.
7. The MSTC delivers value through its transition path from S&T to a defence capability.
8. The MSTC will shape and develop defence S&T capability and build the talent pool for the future through engagement with academia.

Principles and characteristics of science & technology excellence

Principles	Characteristics
1. We achieve our goals and they have impact.	Our S&T achieves high-quality, high-value Defence and national security outcomes.
2. We test our quality against world benchmark standards.	We undergo external quality reviews by independent experts at regular intervals. Staff contribute to symposia, colloquia, conferences, teaching and lecturing.
3. We share and test our ideas with peers.	We actively collaborate with internationally recognised research institutions, defence R&D organisations, and actively contribute to conferences, publications and symposia.
4. We have ongoing professional development.	Every person has a learning and development plan.
5. We publish our work at the highest level.	Staff publish unclassified work in leading refereed journals. Staff publish classified work in client or technical reports.
6. We shape and develop defence S&T capability and build the talent pool for the future through engagement with academia.	Staff are active members of collaborations with universities.
7. We deliver value through transition of S&T from the laboratory to a defence capability.	Staff are active members of collaborations with industry.
8. We employ continuous improvement practices.	We undertake reviews of our capability and outcomes.

Client Engagement with Strategic Focus (D2 Strategic Initiative)

Strategic engagement

A new domain-based engagement framework was developed and endorsed by the Defence Enterprise Business Committee and First Principles Review Implementation Committee. The framework replaces a group and service specific engagement model with one that is aligned with domains and the roles and responsibilities of the capability managers and coordinators. It provides end-to-end science and technology (S&T) support to the capability life cycle, coordinated through a single responsible officer. It also simplifies DST Group's engagement and reduces the number of scientific advisers from seven to five.

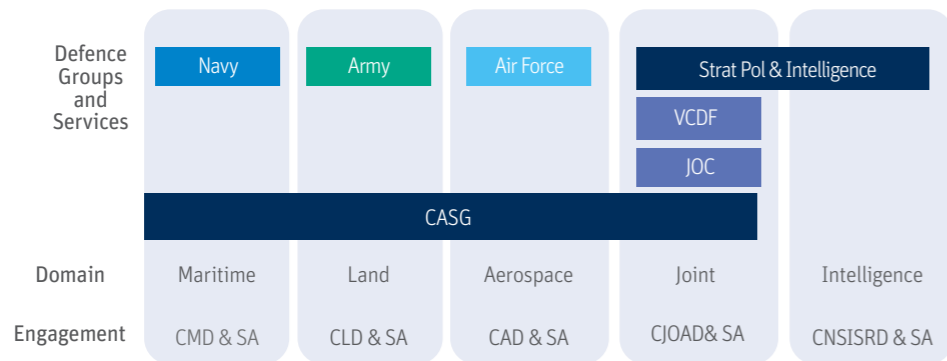
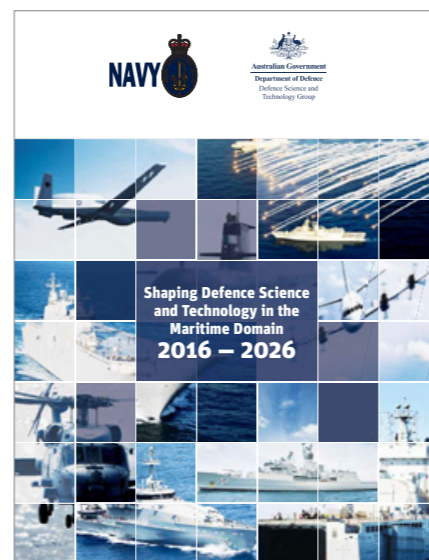


Figure 3: Framework for engagement with Defence where Domain Project Managers (Chiefs of Division) and Scientific Advisers (SA) engage with Capability Managers and the responsible Capability Acquisition and Sustainment Group (CASG) Division Heads based on the domain.

To deliver a strategically driven client program, DST Group introduced domain program managers for each Defence domain – Maritime, Land, Aerospace, Joint, Intelligence and National Security. Domain program managers now have responsibility for the totality of the DST Group program in that domain, and lead the engagement with the relevant Band 2 and 2-star capability managers or capability coordinators and the CASG division heads. They work closely with DST Group's scientific advisers to ensure that the S&T Program in each domain reflects the needs and priorities of its Defence clients.

In developing its 2016-17 S&T Program, DST Group coordinated and facilitated workshops for each domain to discuss and develop domain S&T strategies. These strategies identify the focus areas for research in DST Group and client future priorities. The first of them, 'Shaping Defence S&T in the Maritime Domain 2016-2026', was agreed and signed in March 2016. These S&T strategies are integral to determining investment in DST Group's MSTCs and shaping the S&T program.

The 2015-16 Defence S&T Program was approved by the Defence Enterprise Business Committee.



Cover of the published DST Group strategy for maritime S&T development.

Effort in support of DST Group roles

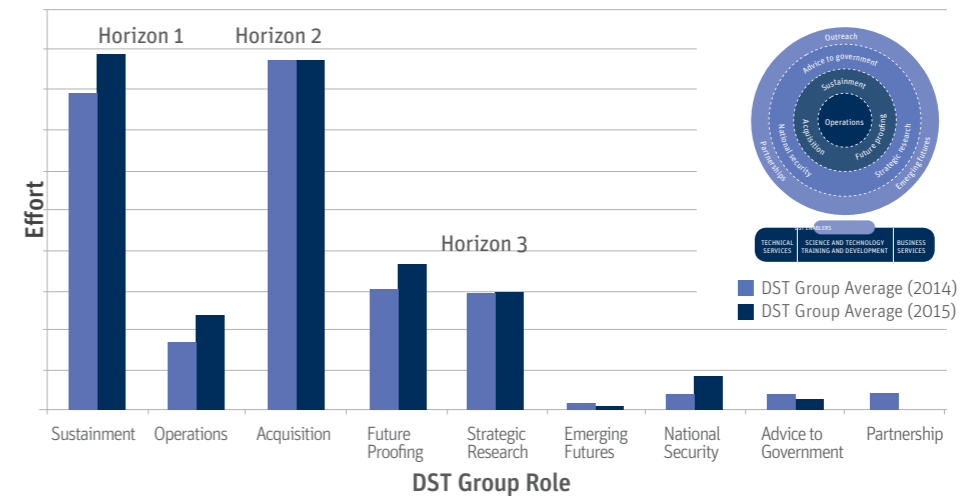


Figure 4: Client review of S&T program and client satisfaction.

Client survey

DST Group continued its use of client satisfaction surveys to gather feedback on the quality and timeliness of S&T support.

The survey results clearly show that, overall, DST Group's S&T support is meeting the needs of Defence. The annual desk officer survey, completed in March 2016, shows 92% of respondents were satisfied with DST Group performance, which compares with 94% satisfaction in 2014-15. Many DST Group staff were praised by name or by work area for their support to clients.

General themes from the feedback included:

- the need to increase the DST Group long-term strategic research program,
- the ability to leverage external partnerships with academia, industry and international partners, and
- the requirement to align research priorities with future force needs.



Figure 5: Levels of client satisfaction.

Prioritisation framework

One of the First Principles Review recommendations and activities for DST Group was to provide a framework to review its research priorities, their alignment with future force requirements and their capacity to leverage from academia, industry, publicly funded research agencies and international partners. In response, DST Group developed a prioritisation framework that provides a robust, transparent and contestable platform for investment decision-making. During 2015-16, the framework was applied to recruitment, the 2016-17 Strategic Research Investment program and the 2016-17 Defence S&T program.

Big-Picture Analysis on Shape of Defence (S1 Strategic Initiative)

The 2016 Defence White Paper was launched by the Prime Minister and the Minister for Defence on 25 February 2016. Two accompanying documents were also released – The 2016 Integrated Investment Program and The 2016 Defence Industry Policy Statement.

The 2016 Integrated Investment Program will guide the implementation of the bulk of Defence investment over the 2016-26 decade to build the future force and Defence capability goals described in the White Paper. The Defence 2016 Industry Policy Statement will deliver the Defence capability necessary to achieve the strategy set out in the Defence White Paper, supported by an internationally competitive and innovative Australian defence industrial base.

The release of the 2016 Defence White Paper was the culmination of over two years work by a team within Defence and government. Included in this team at various stages of the development process were DST Group representatives who provided the S&T perspective. Their inclusion from the very beginning was a key element of a successful White Paper. Not only did DST Group provide assistance with the force design process, its submissions regarding the importance of S&T to Defence and the need to fund science and technology research and innovation activities were also accepted in full, leading to significant funding being included for these activities.

Of the four new innovation-focused initiatives in the White Paper, the Next Generation Technologies Fund is a commitment from Government to invest around \$730 million over the 2016-26 decade in strategic technologies with the potential to deliver game-changing capabilities. DST Group will lead this program in collaboration with academia, publicly funded research agencies, industry and international partners to create a national research and innovation capability focused on Defence outcomes. The Next Generation Technologies Fund will link closely with the new Defence Innovation Hub and the Defence Innovation Portal as part of a national innovation ecosystem.

Defence's new approach to innovation underpins the National Innovation and Science Agenda which focuses on the importance of innovation to the broader national economy.

Keeping track of technology trends

As part of its role to keep abreast of emerging technology trends, DST Group continued to engage with Australian and international stakeholders by hosting relevant events. The inaugural DST-RUPT event in December 2015 sought forward-thinking ideas from staff on potentially disruptive technologies and their impact on Australia's national security while the Emerging and Disruptive Technology Assessment Symposium (EDTAS-2) in February 2016 provided a comprehensive overview of the military effects and impacts of autonomous systems on the ADF.

Grand Challenges for Safeguarding Australia (S2 Strategic Initiative)

A Grand Challenges program is being established as part of the Next Generation Technologies Fund (NGTF) to address intractable Defence problems. An operating model for the program was developed in consultation with key Defence and external stakeholders and endorsed in April 2016. Ideas for potential future topics were also sought in very well-attended workshops conducted with Defence, industry and academia during Partnerships Week in June 2016. The outcomes of these workshops, and other data, are being used to facilitate the development of agile and defensible methods for making topic selections.

As the Grand Challenges program must be a vital and integral element of the broader NGTF program, it was decided in May 2016 to broaden the scope of the S2 Strategic Initiative to reflect the new approach to Defence innovation focused on next-generation technologies. Looking forward, this will ensure that the best possible mechanisms are used to deliver innovative, game-changing capabilities to Defence.

Fostering Innovation (T1 Strategic Initiative)

New approach to innovation in DST Group

In light of the Government's National Innovation and Science Agenda and the strong emphasis on innovation in the 2016 Defence White Paper, a new approach to innovation was incorporated in the Defence Science and Technology Strategic Plan 2013-18 (2016 Update). Activities were embedded across the strategic initiatives around the themes of Enabling Our People, Building Partnerships that Deliver and Delivering Defence and National Outcomes.

DST Group's innovation culture program

For the first time in the organisation's history, staff took time out to focus exclusively on innovation. The inaugural DST Group Innovation Day held on 15 June 2016 was an unqualified success with the entire workforce participating in workshops and seminars to identify new solutions to technology as well as administrative problems and recognising opportunities for future investment. More than 100 new ideas were pitched with the six most promising suggestions accepted for funding and implementation.

Digital and physical workplace transformation

Two other innovative developments were showcased during Innovation Day activities. The prototype of the collaboration tool for DST Group's new intranet was demonstrated. The intranet incorporates all the features of a corporate intranet but extends this to include strong collaboration and real-time communication functionality.

Collaboration spaces to make the workplace more people-friendly and productive were trialled in Adelaide, Melbourne and Canberra, with staff responding positively to the proposed suggestions.

Multi-disciplinary approaches to problem solving (SolveIt)

For the second year running a SolveIt event was hosted to 'crowd-source' ideas from staff to address a specific challenge. A counter-IED SolveIt was successfully completed during the year with around 100 staff from 18 teams participating.

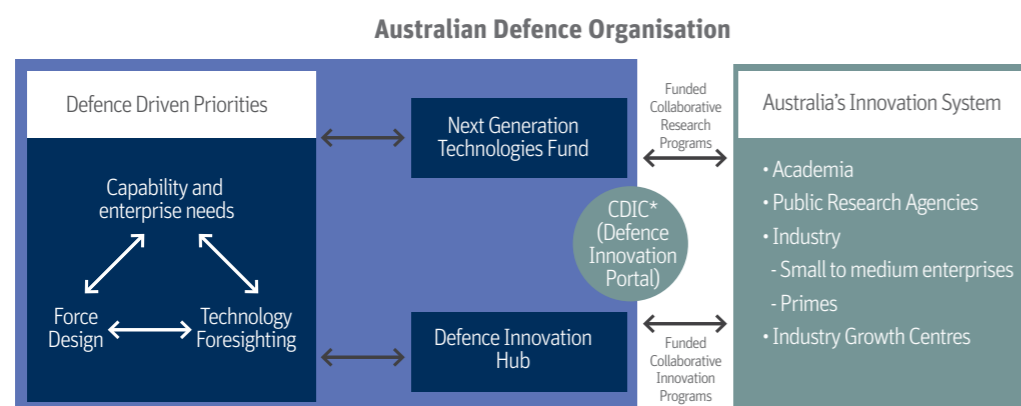


Figure 6: Next Generation Technologies Fund participants and linkages.

*Centre for Defence Industry Capability



Presentations and brainstorming activities during Innovation Day.



US speaker Scott Berkun gave the keynote address on Innovation Day.



Grand Challenges workshop during Partnerships Week.

Leadership, Accountability and Performance Management (O1 Strategic Initiative)

Remodelling leadership and accountability

Leadership and accountability play a central role in developing a future workforce with the correct balance of experience and skills to meet Defence priorities. Scientific staff at the S&T 6 level represent the core group of future leaders in the organisation.

During the year, DST Group remodelled its leadership and accountability framework by developing a consistent definition of roles and responsibilities for staff at the S&T 6 level, and outlining a set of principles for determining supervisory lines of responsibility. There is now a stronger role for senior leaders in the career and performance management of their staff, enabling them to more strategically manage the S&T workforce.

In line with this approach and to develop the leadership skills of the S&T 6 cohort, a series of workshops were held with 442 staff participating.

Talent, Diversity and Career Development Pipeline (O2 Strategic Initiative)

DST Group is recognised within Defence as a leader in Indigenous engagement. Indigenous representation in the organisation increased from 0.2% to 1% during 2015-16. A DST Group Indigenous Engagement Plan was released as a complement to the Defence Reconciliation Action Plan.

DST Group's Career Development Planner was piloted in readiness for release in August 2016. To support the recruitment of staff to 150 advancement positions, training programs were organised to develop qualified selection panels with an emphasis on minimising unconscious bias.

DST Group also joined the science and gender equity program, Science in Australia Gender Equity (SAGE) program of the Athena Scientific Women's Academic Network (SWAN). This is a program of activities designed to improve gender equity and diversity in the science, technology, engineering, mathematics and medicine (STEMM) fields.



DST Group SAGE participants.

Transformation of ICT to Drive Innovation and Collaboration (O3 Strategic Initiative)

The transformation of information and communications technology (ICT) continued as the Information Management and Technology Operations Plan for 2015-16 was progressively implemented.

Highlights include:

- Introduction of an unclassified cloud, enabling researchers to collaborate with domestic and international partners.
- Development of an internal virtualisation/storage cloud, allowing rapid provisioning of research resources on the DST Group network.
- A new Microsoft Azure cloud pilot, enabling selected divisions to collaborate with academic partners across the internet.
- Facilitation of instant messaging and chat to connect DST Group with Defence users.
- Completion of the first phase of a remediation program, resulting in over 80 stand-alone networks being remediated.
- Transitioning library-based services to an agile online delivery system for information resources.

Best Practices for Business Processes and Administration (O4 Strategic Initiative)

Process improvements

A method of processing overseas travel applications has progressed from prototype to production-ready status, with development, engineering and beta testing having been completed by May 2016. When implemented, the new process will significantly reduce the administrative overheads for international travel.

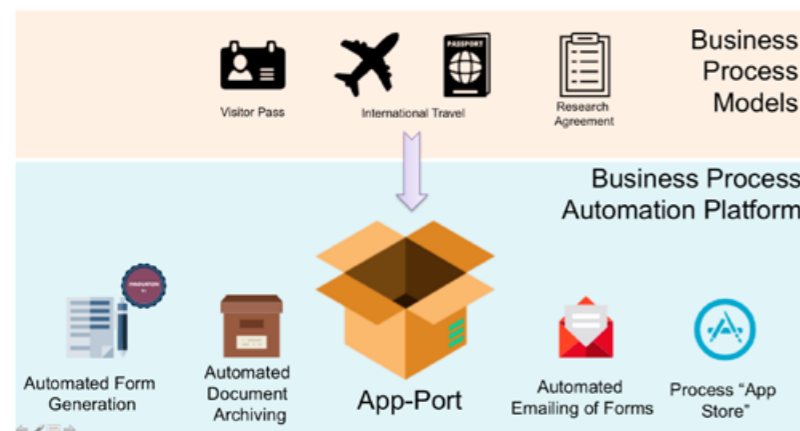
A streamlined system for workflow and approval of S&T publications using the Objective system was launched in November 2015 and has subsequently undergone several updates. An information campaign using a 'how to' video and roadshows has ensured the adoption of the new system across the organisation.

A single access point for all Defence and DST Group policies was implemented during the year, available at <http://intranet.dsto.defence.gov.au/resources/policies/>



The Adelaide-based ICT Rationalisation Team.

Process Modelling & Automation Platform



O4 applied Business Process Automation to streamline international travel approval.



Better engineering support negotiated between Qinetiq (represented by Rohan Armitage) and DST Group (Rob Weimann) as part of Strategic Initiative O4.



SECTION 2

**DELIVERING CAPABILITY
FOR DEFENCE AND
NATIONAL SECURITY**

Supporting Australian Defence Force operations

DST Group provides direct support to Defence personnel undertaking military operations around the world to help ensure missions are conducted safely and successfully.

While the majority of support to operations can be provided from the safety of laboratories and facilities in Australia, DST Group scientists are often deployed on military operations to provide immediate, on-the-ground advice and assistance. 'Fly Away Teams' made up of scientists with particular 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 call on scientists back in Australia for assistance through a support system called 'Reachback'.

DST Group's support for operations is the highest priority work it undertakes.

Deployments

DST Group's Operations Support Centre (OSC) manages and certifies a pool of deployment-ready staff. It selects, prepares and deploys S&T personnel to operational theatres to support significant operational decision-making, address immediate operational needs and provide S&T advice and assessments to Joint Task Force (JTF) commanders.

During the 2015-16 year, twelve scientists were deployed overseas to provide operations analysis and S&T liaison support to JTF Headquarters in support of Operations ACCORDION, MANITOU and OKRA; a further four scientist were deployed on a short-term Fly Away Team in support of Operations OKRA and FIJI ASSIST 16; and forty scientists were maintained at short notice to move across a range of high-readiness capabilities in accordance with the Chief of Defence Force Preparedness Directive.

Key successes from the deployment program during 2015-16 include:

Illicit network interdiction (Operation MANITOU)

Deployed staff assisted in the management and analysis of operational intelligence and established technology solutions for identifying dhows engaged in smuggling activities. This work centred on providing a database design for the Combined Maritime Forces Headquarters and an assessment of standoff measurement technologies and portable chemical analysers for Royal Australian Navy boarding parties operating as part of the Combined Task Force CTF-150.

Heat stress management for the Air Task Group (Operation OKRA)

Deployed DST Group staff contributed to the development of effective heat stress management strategies for both personnel and aircraft operating with the Australian Development Assistance Bureau. Laboratory staff also assisted by conducting advanced modelling and assessment of cooling technologies. Personal cooling systems and work duration guidance were adopted and personal physiological monitoring systems were considered to ensure ground crew could maintain their work capabilities without physical exhaustion or injury.



DST Group scientists Alison Fogarty and Greg Carstairs keeping our Australian Defence Force personnel safe from the risks associated with extreme heat.



A DST Group fly away team was deployed to Fiji for disaster relief assistance.

Information flows study (Operation ACCORDION)

Analysts attached to Headquarters Joint Task Force (HQJTF) 633-Middle East Area of Operations undertook a major study aimed at enhancing the organisational effectiveness of the headquarters' business processes and information management systems. The study made recommendations to overcome identified deficiencies and contributed improvements to the headquarters' ICT data refresh processes.

Humanitarian assistance and disaster relief study (Operation FIJI ASSIST)

A rapid-response Fly Away Team was deployed to undertake an evaluation and lessons study. The team conducted structured interviews with key personnel both inside the Task Force and across a range of Australian, New Zealand and Fijian government agencies. Observations were combined with insights from previous humanitarian assistance and disaster relief missions and presented to the Chief of Joint Operations and the Strategic Command Group. Areas highlighted for improvement have formed the basis of follow-on activities under an enduring S&T program.

Operational Science and Technology

DST Group responds expeditiously to Operational Science and Technology Support Requests to help deployed commanders achieve optimal situational awareness, mission success and survivability on operations.

During 2015-16 successful responses to such requests included:

Capsize risk mitigation for boats (Operation RESOLUTE)

Staff conducted sea trials and modelling to mitigate the capsize risk of jet rigid hull inflatable boats during launch, recovery and personnel transfer operations. The work resulted in changes to the standards for the launch and recovery of these boats under different sea states.

Force protection countermeasures (Operations HIGHROAD and OKRA)

DST Group staff developed and implemented new countermeasure techniques to address a number of radio-controlled IED threats to ADF personnel on Operation OKRA. The team also won a DST Group Achievement Award for Collaborative Partnerships in 2015-16 for the development, manufacture and sale to Afghan forces of Redwing, a suite of unique, low-cost, robust and lightweight protection systems developed to counter improvised explosive devices. This was followed by a Public Sector Innovation Award for Redwing. During 2015-16, Afghan National Security Forces ordered a further 55,000 Redwing systems, bringing the total manufacture and sales of units to 160,000. A Redwing Phase 2 development program commenced in late 2016.



Sea trial to reduce risk of inflatable boats capsizing (Operation RESOLUTE).



Australian-made radio signal jamming devices were provided to the Afghan National Army to protect their soldiers against remote controlled improvised explosive devices (IEDs).

IED threat prediction (Operations HIGHROAD and OKRA)

To identify emerging threats from new types of improvised explosive devices, DST Group conducted a staff competition asking teams to develop designs using commercially available off-the-shelf technologies. Called the SolveIT challenge, many submissions were elicited, with six finalists then chosen to develop mock prototypes. Follow-on work is being conducted to develop effective strategies to defeat these devices.

Insider threat analysis and cultural intelligence training (Operation OKRA)

During 2015-16, analysts produced a conflict assessment for Iraq, generating potential drivers for insider attacks at Taji Military Complex. Results were presented to Task Group Tali (TGT) 2 and TGT 3 Peace Support Operations as well as relevant subordinate force elements. Follow-on work developed and delivered training vignettes (complete with Iraqi role players) for both the training teams and their force protection elements in order to simulate potentially dangerous situations prior to deployment.

ASRAAM flight hour carriage extension (Operation OKRA)

DST Group led a large-scale program to assess how the missile's rocket motor was affected by thermal shocks and vibrations when carried by F/A-18 Hornet aircraft. The ASRAAM rocket motors were considered to be approaching their captive carriage limits due to extensive operational use.

The results of a successful thermal shock experimental program and air carriage vibration assessment provided evidence that the captive carriage life of the ASRAAM can be extended, thereby obviating a large capability gap for the RAAF and allowing the aircraft to continue its missions on Operation OKRA.



ASRAAMs carried on F/A-18 Hornet aircraft.



Thermal shock and vibration test for the ASRAAM rocket motor (Operation OKRA).

Sustaining and enhancing existing Defence capability

Sustaining and enhancing current Defence capability is a prime responsibility for DST Group. The work is aimed at 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.

Enhanced employment of laser-guided munitions

DST Group has worked closely with the RAAF to determine the target location error for the laser targeting pod used on the Classic Hornet. Scientific and mathematical expertise was used to analyse trials data and specify accuracy bounds for target designation under varying conditions. The studies supported closer integration of RAAF assets into the US-led coalition force and enabled the prosecution of more target categories with Classic Hornet aircraft while minimising the potential for collateral damage.

Support to MRH90 helicopter operations on board HMAS Canberra

In June 2016, DST Group investigated damage on flight critical components in the main rotor system of the MRH 90 helicopter caused by the flexing of rotor blade tips at zero or low rotational speeds in high winds. The forensic findings were shared with the manufacturer, and modifications to overcome this problem are currently scheduled for fleet incorporation in 2017.

The investigation also included analysis of the influence of ship air wake on the damage.

The detailed analysis also helped determine a safe operating envelope for the MRH 90 on Landing Helicopter Dock (LHD) vessels and ensured that ongoing flight trials were able to proceed in a timely manner.

Special Operations Headquarters functional analysis

From May to August 2015 DST Group conducted a functional analysis of the Special Operations Headquarters. By applying a variety of qualitative techniques, the analysis identified seven key insights into Headquarters functions and processes, developed eight approaches to addressing the identified issues and problems and proposed four structural options for the Headquarters – all of which were received very positively by Special Operations Headquarters senior staff.



Support to MRH90 helicopter operations on board HMAS Canberra.

Operations analysis support for Plan Jericho

During the year, DST Group supported the RAAF's Plan Jericho by providing operations analysis in two key areas – concept development and the establishment of the Air Warfare Centre (AWC).

Plan Jericho aims to deliver a more balanced, potent and integrated future Air Force.

DST Group has contributed to the development of Air Force concepts of operations and is leading a study in open systems architecture with a particular focus on identifying operational effects. There is also a collaboration with Saab Australia on the use of Microsoft HoloLens and an open systems architecture to develop a concept demonstrator for battlespace visualisation that will further explore Air Force concepts of operations.

Operations analysts embedded in the Air Warfare Centre also provided assistance for tactics development during the US Air Force's Exercise Red Flag 16 and later for the Pitch Black 2016 Exercise.

Exercise analysis for warfighting certification

Navy is using DST Group operations analysts to improve its warfighting capability measurement and certification by inviting them to sea for exercises. In 2015-16, analysts were deployed as observers during Exercises Sea Horizon and Sea Raider and the Fleet Concentration Period to collect performance data, obtain contextual narratives and observe current evaluation methods.

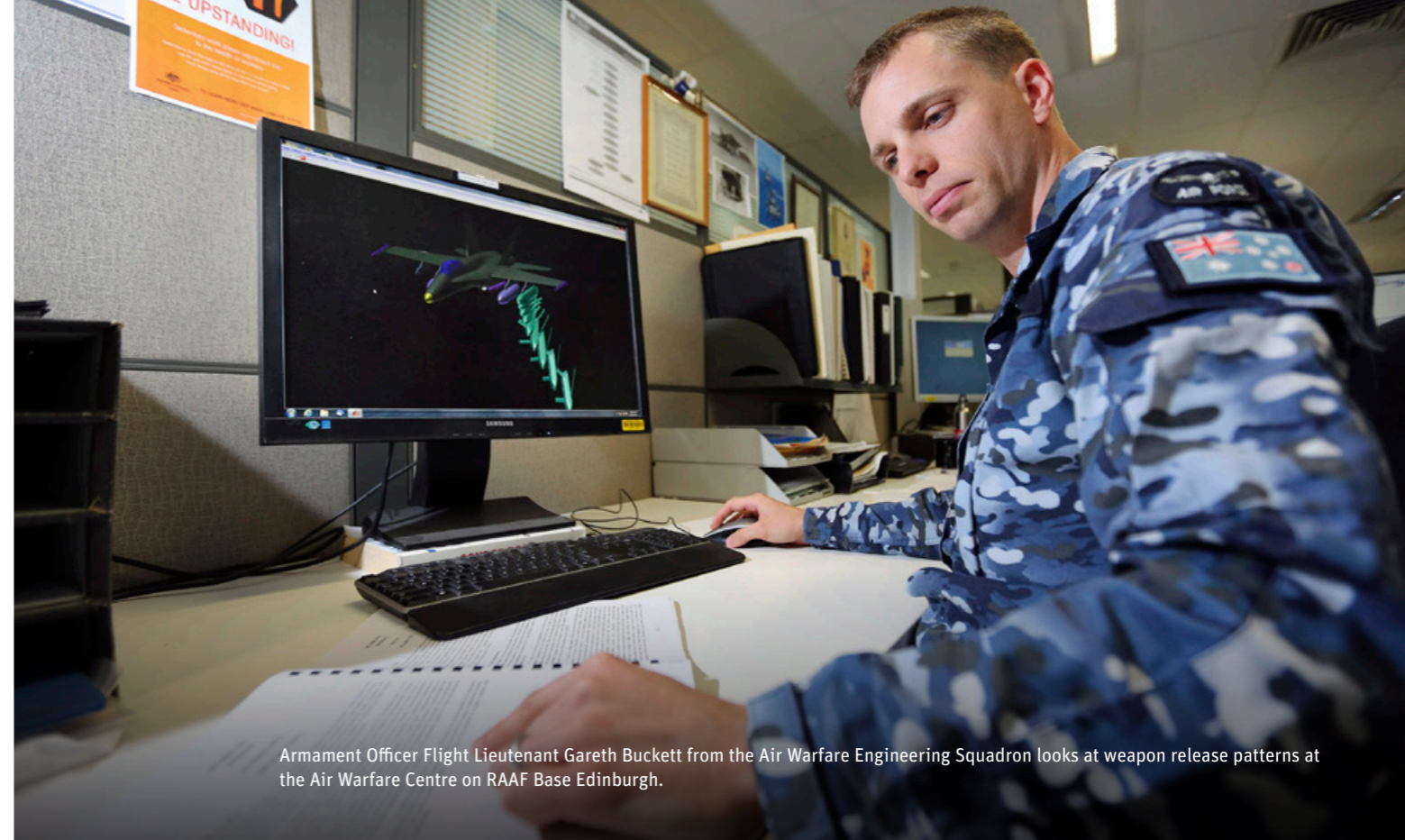
This work starts long before going to sea. Modelling and simulation are used to provide advice on tactics and to forecast system performance in expected conditions. Capability frameworks are refined to reflect current tactics and operations and data collection plans developed. Immediately following the exercises, a reconstruction is completed to show what happened before conducting the analysis to determine why it happened and what improvements can be made. Feedback is provided on the force evaluation methods used and proposed enhancements are recommended.

As well as providing ADF commanders with evidence on which to base warfighting certification decisions, exercise analysis provides a great opportunity for DST Group scientists to work closely with warfare teams and gain the necessary military domain knowledge to ensure their analysis is focused and relevant.

ELIIXAR for situational awareness and decision-making

During 2015-16, DST Group deployed its exemplar ISR integration architecture (ELIIXAR) for Exercises Talisman Sabre and Iron Moon, demonstrating real-time exploitation of motion imagery from airborne platforms in remote operations.

ELIIXAR provides a framework to develop and demonstrate an enterprise integrated ISR capability designed to enhance Defence situational awareness and support decision superiority.



Armament Officer Flight Lieutenant Gareth Buckett from the Air Warfare Engineering Squadron looks at weapon release patterns at the Air Warfare Centre on RAAF Base Edinburgh.



ELIIXAR for situational awareness and decision-making.

Case study

Vantage data analysis of supply chain risk

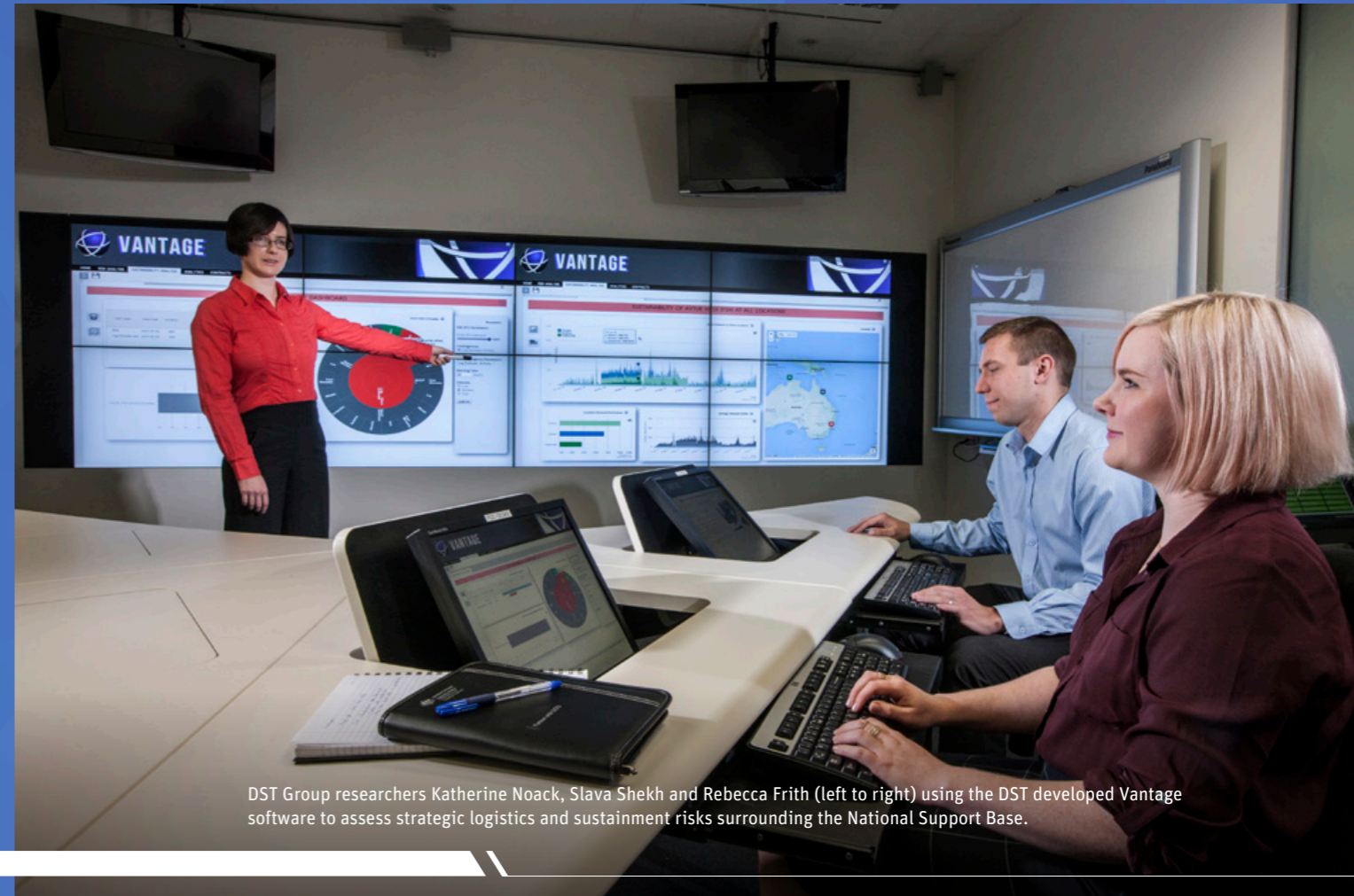
To ensure optimal ADF operations, Defence sources thousands of items of equipment, consumables and ammunition, all of which must be delivered to theatres on time and in sufficient quantities from local and global suppliers. This is a complex supply chain with a concomitant risk of disruption to supplies which needs to be mitigated and ensure operational sustainability is not impacted.

DST Group's Vantage project is applying the discipline of data science to the task of identifying supply chain risks to critical materiel availabilities. This R&D venture has undertaken to source and integrate data from various procurement databases; implement algorithms for analysing risk identifiers such as mismatches in contractual arrangements and demand, delivery delays, long lead times and supplier diversity; and finally, develop data visualisations to help analysts identify potential risks.

A Vantage prototype application has been built and applied to examine the trade-offs between fuel throughput and Defence storage capacity in play at the Townsville Defence Fuel Installation. DST Group was asked to examine whether Defence could viably partner with Shell and BP to use Defence's storage to supply civilian as well as RAAF and Army fuel requirements.

Using the Vantage software, the capacity and inventory requirements of the Townsville Defence Fuel Installation were modelled for a scenario in which RAAF, Army and civilian jet fuel needs were all sourced from the Defence installation, thus constituting a joint user hydrant installation (JUHI) facility.

With the use of linear programming, DST Group examined the trade-offs between storage volume and throughput. The work confirmed that a Defence-civilian JUHI would in fact be logistically viable by increasing the road-tanker throughput from the Townsville Bulk Fuel Terminal at the Townsville port. A report detailing the analysis conducted and benefit of the proposal has been presented to the senior Defence committees to inform their decision-making.



DST Group researchers Katherine Noack, Slava Shekh and Rebecca Frith (left to right) using the DST developed Vantage software to assess strategic logistics and sustainment risks surrounding the National Support Base.

Signature management practices trial

Field trials were conducted by DST Group to assess the effectiveness of 1st Brigade signature management practices for a deployed ground force. Exercise Predator Sightings comprised a series of trials integrated with deployed 1st Brigade elements over the period September 2015 to June 2016. The results have been reported to the Commander 1st Brigade.

Support for Nulka launch tactics

To address obsolescence issues with the Nulka Launch Sub-System DST Group has contributed technical support over the past year to the SEA 1397 Phase 5B program. This has involved work on Nulka tactics updates and human-machine interface research to develop new control concepts of the firing solution.

In August 2015, DST Group also completed a major ship-motion wind data trial on the new Landing Helicopter Dock Canberra-class ships to assist the work of the designers of the new Nulka Launch Sub-System.

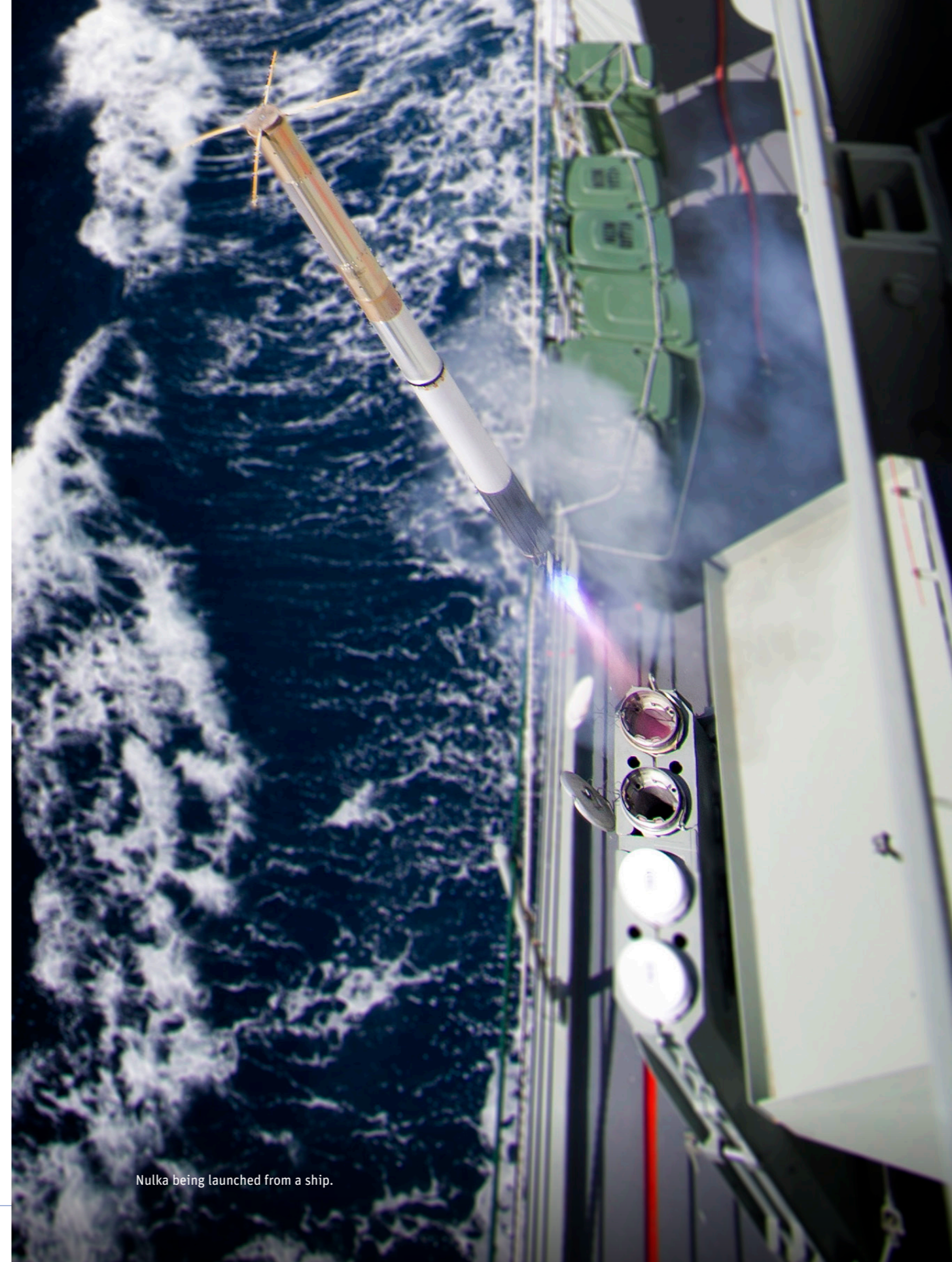
Surface-to-air missile threats to Navy helicopters

DST Group has performed detailed simulations to quantify the vulnerability of Navy helicopters to surface-to-air missiles launched from small surface vessels. The work was undertaken using the Integrated Hardware-in-the-Loop Facility, a world-class capability for high fidelity simulation of threat weapons developed by DST Group and used by several allied nations. The advice provided to Navy has led to changes in the tactical guidance being offered to helicopter crews assigned to interrogate small vessels in high-threat conditions.

Virtual Wedgetail

The Wedgetail Integration and Research Environment (WIRE) was created by DST Group to facilitate research on the mission system software running on the ADF's Aerial Early Warning and Control aircraft. Industry-standard simulation interfaces were later added to WIRE to develop a prototype simulation platform allowing Wedgetail operators to participate in distributed training exercises. These exercises have included the Black Skies series (mission rehearsals for the live Exercise Pitch Black) and large Coalition training events such as Coalition Virtual Flag.

The prototype was transitioned during the year via Boeing into the Virtual Wedgetail distributed-mission training service for RAAF. Boeing acknowledged the assistance provided by DST Group researchers Adam Iannos and Ryan Hales to the Boeing team that established Virtual Wedgetail, an achievement the company acclaimed by presenting the team with its Wirraway Award.



Nulka being launched from a ship.

Aircraft sustainment

Forensic crack investigations in RAAF's P-3C fleet

DST Group applied advanced forensic engineering to assess crack indications in critical P-3C wing panels. Although the cracks were confirmed, DST Group's expert analysis concluded that they were not a threat to structural integrity. This allowed P-3C operations to continue with minimal interruption.

DST Group also played a major role in investigating an anomalous whole-airframe vibration that was impacting the operations of the P-3C aircraft and causing airworthiness concerns. The testing and subsequent analyses were used to characterise the vibration, provide structural integrity advice and recommend maintenance inspections.

New fatigue damage algorithm for RAAF's F/A-18 aircraft

A new algorithm that combines a crack growth calculation with the traditional damage accumulation approach was developed, providing a more accurate calculation of the accrued fatigue damage in each F/A-18 aircraft. This allowed the fleet to be managed using existing metrics and procedures. As a result of RAAF's adoption of this method, the actual consumed fatigue life for each F/A-18 aircraft was recalculated and in a significant number of instances, the figure for consumed life was reduced. The implications of this change are significant and mean that fatigue is no longer likely to limit some operations of the fleet or lead to premature retirement of aircraft.

HOWSAT Program for RAAF Classic Hornet service life management

A novel rapid structural certification of the F/A-18 outer wing called the Hornet Outer Wing StAtic Testing (HOWSAT) Program delivered its findings about the aircraft's service life. Conceived and conducted by DST Group and RAAF, it demonstrated that the outer wing will not require costly wing skin removal and internal inspections prior to the end of service life. Follow-on testing is being conducted at a minimal cost to provide additional information for a few difficult-to-analyse locations, along with testing additional locations requested by the US Navy.

C-130J Wing Fatigue Test Program

In December 2015, after six years of fatigue test cycling amounting to over two lifetimes of operational usage, the international collaborative C-130J-30 Hercules Wing Fatigue Test Program came to a successful end. While structural teardown is yet to proceed, it is clear at this stage that the C-130J wing airframe is a highly durable structure, which can be expected to deliver significant financial and capability availability advantages for Defence.



Jireh Choi, Michael Konak and Crystal Forrester working on the F/A-18 Hornet Outer Wing Static Test (HOWSAT).



Simon Barter and Madeleine Burchill working on the Hornet Outer Wing Static Test Program.

ADF Wear Debris Analysis Laboratory

The ADF's Directorate General Technical Airworthiness recently partnered with DST Group to establish a laboratory dedicated to the rapid assessment of metallic debris recovered from aviation propulsion systems. The analysis conducted by the laboratory directly enhances the safety and availability of aircraft by enabling smart and informed maintenance decisions to be made regarding aircraft propulsion system health. For example, analysis of tiny particles discovered from an F/A-18 lubrication system were analysed and assessed as benign, enabling the engine to remain installed in the aircraft and allowing it to return to operations. This job alone saved potentially hundreds of thousands of dollars in unnecessary maintenance and enhanced the availability of the aircraft.

Filter screening tool for RAAF's PC9 fleet

Similarly, an instrument called the Filter Screening Tool, designed and built by DST Group and installed at RAAF Base East Sale and RAAF Base Pearce, is enhancing the safety of the PC9 fleet by accurately measuring the amount of metallic wear debris contained in an aircraft's lubrication filter.

Analysis of filter debris is an excellent means of assessing the health of gears, bearing and other critical rotating components in the engine and gearbox. The device uses an advanced sensor identical to that incorporated into the Joint Strike Fighter engine and provides instant feedback to maintenance staff about propulsion system health for the majority of RAAF PC9 aircraft. It has been approved by the Training Aircraft Systems Program Office as the primary assessment tool for PC9 filter debris with the potential for use in other types of aircraft.

Waterborne paints for RAAF aircraft

Due to the increasing environmental and regulatory pressures to reduce organic solvent emissions, and recommendations from the F-111 Deseal Reseal Board of Inquiry still resonating, the ADF is striving to minimise the volatile organic compound levels of coatings used to protect Defence platforms. New aqueous coatings formulated by DST Group have greatly reduced these levels while demonstrating considerable advantages over coatings currently in use. These waterborne topcoats also exhibit significantly extended durability under Australia's climate conditions compared to solvent-based paints. The new improved topcoats have recently been introduced into service on three RAAF C130J aircraft.

Similarly, DST Group has been evaluating the durability of an improved colour-stable low-solar absorbing non-skid deck coating for use on Navy ships. Advice has been provided to Navy and the new coating is now in use across the fleet.



Alvin Ng, Jarred Cyvulski and Peter Stanhope in the ADF Wear Debris Analysis Laboratory.



AP-3C aircraft in hangar (February 2016) for ground vibration testing to investigate airframe and control system response characteristics.



Flight tests were conducted during April to December 2016 on several AP-3C aircraft to investigate vibrations impacting operations.

Ensuring Defence is a smart buyer

DST Group supports Defence acquisitions by providing critical scientific and technical advice. It provides input to all stages of the acquisition process from the initial capability definition through to the selection process and introduction into service.

Technical Risk Assessments

Technical Risk Assessments are the primary method of providing acquisition advice. These assessments ensure that decision-makers in Defence and government are fully aware of the risks associated with a project, and help inform risk management strategies. The AS/NZ ISO 31000 Risk Management Framework is applied in providing technical risk assessments.

During 2015-16, a total of 21 technical risk assessments were completed for acquisition projects and 31 technical risk certifications were issued.

Support for the Future Frigate

DST Group's operations analysts have been assisting Navy studies on the Future Frigate being acquired under Project SEA 5000. A suite of modelling and simulation tools were developed to study the performance of the Future Frigate in different maritime warfare domains. The advice subsequently given to Navy on air warfare, surface warfare and anti-submarine warfare requirements has allowed the capability acquisition process to progress.

Meanwhile, an agile virtual combat system laboratory was set up for use in a human factors study to examine potential layout concepts for the Future Frigate's operations room to ensure that its design supports effective and efficient Navy operations. Data gathered from the simulated experiments with Navy personnel will identify user requirements and inform the next stage of the project.

Support to the Future Submarine Competitive Evaluation Process

DST Group provided extensive analysis that supported the competitive evaluation process used to select the international partner for the design and build of the next generation of Australia's submarines. The analysis included work on command team performance, control room layout, future technology drivers, combat system technology and architecture evolution.

Support for JSF acquisition

The marker band technique, developed by DST Group, provides a simple and efficient means of measuring crack growth in aircraft structures. US and international partners have accepted advice to extend the duration of airframe testing for the Joint Strike Fighter, using the marker band technique. In June 2016, the third and final period of airframe durability testing commenced on AJ-1, the variant relevant to RAAF. DST Group's fracture surface marker loads were also added to facilitate post-test interpretation of the growth of any cracking that may have occurred – a significant innovation in this test program. The outcomes of the program along with further DST Group input are expected to reduce sustainment risks and costs of the JSF airframe under RAAF usage.

Meanwhile, evaluation continues on the corrosion prevention performance of the JSF's environmentally friendly coating system in Australia's severe operating conditions. Advice is being provided on proactive strategies that can be used to minimise the incidence of corrosion on RAAF F-35s. Under its strategic alliance, DST Group is assisting BAE Systems Australia to develop the corrosion monitoring system (including sensors and corrosion prognostic algorithms) to be used on F-35 aircraft worldwide.



Vern Dutschke, Andrew Donohoo (at rear), Jason Barles (centre) and Julie Vaughn (right) conducting human factors study in support of the ADF's Future Frigate acquisition.



Acquisition of the Joint Strike Fighter is being assisted by DST Group research in a range of areas.

Attrition estimate for Triton surveillance aircraft

Defence is acquiring a fleet of MQ-4C Tritons – its first large high-altitude long-endurance remotely piloted aircraft – for use on extended surveillance missions, primarily over water. The business case identified attrition as the highest risk for the acquisition project (AIR 7000 Phase 1). Initial estimates of the attrition rates were found to be unviable and unaffordable.

In collaboration with the University of Melbourne, DST Group established an attrition estimate with robust and defensible results that were subsequently included in the updated business case to government, allowing the acquisition to proceed. DST Group played a critical role in providing this advice to Defence and government on a major acquisition project.

Support for body armour and soldier ensemble

Determining the size and location of body armour, in particular the hard ballistic body plate, is a challenging task that involves a trade-off between protection and soldier comfort. By using magnetic resonance imaging to scan the bodies of soldiers, DST Group was able to advise on the size of body plate needed to provide adequate protection. A suite of plate sizes was provided to Army to inform its decisions about plate acquisitions.

At the same time DST Group has undertaken human factors analysis of soldier body armour, load carriage systems, combat helmet and hearing protection equipment presented for Defence acquisition by industry suppliers. In the course of this work, a defence supplier was assisted in optimising the suitability of a load carriage system.

DST Group also undertook human factor assessments of tendered chemical, biological and radiological detection and protection systems in terms of their utility, suitability for purpose, sizing and thermal strain. These evaluations substantially influenced the choice of the preferred tenderer.

Camouflage vehicle canopy

Working with Army Headquarters and industry, DST Group designed and developed a replacement camouflage vehicle canopy for the new medium-heavy capability vehicles to be delivered under Land 121 3B. The new design introduces a modern rebranded and distinctive canopy that extends and blends both the vehicle and the canopy in an integrated systems approach, visually complementing the disruptive pattern paint system. The new Terra Australis Camouflage Canvas canopies are already being manufactured and progressively fitted to new vehicles.

Support for military radios

The Adaptive Networking Wideband Waveform is a military radio protocol for mobile ad-hoc networks. It has been implemented in the Australian Army's latest tactical software-defined combat radios to improve the capabilities of multi-mission radios tailored to the specifics of a military mission. DST Group undertook a detailed analysis of the radio protocol.

The work has informed projects for Enhanced Special Operations Capabilities and Land Tactical Networks. It has directly influenced project decision-making and enabled Australia's Special Forces to use their newly acquired radios and data networks to best effect.

For in-depth network performance testing of modern tactical military radios, DST Group developed a Network Analysis Tool which was enhanced during the year to support multiple tactical radio types, including those considered for acquisition. The tool is now being used successfully by Army's Land Network Integration Centre for tactical data network field experimentation and proving of network design concepts. Radio manufacturers have also shown an interest in accessing the 'smarts' behind this tool, particularly because of its ability to undertake controlled network analysis in the field.



Soldier modelling uniform and equipment to assist DST Group research.



Tom Schar working with soldiers on military radio protocol analysis.

Case study

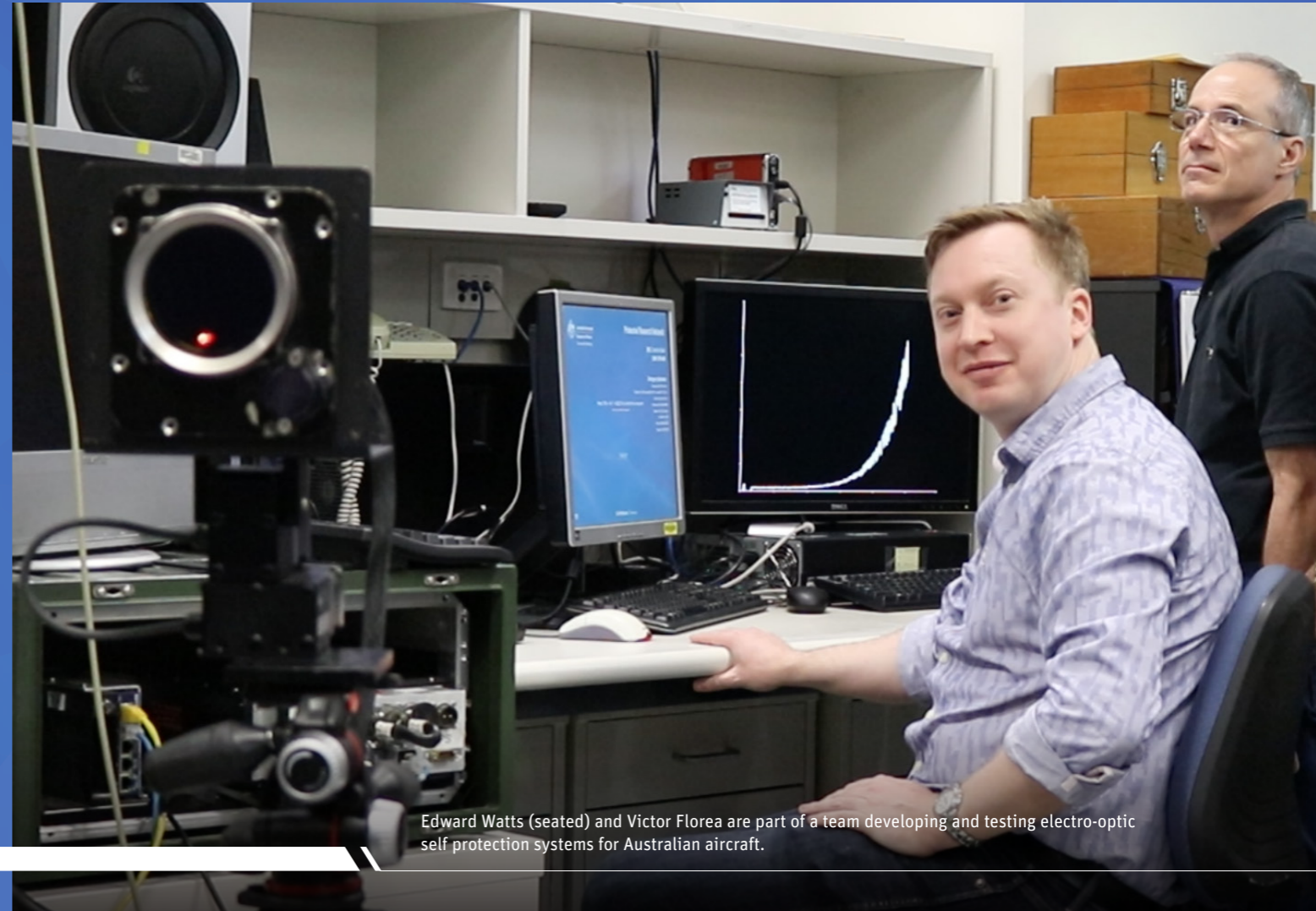
Missile warning system investigation

The AN/AAR-60 Missile Warning System is installed on Army's Armed Reconnaissance Helicopter and the MRH-90 Taipan helicopter used by both Army and the Navy's Fleet Air Arm.

During a software upgrade it was discovered that the manner in which the missile warning system was integrated in these two helicopters could affect their performance. DST Group's Electro-Optic Survivability Integration Laboratory was then used to quantify the impact on performance, enabling Defence to definitively demonstrate that a problem would occur when these aircraft were operated in a typical flight regime.

As a consequence, this problem was accepted by Airbus as a latent defect. DST Group worked with both projects (AIR 87 and AIR 9000) and Airbus to assess the effect of various rectification proposals, and solutions have since been identified. Without the Electro-Optic Survivability Integration Laboratory – an element of the Defence Airborne Countermeasure Development and Validation capability supported by BAE Systems Australia – this issue and the proposed solutions could not have been quantified and rigorously investigated.

According to Lieutenant Colonel David Lynch, the Armed Reconnaissance Helicopter and Multi Role Helicopter Resident Team Leader in France, "The work ... on ARH was of immense value in sourcing a solution from industry. For the first time in my memory ... we held the cards with superior knowledge of the problem. This led to us working with industry and directing rectification at low risk to the Commonwealth of Australia."



Edward Watts (seated) and Victor Florea are part of a team developing and testing electro-optic self protection systems for Australian aircraft.

Future-proofing Defence

An important responsibility for DST Group 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 Group 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.

Power and energy capabilities for deployed land forces

DST Group researchers have been taking a multi-pronged approach to delivering power and energy capabilities for use by deployed land forces. Different combinations of power generation, energy storage and power management technologies and systems have been investigated along with reducing energy demand in vehicles and deployed infrastructure. These measures include the use of phase-change materials that mitigate temperature rise and the application of a superior insulation material known as Aerogel, which could substantially reduce energy demand while maintaining occupant comfort.

For the dismounted combatant, flexible, ultra-high efficiency, ultra-thin silicon photovoltaic solar panels are being developed through a jointly funded Australian-US partnership with the University of NSW and the US Naval Research Laboratory. This project supports the Priority One Army Modernisation Line of Effort requirement to ensure freedom of access to power and energy in deployed environments.

Composite material for future vehicle armour

Researchers at the Ernst-Mach Institute in Germany worked with DST Group's Dr Long Nguyen on studies of the ballistic performance of ultra-high-molecular-weight polyethylene – a material that has shown great promise for use as body and vehicle armour. This collaboration, undertaken as part of Dr Nguyen's PhD studies, led to the creation of analytical and numerical models for ballistic impact research that gained significant international recognition by world-leading international peers.

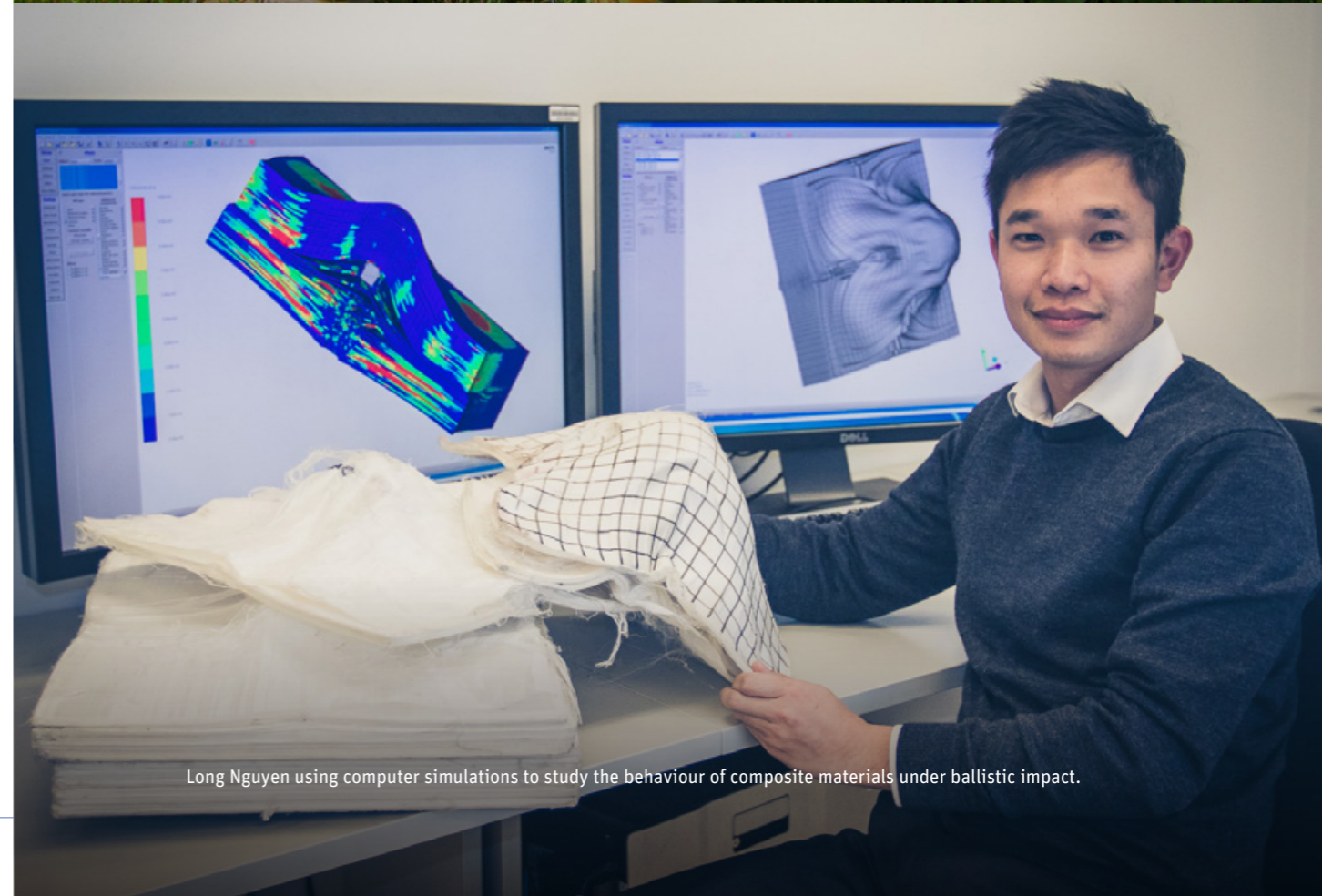
The work appeared in four peer reviewed high ranking journals and has also been presented at two of the largest international conferences in this field, the International Symposium on Ballistics and the Hypervelocity Impact Symposium. Dr Nguyen was awarded the Alex Charter Student Scholarship at the 2015 (international) Hypervelocity Impact Symposium for his numerical work and subsequently won the Land Defence Australia's Young Innovator Scholarship. His study has identified the potential to develop next generation vehicle armour from a composite material.

Defining protection for new armoured truck fleet

During the year, DST Group hosted the first ever meeting held in Australia of the North Atlantic Treaty Organization (NATO) Standardization Agreement 4569 panel on armoured vehicle protection. This intra-government panel of over 40 scientific and military experts from 16 countries is engaged in defining vehicle ballistic and blast protection levels against symmetric and asymmetric threats. DST Group's work within this panel is critical in defining the protection levels that Army's new armoured truck fleet and next generation of combat vehicles will provide to Australian soldiers. It also furthers Defence's understanding of the protection performance of military vehicles on operations.



Solar panels for powering soldier equipment.



Long Nguyen using computer simulations to study the behaviour of composite materials under ballistic impact.

High frequency line-of-sight radar

DST Group has developed a high-frequency line-of-sight radar (HF-LOSR) for use in a range of applications including the surveillance of space. The radar was first used in 2012 and has been employed regularly since then in various experimental campaigns and locations, including the HIFiRE 5B hypersonics flight test in May 2016. This radar is different to most HF radars that use either skywave or surface-wave propagation to achieve beyond-horizon target detection.

HF-LOSR is a bistatic high-frequency radar designed to achieve a simultaneous wide field of coverage by exploiting a floodlight transmitter system and a concurrent beam-of-receive architecture. Instantaneous coverage extends to more than a ninety-degree cone directed vertically and allows multiple satellites and air vehicles to be detected and tracked at the same time including fleeting targets that may be missed by scanning sensors. The system also provides insight into the scattering properties of targets relevant to the better-known over-the-horizon radars.

Improving Nulka missile decoy

SEA 1397 Phase 5C is a joint Australia-US program to develop an upgraded Nulka electronic warfare decoy payload to counter advanced missile threats to ships. DST Group has been supporting this phase of the program since 2007. The follow-on Phase 5D will focus on the production of the decoy rounds and will require ongoing considerations of architectural design and tactics development and refinement.

SEA 1397 Phase 6 aims to develop a completely new decoy type. Under a Future Naval Capabilities program, DST Group has engaged with Australian companies and the US Naval Research Laboratory, completing a number of concept prototypes including test and validation in real-world trials. The outcome has been a prototype that successfully demonstrates a novel architectural design.

High data rate satellite communications on the move

Defence's Capability and Technology Demonstrator (CTD) program recently delivered a Ka-Band tracking antenna land vehicle application. Building on this success, DST Group has been able to significantly increase the performance of high data-rate SATCOM-On-The-Move communications in the land environment by applying advanced communications signal processing techniques. The improved system was successfully trialled on a vehicle in late 2015 using the OPTUS C1 spacecraft, demonstrating the enhanced performance and bringing the capability one step closer to meeting the Future Land Force's requirements of a high data rate SATCOM-On-The-Move communications capability.

Mulwala propellant redevelopment project

The Mulwala Redevelopment Project aims to replace Australia's 1940s-era vintage nitrocellulose and propellant manufacturing facility with a modern plant capable of producing the range of propellants required by the ADF at enhanced production rates and with improved environmental and Work Health and Safety characteristics.

In support of this project, DST Group undertook extensive enabling research activities and developed an end-to-end characterisation capability – unique in Australia – to permit a robust assessment of the quality of the modernised propellant. This product assessment is essential for the qualification and certification of the modernised propellant and associated ammunition.



High data rate satellite communications on the move.

Coastal analysis for Army

Under the Army Experimental Framework, DST Group conducted a needs analysis for the ADF Coastal Littoral Estuarine and Riverine (CLEAR) capability. The study articulated the critical impact of extant CLEAR capabilities that are reaching life-of-type and defined how the CLEAR capability intersects with the Australian Amphibious Force to deliver a unified amphibious capability spanning littoral and riverine environments. The study sponsor, Lieutenant Colonel Dan Conners, commented that “the study feeds directly into the Joint Capability needs narrative, nested within the strategic guidance.”

Command, control, communications and ISR concept development

Through Army’s Limited Objective Experiments, DST Group developed a causal model of the future operational Combat Brigade Headquarters (CB HQ). The model is to determine the individual and combined impact on operations of the command, control and communications (C3) and intelligence, surveillance and reconnaissance (ISR) functions for different organisational, conceptual and technology enabled futures.

The experiment involved wargaming within a 2030 scenario and exceeded expectations. It delivered a causal decision-aiding model that combined existing evidence and expert opinion to inform C3 and ISR aspects of the future land operating concept. It also highlighted key areas of concern for the effectiveness of C3 and ISR in a future degraded and contested environment. Furthermore, it provided a modelling framework that could be reused to inform future follow-on concept studies.

Metamaterial innovations

In collaboration with researchers from RMIT University and the University of Arizona, DST Group is exploring innovative ways of using metamaterials – materials engineered to have properties not found in nature – in vehicle skins. Antennas integrated into composite structures have already been used in micro-UAV systems for advanced sensing systems that will help in ADF field deployment operations. An application for troop carriers is also being developed in collaboration with Thales, CASG and the Defence Materials Technology Centre via the University of Queensland.

Environmental signatures program

A research program was initiated to identify and prioritise the environmental signature threats such as bioluminescence (the light emitted by living organisms like deep sea fish), platform chemical discharges and underwater thermal signatures.

DST Group has constructed an in-house flow characterisation laboratory to measure bioluminescence associated with underwater bodies while collaborative work with Navy and the University of Melbourne has begun to determine the distribution of bioluminescence in Australian waters.

A new capability has also been developed to model and map chemical discharge signatures from undersea platforms. The findings are being fed directly into plans for the Future Submarine acquisition program.



A DST Group team investigated and improved the performance of embedded metamaterial antennas such as this Egyptian Axe Dipole design being embroidered into a composite material, with the help of DST Fulbright scholar Professor Rick Ziolkowski.

Advanced underwater autonomy

In September 2015, four scientists from DST Group participated in a TTCP exercise on collaborative missions with autonomous platforms held at the Advanced Maritime Technology Centre in the USA. The trial was an opportunity to demonstrate Australia's capabilities in advanced underwater autonomy including real-time time data collection and on-board processing with DST Group's synthetic aperture sonar and the automated target recognition (ATR) software developed to integrate and visualise results from all nations.

In addition to interoperating with US assets, the main objective was to demonstrate a workable collaborative mission between a REMUS 600 vehicle equipped with synthetic aperture sonar for wide-area search and smaller REMUS 100 vehicles equipped with shorter-range side-scan sonar for close-range classification of suspicious objects. One highlight of the trial was the discovery of a large torpedo that had been lost during WWII. The torpedo was imaged at a range of 100 metres with the synthetic aperture sonar and later revisited by a US REMUS 100 for high-resolution imaging and classification.

Urban autonomous system operations

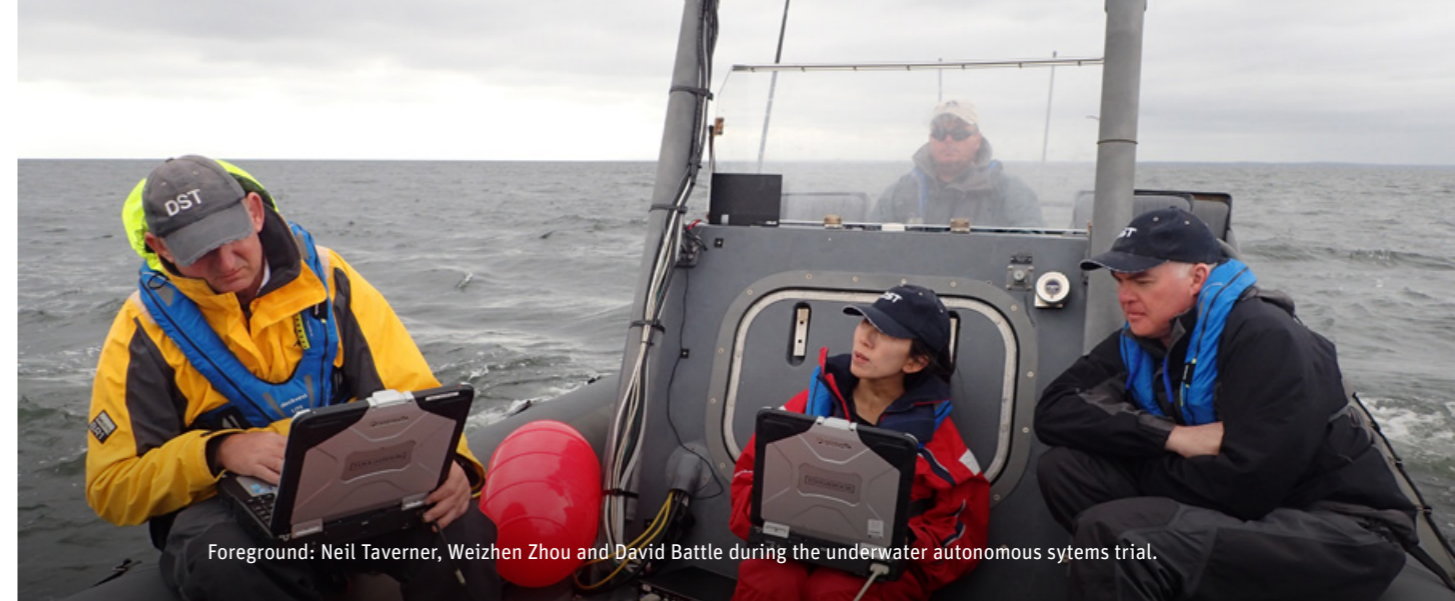
The use of autonomous systems in urban environments is a huge challenge. DST Group is undertaking research to demonstrate autonomous navigation, control and communication technologies suitable for terrain that is cluttered, congested and potentially contested. The research project is a collaboration with the MARCS Institute, RMIT University, the Australian Centre for Robotic Vision at the Queensland University of Technology and the Swarm Robotics Laboratory at Monash University.

The researchers are demonstrating the use of teams of airborne and ground robots for intelligence, surveillance and reconnaissance (e.g. mapping) missions and specialised missions such as localising the source of dangerous chemicals. These activities support TTCP's Contested Urban Environment Strategic Challenge as well as a Project Arrangement with Singapore on GPS-denied navigation in the urban canyon.

Autonomous systems supporting agile and resilient communications

In the course of high-tempo operations, hostile interference and node damage can cause lines of communications to be easily broken or to lose their efficiency and effectiveness. DST Group's OPAL system improves the survivability of communications in mobile tactical networks through the use of additional network nodes carried on autonomous airborne platforms.

The airborne nodes intelligently adapt their position in response to changing network and radio frequency conditions to self-heal the network. The OPAL algorithms have been validated in collaboration with the US Air Force Research Laboratory during a series of trials that will extend into 2017.



Foreground: Neil Taverner, Weizhen Zhou and David Battle during the underwater autonomous systems trial.



Research into autonomous aerial systems for urban operations.



Tom Stevens experimenting with the OPAL system for resilient communications.

Case study

Tyche – a strategic research initiative on trusted autonomous systems

The Tyche Program seeks to research and develop game-changing autonomous systems to operate in contested and complex environments. The program is structured around several themes.

DST Group is working closely with international partners and Australian research institutions to develop advanced navigation technologies that will allow unmanned aerial systems to navigate in GPS-degraded and denied environments. The technologies fuse data from bio-inspired solutions (including sunlight polarisation, geo-registration and optical flow) to allow successful navigation over sparse terrain without external GPS data. Ultimately, this will improve the resilience and safety of aircraft flight operating in GPS-degraded situations.

DST Group has partnered with the Australian Driverless Vehicles Initiative to examine the potential for autonomous fuel truck platoons to supply Defence's remote air bases with fuel. An innovative solution has been assessed to hold the potential to improve strategic air readiness, reduce exposure to risks and offer significant savings in operating costs.

Research was also advanced on autonomous planning for a cross-country undersea glider called Deep Ray, which seeks to exploit oceanic currents for improved efficiency during months of operation.

A multi-domain robotic teaming capability was developed in partnership with AOS Group, Boeing-Insitu and Deakin University using Insitu's CT-100 quad-rotor UAVs, a DST Group Polaris 6x6 all-terrain vehicle converted into an unmanned ground system, newly-developed intelligent agent teaming software and a new multi-vehicle tasking station. This test-bed forms part of a demonstration system showcasing what unmanned teams might be able to contribute to integrated force protection and area surveillance and response missions for Defence.

Development funding is being provided by the Air Force and Navy, both of whom are interested in the concept for airfield and harbour defence purposes. This represents a tangible and direct partnership cutting across academia and industry that is enhancing understanding of how to exploit teams of robots and also prepare the pathway for transitioning new technology to Defence.



A DST/AOS Polaris 6x6 Autonomous ground vehicle participating in the December 2016 demonstration of the multi-robot Extended Intelligent Watchdog system.

Enhancing national security

DST Group leads the co-ordination of science and technology research to enhance Australia's whole-of-government program for national security.

It works with other government agencies to:

- implement national security science and technology policy and coordination processes;
- manage the DST Group National Security Program;
- foster international national security research collaborations;
- provide strategic analysis of national security priorities and resourcing; and
- integrate counter-terrorism technologies to benefit Defence and civilian agencies.

Cyber security

A cyber security review was conducted by the Department of the Prime Minister and Cabinet, and DST Group made a particularly valuable contribution with advice on ICT supply chain security. This work facilitated the development of the Australian government's Cyber Security Strategy.

DST Group also reached the first milestone for the Joint Action Plan with the US Department of Homeland Security in cyber-physical system security by completing an initial study of elements of the maritime critical infrastructure sector regarding their dependence on information and communications technology.

Cyber security is a strategic challenge under The Technical Cooperation Program of the Five Eyes nations. DST Group is closely involved in each of the three activities that make up the program: Mission Assurance and Situational Awareness, Trustworthy Systems and Electromagnetic Cyber. These activities are strongly focused on engaging the operational community to shape current and future military cyber capability for Australia and its allies.

Home made explosives

A three-phase project to characterise the physical, sensitiveness and explosive properties of a home made explosive was conducted in collaboration with the US Combating Terrorism Technical Support Office and the ADF Joint Counter Improvised Threat Task Force. The aim was to understand the threat posed by this home made explosive to national security and current operations.

The task, conducted over four years, represents the most in-depth study of this class of home made explosive. The information obtained has been used to inform national threat assessments, enable the development of protection upgrades to vehicles, provide performance data to develop computational models and to enhance collaboration and information exchange among the Five Eyes partners.

National Security Science and Technology Centre highlights

The National Security Science and Technology Centre, a part of DST Group, coordinates and fosters the development of science and technology to enhance Australia's national security.

The highlights of its work for 2015-16 include:

- Presentation of a Cyber Operators Social Media Exploitation course;
- Obtaining the first imagery from Teledyne multiple input/multiple output radar scanner;
- Commendation from the Australian Federal Police Commissioner for support given to investigations into the MH17 airline disaster;
- Implementation of the Emergency Response Decision Support System on digital tablets and providing 37 domestic agencies with access to the system;
- Progress in research on MRI scanning for post traumatic stress disorder and brain trauma;
- Ongoing support to the international search for missing Malaysian Airlines aircraft MH370; and
- International collaborations with the Combating Terrorism Technical Support Office and the Department of Homeland Security in the US and the Home Office in the UK.



DST Group researchers working on home-made explosives experiments.



MRI scanning for post traumatic stress disorder and brain trauma.

Case study

Waterside security

Australian defence scientists participated in the final system evaluation trial of the Waterside Rapid Deployment Security System (WRDSS) project under a Project Arrangement of The Technical Cooperation Program (TTCP).

DST Group contributed the above-water security components for this system including the Shipboard Perimeter Protection System and a new multi-rotor UAV called Black Kite. The US partner, Naval Undersea Warfare Center, contributed underwater security systems including sonar sensors and effectors as well as the command and control software that connects all of the components.

The outcome of the project was a more comprehensive understanding of what is possible when a variety of modern technologies are combined to build a complete security system for protection of warships and critical waterside facilities.

Black Kite, developed by DST Group and RMIT University as part of the project, carries various camera and warning system payloads. The trial showed that incorporating the UAV into the security system improved identification, classification and response times, thereby improving the overall effectiveness of the security forces.

This project has been held up as an exemplar for the Enhanced Mutual Reliance concept promoted under TTCP. With the above-water components being contributed by Australia and underwater components by the US, the partners arrived at a system-of-systems that neither would have managed to develop alone.

The project team received a TTCP achievement award.



DST Group's Shipboard Perimeter Protection System (on tripod) and Black Kite UAV in use during the TTCP Waterside Rapid Deployment Security System project.

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.

During 2015-16, DST Group provided advice to the authorities during the Lindt Café siege in Sydney and continued to be involved in the investigations relating to the search for Malaysian Airlines flight MH370 and the MH17 flight shot down over Ukraine in 2014.

Remediation modelling after chemical/biological attack

For several years DST Group and Geoscience Australia have collaborated to estimate the remediation cost after a terrorist attack involving a chemical or biological weapon on an Australian city. This collaboration has involved combining DST Group predictions of the extent of contamination with Geoscience Australia's modelling of the clean-up costs.

The information is being used by the Australian Reinsurance Pool Corporation to support decisions on the size of the reinsurance pool required. The corporation was set up by the Australian government following the 2001 Amerithrax incident in the US that led to a global withdrawal of terrorism insurance.

MH17 investigations

DST Group continued to assist a whole-of-government response supporting the investigation and recovery operations following the destruction of Malaysian Airlines aircraft flight MH17 on 17 July 2014 in a conflict zone over Ukraine.

Work was completed on the formal program developed to support the overall forensic investigation into the incident.

The collaboration between DST Group and the Australian Federal Police Force has been highly successful, resulting in a combined keynote address at the Australia-New Zealand Forensic Sciences Symposium held in Auckland, New Zealand, during September 2016.

The team received a DST Group Achievement Award for Technical Excellence.



MH17 wreckage.



SECTION 3

PARTNERSHIPS AND OUTREACH

Enhancing outcomes through collaboration and engagement

DST Group 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, academia and other research organisations within Australia and overseas, DST Group greatly benefits from the knowledge, expertise and capability thus obtained, and ensures it can continue to provide world-class outcomes for Defence.

Partnering with industry

Alliances and agreements

Two new strategic industry alliances were signed in 2015-16, one with Qinetiq (focusing on aircraft and maritime structural integrity and unmanned aerial systems) and the other with Raytheon (focusing on submarine combat systems).

Four interactive project agreements were established during 2015-16 with BAE Systems Australia (Passive RF Sensor Performance and Additive Manufacturing); Airbus Group Australia Pacific (Armed Reconnaissance Helicopter, Fuel Tank Cap impact testing); and Northrop Grumman Australia (Unmanned Airborne Systems performance and logistics modelling).

Thales partnership on digital human modelling

The design of the internal components of concept military vehicles can be improved by employing Digital Human Modelling. DST Group and Thales have partnered to enhance commercially available digital models by taking soldiers' combat ensemble into account. These improved models provide designers with greater confidence that occupants will be able to complete their tasks efficiently in the newly designed concept vehicles.

Small and Medium Enterprises

A collaboration agreement was successfully negotiated with Jenkins Engineering Defence Systems, the first such agreement with a small business enterprise. The company will adapt DST Group's cone direction finder for its countermeasures systems.

Research outcomes taken up by Ultra Electronics Avalon Systems

DST Group transitioned its next-generation digital signal processing techniques and architecture into operational surveillance systems and transferred the intellectual property to Ultra Electronics Avalon Systems.

The next generation ultra-wideband digital receiver technology is also being transitioned to the company to provide a large capability improvement in Navy's electronic surveillance systems. This technology is being further transitioned to airborne maritime surveillance and collection systems in partnership with the US Navy, which is developing next generation maritime surveillance and collection capabilities and multi-intelligence systems as part of an anti-submarine warfare capability.

Intellectual Property

In November 2015, DST Group participated in IP Australia's launch of "Source IP", a single website for information sharing, licensing preferences and facilitating contact for intellectual property generated by the public research sector. Some 42 defence science and technology inventions are listed, of which 16 are flagged as available for further collaboration/licensing opportunities.



Raytheon Australia Managing Director Michael Ward and Chief Defence Scientist Alex Zelinsky after signing the Strategic Alliance during Partnerships Week.



DST Group's Dr Sam Drake and Jenkins Engineering Defence Systems Managing Director Mr Peter Jenkins at Partnerships Week 2016 during the signing of a collaboration agreement to boost the development of military electronic surveillance systems.

Partnering with universities

Over the 2015-16 year, six more universities joined the Defence Science Partnerships framework which provides a standardised agreement and costing model for engagement with DST Group. The total number of universities in the program is now 30 while another four were invited to join.

Due to the streamlined engagement process, there has been an increase in the number of agreements processed with a reduced transaction time. During 2015-16, 224 agreements were signed with a total value of \$20.4 million.

Any area within Defence can use the university engagement framework for research and collaborative interactions. The first collaboration under the new framework was facilitated between RAAF and the University of Technology Sydney.

University of Melbourne partnership on injury criteria

DST Group is partnering with the University of Melbourne to develop criteria for pelvis and spine injuries sustained by occupants when their land vehicle is attacked from underneath by an Improved Explosive Device. Existing crash test dummies are not appropriately designed for such threats. Consequently, the US Army is designing a new military crash test dummy, requiring new injury criteria.

Computing collaboration with the University of Adelaide

A new collaborative arrangement was established with the University of Adelaide on open and cloud information architectures for mixed military and civilian environments. Through the use of a service-oriented architecture framework, data retrieval and processing services will be collocated on the sensor owner's network, thereby reducing the volume of data transferred and processed centrally. The proof of concept will be demonstrated through a series of experiments on a simulated environment.

Siemens collaboration with the Queensland University of Technology

DST Group, Queensland University of Technology, Siemens Australia, and Siemens Global launched a five-year collaboration with the aim of advancing applied research in high temperature superconductors and transitioning these advancements to the defence, power and transport industries.

Defence Science Institute connecting university partners

Founded as a joint venture between DST Group and Victorian university partners in 2010, the Defence Science Institute (DSI) facilitates R&D connections that foster a globally engaged, competitive and innovative defence and national security sector.

As an example, in April 2016, the Institute convened its inaugural symposium at Engineers Australia's Melbourne facility, bringing together researchers, scientists, experts, small business enterprises and major corporations to discuss progress on Institute projects and the challenges currently facing their area of research. It provided an opportunity for potential collaborations and aligning activities with Defence's research and development priorities.

The Institute also administered a call for proposals for the pilot DST Group Competitive Evaluation Research Agreement (CERA) program which seeds Defence-related research proposals to maximise Defence outcomes and leverage activities between academia, industry and DST Group. Of the hundred-plus submissions received, six projects were funded. Following the successful pilot, DST Group will fund an additional round in March 2017.

Discussions have begun with State governments in New South Wales and South Australia, as well as with the University of Tasmania, on their initiatives to develop collaborative research arrangements similar to the Defence Science Institute model.

Partnership in Assistive Technology Innovation

Following a market testing strategy by DST Group, an organisation called the Partnership in Assistive Technology Innovation (PATI) was established involving Victoria University and the University of Melbourne. The strategic model of engagement has encouraged significant co-investment from the consortium (attracting support three times this amount from the Australian government) bringing together world-class expertise in ergonomics, physiology, biomechanics and engineering.

Aiming to become the Australian authority in assistive technology, PATI seeks to develop devices and test methods that enhance soldier mobility by reducing or transferring mechanical load and/or reducing physiological work rate. The strategic engagement involves not only clear near-term research outcomes for Defence but sets a framework for a self-sustaining entity beyond the initial four-year funding cycle.

DST Group partnership with Army for university collaborations

Based on the PATI engagement model, DST Group and Army have partnered to establish the Human Performance Research network (HPRnet) of universities across Australia to conduct collaborative research on Army's human performance research priorities. With a funding of \$4 million over four years, some six to eight Australian universities will form the initial nucleus of the HPRnet to undertake future-focused research on human performance and build a cross-discipline network of expertise to augment and enhance Defence outcomes.

Defence Science Partnerships

The universities in the program include:

- Charles Darwin University
- Curtin University
- Deakin University
- Edith Cowan University
- Federation University
- Flinders University
- Griffith University
- La Trobe University
- Macquarie University
- Monash University
- Queensland University of Technology
- RMIT University
- Swinburne University
- The Australian National University
- The University of Adelaide
- The University of Melbourne
- The University of New South Wales
- The University of Queensland
- The University of Sydney
- The University of Western Australia
- University of Canberra
- University of Newcastle
- University of South Australia
- University of Southern Queensland
- University of the Sunshine Coast
- University of Tasmania
- University of Technology Sydney
- University of Wollongong
- Victoria University
- Western Sydney University

The universities currently negotiating to join the program include:

- Australian Catholic University
- Bond University
- James Cook University
- Murdoch University

Partnering with government organisations

DST Group seeks to enhance its science and technology outcomes by collaborating with other government agencies, both domestically and internationally.

During the 2015-16 year, DST Group continued to work closely with three publicly funded Australian research agencies – CSIRO, the Bureau of Meteorology and the Australian Nuclear Science and Technology Organisation. It also developed a closer working relationship with the Australian Institute of Marine Sciences.

Research collaboration and support continued with the Department of Immigration and Border Protection, the Australian Federal Police and the state governments of South Australia and Victoria.

CBR protection collaborations

Maximising protection against chemical-biological-radiological threats while minimising the burden associated with respiratory and dermal protection is key to maximising mission effectiveness in a hazardous environment. DST Group partnered with the Defence Materials Technology Centre to develop a nanofibre composite material to improve dermal protection against aerosol threats. It also entered into a partnership with the Rapid Prototype Development and Evaluation program to develop broader spectrum longer life respirator canisters.

International engagement

Engagement with allies and regional partners is an important element of Australia's defence science and technology capability.

Effective international engagement provides opportunities to leverage from the capabilities and facilities of allies; increase interoperability; avoid duplication of effort; and exchange information, skills and expertise. This engagement has the potential to reduce costs for all parties while maintaining delivery of high level support to our Defence forces and national security agencies.

The 2016 Defence White Paper identified international engagement as an integrated core function across the entire Defence portfolio, aligned with the Strategic Defence Objectives.

In 2015-16, DST Group continued to build on its relationships with its traditional partners in the USA, UK, Canada and New Zealand while strengthening its regional engagement. This included the finalisation of a renewed Memorandum of Understanding with Singapore (July 2015), the first staff exchange of a DST Group official to Singapore (April 2016), signing of the first collaborative project with Japan in the area of marine hydrodynamics (December 2015) and negotiating collaborative arrangements with the Republic of Korea, Japan and India.

The 51st Principals Meeting of The Technical Cooperation Program (TTCP) was hosted in Sydney by DST Group. TTCP is Australia's most important collaborative agreement in Defence science, involving the Five Eyes partners USA, UK, Canada and New Zealand.

The Sydney meeting was one of the most significant TTCP meetings held in recent years with the Principals realigning the program's strategic intent to be outcomes-focused, departing from the historical emphasis on information exchange. The meeting reiterated the commitment to enhanced mutual reliance and support for strategic challenges such as cyber, autonomy and operations in contested urban environments. DST Group is playing a leading role in these research areas.



Minister for Defence Senator Marise Payne at the 51st Principals Meeting of The Technical Cooperation Program with (L-R): Dr Brian Young (NZ), Mr Jonathan Lyle (UK), Chief Defence Scientist Dr Alex Zelinsky (Australia), Dr Marc Fortin (Canada), Mr Stephen Welby (US).



President of Agency Defense Development from the Republic of Korea (6th from left) and his delegation during a visit to DST Group's Melbourne laboratory. (L-R) Mr Brendon Anderson, Dr Yong Woon Park, Mr Peter Shin, Ms So Rog Kim, Dr Seong Jin Ju, Dr Inho Kim, Dr Brian Hanlon, Dr Stuart Cannon, Dr David Holmes and Mr Murray Stimson.

Ricin test kit development

DST Group has been working with DSO National Laboratories (Singapore) and the United States Army Medical Research Institute of Infectious Diseases to develop and validate a robust test kit for the detection of ricin poisoning from clinical and environmental specimens.

Building on an Intellectual Property Agreement signed in 2014, a licensing agreement was signed in May 2016 by all parties, along with the Singaporean company, PWG Genetics Pty Ltd that will be responsible for commercialising the technology.

A Project Arrangement with the Singapore government's Defence Science and Technology Agency on Cognitive Engineering and Human Systems integration was also updated during the year and a program of work is being developed.

Atmospheric effects collaborative study

Atmospheric conditions significantly affect radio wave propagation impacting the performance of radio frequency equipment such as radar, communications and sensor systems. While modelling tools have been developed to predict RF propagation properties for various atmospheric states, these tools require validation through real-world testing. To this end, DST Group is conducting refractive index forecasting research through collaborations within Australia and overseas.

Australian partners include Navy and the Australian Bureau of Meteorology while those overseas include the Naval Research Laboratory, the US Space and Naval Warfare Systems Command, the Met Office in the UK, the Defence Technology Agency in New Zealand and Defence Research and Development Canada.

Fulbright Distinguished Chair in Advanced Science and Technology

DST Group sponsors the Fulbright Distinguished Chair in Advanced Science and Technology, which brings senior United States researchers to Australia on a four to five month appointment at DST Group or another research institution in Australia linked to DST Group.

The purpose of the Chair is for a distinguished researcher to undertake research into priority research areas for Defence, engage with DST Group staff through seminars and workshops and explore long-term collaborations and linkages. This also helps advance mutual understanding between Australia and the US through research and cultural exchange.

The 2016 Distinguished Chair was Professor Doug Cochran from Arizona State University, who brought to DST Group an in-depth knowledge of mathematical methods and their application to electronic remote sensing systems. While in Australia, he collaborated closely with DST Group mathematicians Songsri Sirianunpiboon and Stephen Howard to work towards better signal processing algorithms with potential Defence and civilian applications.



Professor Doug Cochran

Successful Round 20 Capability and Technology Demonstrator proposals

The purpose of the Capability and Technology Demonstrator program is to enable Australian and New Zealand industry to demonstrate how a particular technology might be used to enhance or replace a Defence capability. Throughout its history, the CTD program has proven to be highly successful in bringing together Defence, research organisations and industry to work on developing new technologies to the demonstrator level.

Under the new unified model for Defence innovation the program has been transferred to the Innovation Hub coordinated by the Strategic Policy and Intelligence Group.

During the 2015-16 year, the latest round of approved technology development proposals included:

See and hear-through armour

Tectonica Australia will demonstrate a system that will enable an armoured vehicle crew to see and hear through the sides of their vehicle. Wearing virtual reality glasses with headphones, the user will see what is happening outside the vehicle and hear the direction of sounds relative to their head.

Maritime composite RF sensor performance-decision support system

BAE Systems has proposed the development of a decision support system to significantly enhance battlespace awareness in the maritime domain. The system will enable warfighters at sea to make better decisions by combining the performance of available radars.

Laser cladding repair technology

RUAG is developing laser cladding technology to rapidly and readily repair corroded, worn and damaged aircraft components. This will reduce the costs associated with aircraft maintenance and improve aircraft availability.

Ultra-high quality signal generation for over-the-horizon radar

The University of Adelaide aims to upgrade the overall performance of JORN through an upgrade of its essential sub-systems to improve detection of targets.

Precision inertial navigation with cold atoms

The Australian National University aims to improve the performance of inertial navigational systems in GPS-denied or degraded situations. This technology can be applied in the maritime, land and air domains.

Intelligent battlespace advisor

Agent Oriented Software is developing technology that acts as an advisor to intelligence analysts and operators to augment their skills and provide an additional layer of certainty.

Submarine stealth induction mast

PMB Defence Engineering proposes to demonstrate a highly hydrodynamic mast for submarines to improve their stealth capability.

Outreach, diversity and inclusion

DST Group reaches out to foster the development of new talent, supports the career development of future leaders and helps shape workplace diversity through inclusion. These efforts were increased during the year by engaging with schools, tertiary institutions and community development programs.

During the year, student placements into DST Group increased to 83, with a record number of 21 enrolments in the Science, Technology, Engineering and Mathematics Cadetship Program. Of these students, seven graduates are expected to transition to ongoing employment in December 2016 and a further 10 next year. More cadets will be recruited for the 2017-18 program.

The year also saw the inaugural Defence Student Conference held in February 2016. The conference was a finale to the student placement programs, enabling each student to showcase their research experience through presentations.

A STEM Day was one of the highlights of Partnerships Week held in the Melbourne laboratory. Future talent influencers (STEM teachers, STEM organisations, education and curriculum bodies, publicly funded research organisations and government stakeholders) came together to get a better understanding of science and technology in a Defence environment. New and emerging partnerships have formed from this event, including more opportunities for scientists to contribute in a greater variety of outreach and engagement activities, which in turn are building a positive reputation for the DST Group within the community.

As part of the Scientists and Mathematicians in Schools program, DST Group hosted a visit to its Edinburgh laboratory by year 11 and 12 physics and chemistry students from Adelaide's St Mary's Girls College. In Melbourne, a group of sixteen Year 9 students, who have signed up for a Year 10 engineering course at Eltham College, visited the Fishermans Bend laboratory for a tour of activities in the Aerospace Division.

As Indigenous Champion for Defence and in alignment with Defence's Reconciliation Action Plan 2015-2018, the Chief Defence Scientist launched DST Group's Indigenous Engagement Program 2015-2018. The program seeks to attract and develop a strong and capable Indigenous workforce, foster knowledge of Indigenous culture amongst all staff and leverage the diverse perspectives, experience and knowledge of Indigenous colleagues. The Indigenous artwork *Song of the Seven Sisters*, launched in 2014, was replicated at all DST Group sites. The Chief of the Defence Force commissioned its sister piece as a demonstration of the importance of gender inclusion in Defence.

Partnerships Week 2016

Following the success of the inaugural event in Adelaide during 2015, the second Partnerships Week was held at the Melbourne laboratory in June 2016. A total of 326 visitors from industry, universities and other research organisations participated in the two open days, and almost 60 from the education sector attended the STEM day.

A series of presentations, interactive workshops, laboratory tours, technology pitches, demonstrations and displays kept the visitors engaged as new connections were forged and collaboration opportunities were explored.

A workshop on Grand Challenges for Defence was very well attended as part of consultations with industry and academia to identify complex problems requiring solutions.

A new strategic alliance was signed with Raytheon during the week as was a collaboration agreement with the small business Australian company, Jenkins Engineering Defence Systems.

Feedback from the attendees was clearly in favour of continuing the event in future years to maintain the momentum for external engagement.



Propulsion engineer Matthew McKinna with Year 11 and 12 science students from St Mary's Girls College in Adelaide.



Science experiments for students during Partnerships Week.

Raising awareness and enhancing reputation

Raising the profile and enhancing the reputation of the organisation are core elements of external engagement for DST Group.

While coverage in mainstream media continues to grow with prominent features in *The Australian*, *The Financial Review*, *Sun-Herald* and *Networks 9 and 10*, the emphasis this year was on social media coverage, particularly Twitter and Instagram.

There was a 60% increase in Twitter followers and 11.5% among LinkedIn followers. During Partnerships Week, DST Group tweets generated 30,700 impressions over 5 days; i.e. they were delivered to 30,700 Twitter streams. The engagement rate for these tweets was above average, ranging from 1.3% to 3.2% while the global average is between 0.5% to 1%. Twitter posts were viewed by members of the general public as well as academics, students, industry and media, spanning a range of age profiles. The use of social media has introduced DST Group to new and untapped audiences in the wider community.

Participation in high-profile science and industry events was supported during the year. They included the Pacific Maritime Expo, the Future Land Force Conference, Science Meets Parliament, Science Meets Business, National Science Week, Invitational Symposium on Trusted Autonomous Systems and the Eureka Prizes.

DST Group has been proactively nominating for prestigious science and innovation awards to validate its reputation for scientific excellence by benchmarking its work against other contenders. As a result of these efforts, during the year, the Redwing suite of counter-IED systems developed by DST Group jointly with Defence and industry received the inaugural innovation award from the Institute of Public Administration Australia.

The Chief Defence Scientist remained tireless in raising awareness of defence science and technology among a wide range of stakeholders. He gave presentations at high-profile industry and university events throughout the year.



Paul Phillips briefing Minister for Defence Industry Christopher Pyne at the DST Group display stand during the Land Forces event.



SECTION 4

INVESTING IN OUR PEOPLE, OUR ASSETS, OUR SUCCESS

Valuing our people

DST Group is committed to nurturing staff to become effective future leaders and supports their career development to ensure they give of their best and deliver outstanding scientific support to Defence.

A range of initiatives to advance talent, diversity and career development is yielding results.

Leadership, accountability, learning and development

DST Group is remodelling its leadership and accountability framework in the S&T classification structure. The introduction of a range of specialist roles at the S&T 6 classification level – advisors, research specialists, applied S&T specialists, discipline leaders and S&T managers – will play a central role in developing a future workforce with the correct balance of experience and skills to meet future challenges.

The science leadership program continued as a primary element of the strategy to achieve a workforce skilled to deliver the future outcomes needed by Defence and national security clients. The ongoing Science Leadership Development Program, the Graduate Program in Scientific Leadership and the Leadership Exploration and Development in Science Program were instrumental in providing staff with skill sets critical for scientific leadership and succession planning.

The new Science Strategy Innovation and Excellence (SIX) Program reached around 450 S&T6 staff in 15 workshops during 2015-16. SIX aligns with DST Group's Strategic Plan Initiative O1 to provide the S&T6 cohort with enhanced strategic awareness, mentoring and coaching ability and good grounding in the strategic leadership, collaboration and innovation skills needed in their future roles.

Training in change management was provided for a further 20 staff, expanding the team within DST Group who are accredited in the Prosci methodology and the associated ADKAR change management principles.

The S&T Education Initiative also assisted around 30 people with their post-graduate coursework studies.

DST Group conducted induction programs for the cohort of new employees, cadets, participants from the Indigenous Australian Government Development Program and a number of Defence employees.

Recruitment

Chief of Division level 2 roles in Maritime and Land Divisions saw the pilot of a rigorous benchmark approach involving interviews, stakeholder discussions and technical presentations with a variety of ADF clients, industry and academic partners, peers and staff.

To address the risk of loss of developing talent from the S&T ranks, 150 career development positions at S&T 5 and 6 classification levels were advertised. A contemporary approach to selection involved removal of personal and diversity identifiers to ensure a transparent and fair approach to decision-making, with 150 successful candidates commencing new roles around the beginning of July 2016.

DST Group continued to grow its talent pipeline through initiatives that provide a seamless transition from university into the workforce for high performing undergraduate students in difficult-to-recruit disciplines. Two cadets from the inaugural DST Group cadetship program have now commenced S&T 3-4 roles with Weapons & Combat Systems and Maritime Divisions respectively. A further nine cadets were recruited in 2015-16 to expand the program to 20 cadets across all research divisions.

To further increase the research capability in critical science and technology areas, eleven post-doctorates and five graduates were recruited – the largest entry-level intake of graduates and post-doctorates since 2011.



Team members at a SIX workshop (L-R): Sam Huf, Warren Smith, Peter Henley, Thanh Ly, Lloyd Hammond, Cath Morgan, Maree Agiazis, David Bowden, Jim Smelt, Kevin Gaylor, Jane Perkins, Derek Bertilone and Steve Hoefs.



DST Group cadet Katie Mortimer-Murphy worked with summer vacation student Jonathon Milford on a research project.

Diversity

Gender diversity in Science, Technology, Engineering, Mathematics & Medicine (STEMM) is recognised nationally and internationally as critical to organisational productivity and innovation. DST Group has been working on accelerating and embedding gender diversity across the organisation.

During the year, DST Group joined the Science in Australia Gender Equity (SAGE) program of the Athena Scientific Women's Academic Network (SWAN) Pilot promoting gender equity and gender diversity in STEMM organisations. Australia's most respected STEMM organisations are part of the SAGE Pilot, including 25 universities, five medical research institutes, the Australian Nuclear Science and Technology Organisation and CSIRO.

As part of the SAGE Pilot, DST Group will collect, analyse and present data on gender equity policies and practices, identify gaps and opportunities for improvement and share strategies and findings with other participating organisations.

Athena SWAN has an international reputation for creating gender inclusive workplaces in science agencies, with accredited institutions demonstrating a competitive edge in attracting the best scientists. Participation in SAGE demonstrates a strong commitment that DST Group is serious about advancing gender diversity in the organisation.

Pathway to change insights

Staff participated in an insights survey and a one-pulse poll to give ongoing feedback on organisational performance. The feedback enables the leadership team to determine priority areas for changes and improvements, and assists in monitoring Strategic Plan implementation.

Since 2014, there have been significant improvements in staff attitudes in two areas: teamwork and collaboration, and client outcomes.

Employees communicated their strong belief that the best things about working for DST Group include:

- the ability to achieve client outcomes (particularly for the ADF);
- working with smart professionals and in strong teams;
- engaging in applied science work that was diverse, challenging, interesting, innovative and rewarding; and
- having access to flexible employment conditions with work-life balance.

Areas that staff considered could be improved included managing workforce resources to meet work and capability demands as well as improving information and communications technology (ICT) and information management and technology (IM&T) systems. Divisional action plans have been established and implemented with a high level of employee consultation and engagement.

Staffing and structure

In line with Government direction to all Commonwealth organisations, DST Group undertook a program of workforce rationalisation throughout 2015-16. As a result, the workforce fell from 2,175 full time equivalent staff at the beginning of the financial year to 2,105 at the end.

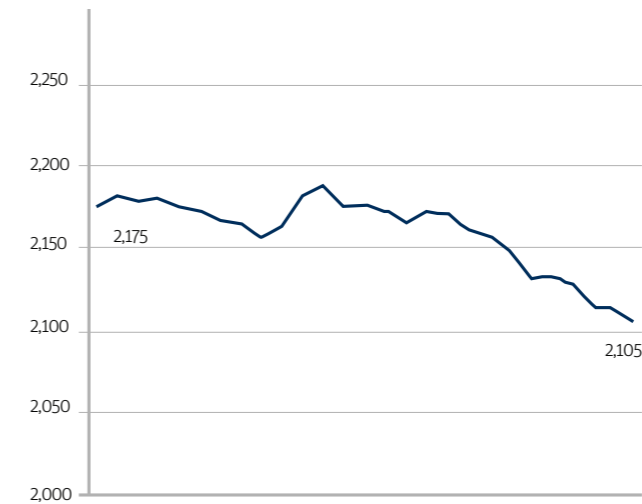


Figure 7: DST Group staffing numbers 1 July 2015 to 30 June 2016.

DST Group also undertook restructuring as part of implementing recommendations from the First Principles Review, *Creating One Defence*, released in April 2015. The two Chief of Division level 3 positions located in Adelaide and Melbourne were abolished in July 2015, and two new enabling divisions, Science Partnerships & Engagement and Science Strategy & Program were established under Chief of Division level 2 managers.

Two new Chief of Division level 1 positions were established during 2016. The Chief Science and Technology Program will manage the critical relationships DST Group shares with the ADF while the Chief Technology Officer-National Security, provides an important link between DST Group S&T capability and its national security clients.

High achievers



Order of Australia

Loris Molent for significant service to aeronautical engineering, particularly to the structural integrity and airworthiness of Australian Defence Force aircraft.

Seen here receiving the award from Her Excellency, the Honourable Linda Dessau AM, Governor of Victoria.

2015 Minister's Award for Achievement in Defence Science

Dr Mark Patterson for outstanding contributions to enhancing the protection and performance of ADF personnel.

Seen here receiving the award from the Honourable Mal Brough, former Minister for Defence Materiel and Science.



2016 Public Service Medal

Zenka Mathys for outstanding public service supporting Australian Defence Force platforms and operations, especially her contribution to fire protection systems on naval platforms.

Seen here receiving the award from Her Excellency, the Honourable Linda Dessau AM, Governor of Victoria.

Directors' Spyglass Award

Tony Lindsay for contributions to the US National Reconnaissance Office.



2015 Cooperative Research Centre Association "Excellence in Innovation" Award

Michael Ling for leading a team in the development of boron carbide ceramic armour.

Jim Arnold Square Dance Award

Nick Redding, Jamie Sherrah, Carmine Pontecorvo, Guy Blucher, Ian Ligertwood, David Booth, Michelle Chamalaun, Gary Brushe, Darren Frith for efforts exemplifying true multinational collaboration with the US Department of Defense, achieving true technological advances with a clear exploitation route.



US National Intelligence Meritorious Unit Citation

(Back, L-R): Dan Meehan, Gordon Frazer;
(Front, L-R): Larisa Lindsay and Glenn Keesing
 for outstanding service over eight years to the Australian-US RASCAL Project.



Combating Terrorism Awards (Australia-US)

Two teams of DST Group staff received awards to acknowledge the excellent research being undertaken in the partnership between Australia and the United States to combat terrorism:

Structural Vulnerability and Assessment Team (Christine Pienaar, Norbert Burman (ret.), Jadranka Sunde (ret.), Hiroshi Yokohama, Simon Ellis-Steinborner, Rob Hart, Andrew Smith, Phillip Mellen, Ken Schebella (ret.), Michael Podlesak (ret.), Johnson Tran) for significant contributions to blast effects and mitigation studies including development of modelling tools.

Improvised Explosives & Devices Team (Ben Hall, David Armitt, Phil Davies, Matt Smith, Ben Rogers, Simon Ellis-Steinborner, Mark Fitzgerald) for significant contributions to the study of home made explosives.



Christine Pienaar



Ben Hall



Ben Rogers



Rob Hart



Hiroshi Yokohama



Johnson Tran



Mark Fitzgerald



Simon Ellis-Steinborner



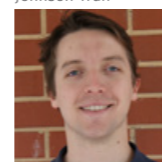
Andrew Smith



Phil Davies



Matt Smith



Phillip Mellen

Chief of Air Force Gold Commendation

Craig Hardie, Alex Ziegeler, Mark Pszczel for supporting RAAF Classic Hornet operations in the Middle East, including significantly improving the operational capabilities of ASRAAM.



CDS Fellowships

Two scientists commenced CDS Fellowships in July 2015.



Dr Bruce Crawford (Aerospace Division)

Project title: *A unified model of how environmental degradation reduces structural integrity.* By combining experimental work and probabilistic modelling of crack growth, Dr Crawford's research will develop a new model to predict the effects of multiple kinds of environmental degradation simultaneously on corrosion affecting aircraft structural integrity.

Dr Lucia Falzon (National Security, Intelligence Reconnaissance and Surveillance Division)

Project title: *Tracking diffusion and coordination processes over social media networks.* Dr Falzon's research aims to assess the extent to which time-stamped social media data can be used to answer questions in the intelligence domain about potential social trends, group formation and coordinated activities.



Divisional Fellowship



Dr Kevin Hong (Weapons and Combat Systems Division)

Dr Hong's research is focused on high-power microwave (HPM) directed-energy weapons, highlighting technical areas for further investigation.

DST Achievement Awards 2015

Category	Winner(s)
Science and Engineering Excellence	MH370 team (cross divisional) for their significant contributions to the Australian Transport Safety Bureau investigation and search for the missing passenger aircraft MH370.
Technical Excellence	OASIS team (Cyber & Electronic Warfare Division), recognising five years of work developing a solution to one of Navy's most important problems - how to provide high data-rate satellite communications to Navy ships in high threat environments
Outstanding Contribution to Defence Outcomes	Haze Grey Paint team (Maritime Division) for their development of a colour-stable, low solar absorbing topcoat paint for Navy vessels.
Outstanding Contribution to Defence Outcomes	Australian Multicam Camouflage Uniform team (Land Division) for their development of the Australian Multicam Camouflage Uniform with enhanced visual and IR protection for the ADF.
Outstanding Contribution to Defence Outcomes	Chris Ekins (National Security & ISR Division) for his contribution to the delivery of geospatial information infrastructure and services to Defence and, in particular, for his exceptional initiative in providing geospatial imagery to civilian authorities during the 2015 Sampson Flat bushfire emergency.
Outstanding Corporate Contribution	ReSET Panel team (cross divisional) for their successful development and implementation of a Standing Offer Panel that has helped achieve important cost savings and value-for-money when engaging research, science, engineering or technical services.
Outstanding Early Career Achiever	Huon Bornstein (Land Division) for his invaluable contribution to the blast protection of military vehicles, particularly those used by deployed Australian forces.
Outstanding Contribution to Collaborative Partnerships	Redwing team (cross divisional), for working closely with the Counter-IED Task Force, the Australian Military Sales Office and various industry partners to develop, manufacture and deploy a large volume of specialised force protection systems for use by National Defence and Security Forces in Afghanistan within extremely short time frames.
Outstanding Communication of Science and Technology	Marc West (Joint and Operations Analysis Division) for a long, impressive and passionate history promoting science to the wider community through his volunteer work as a radio presenter and work with school students.

TTCP Awards 2015

Category	Winner(s)
Joint Systems Analysis Group Technical Panel 4, Systems Engineering for Defence Modernisation	Aase Jakobsson and Shari Southberg for developing recommended practices in the engineering of military systems – practices that are helping to reduce the risk involved in fielding new systems, improve the ease of integration, lower acquisition and ownership costs and enhance military capability.
Materials and Processing Technology Group Technical Panel 1, Incorporation of Higher Strength Steels and Advanced Welding Processes in the Fabrication of Naval Surface Vessels	Zoran Sterjovski and Joe Donato for significant contribution to the advancement of welding technologies, resulting, most notably, in the incorporation of pulsed tandem gas metal arc welding into the fabrication of the Australian Air Warfare Destroyers.
Maritime Systems Group Technical Panel 13	David Battle and Weizhen Zhou for significant contributions to improving the performance and survivability of maritime unmanned systems.
Distinguished Service Award	Jeremy Blackwell for his outstanding contribution to the Aerospace Systems Group of TTCP since 2002.

Investing in organisational enablers

During the year, investments were made in infrastructure and resources to enhance research capabilities and organisational effectiveness.

Improved research infrastructure and facilities

A number of projects of new and enhanced infrastructure projects for platform divisions based at the Melbourne site were completed. The centrepiece was the completion of state-of-the-art positive containment laboratories in a secure environment. The containment systems enable the safe handling of a range of hazardous materials that the ADF may encounter, thereby facilitating the development of appropriate counter-measures and decontamination procedures. These laboratories are designed to deliver a rapid response capability for the ADF when encountering new threats, and to enable continuous improvement trials for their existing protection systems.

A new reconfigurable test facility was also opened for engine and battery testing. This can be connected to a number of fuel, load and atmospheric supply systems, enabling tests to be conducted in ideal conditions.

In addition, other laboratories and facilities were refurbished and updated across the DST Group estate, improving routine operations capabilities.

Enhanced advanced scientific engineering capabilities

Investments in leading edge engineering facilities were made to provide substantial improvements in both design and manufacturing capabilities. Enhancements in micro-engineering included world-leading R&D-focused sputtering coating systems, plasma-enhanced chemical vapour deposition and laser micro-machining and inspection processes. The new additive manufacturing capability is one of the most advanced and versatile in Australia, with the capability to work in a range of metals and several alternative plastic-based technologies.

Transforming research ICT capabilities

Through its Strategic Initiative on transforming ICT to drive innovation and collaboration, DST Group made substantial improvements to its ICT capabilities for research. The centralisation of ICT research services and support made steady progress while a large number of stand-alone networks were remediating, leading to a reduction in the security threat footprint and more consistent access to centralised research networks. The ability to rapidly and securely ingest large volumes of research data into research networks was improved, allowing more rapid analysis of information for research outcomes. The amount of centralised storage and computer capacity was substantially increased to provide scalable solutions for future research growth.

A public cloud-based collaborative service was piloted to enable unclassified code and data to be jointly developed and shared by both DST Group and university researchers. In parallel, a pilot was established to introduce virtualised server technologies to deliver light-weight clients as well as the rapid provision of server clusters for research purposes. A new supercomputer was procured for AIR 6000 while the Defence Integrated Investment Program included funding for further investment in secure high performance computing and supercomputing to meet future DST Group and Defence research and simulation requirements.

During the year, transition continued towards digital delivery of research information and library services. Digital resources were expanded through the Safari Books online service, the introduction of BrowZine online journals, and SciVal citation analysis tools. Rationalisation and consolidation of physical collections commenced and the Research Information Services web site was redesigned to enable more efficient search and discovery by scientists. In-perpetuity borrowing rights were introduced for both physical and digital information resources.



New Human Protection, Performance and Security facility at Fishermans Bend.



3D printer for additive manufacturing.

An aerial photograph of a rocket launch. The rocket is ascending vertically, leaving a thick, white plume of smoke and fire. The launch is taking place in a vast, flat, arid desert landscape with some scattered buildings and roads. The sky is a clear, bright blue. The text 'SECTION 5' and 'EMERGING FUTURES' is overlaid in the bottom right corner.

SECTION 5
EMERGING FUTURES

Emerging futures

Foresighting studies provide insights into long-term futures and how broader socio-economic trends impact science and technology developments. The study of emerging science and technology areas enables Defence to avoid strategic surprise as well as exploit opportunities for building capability.

DST Group's assessment of science and technology trends was instrumental in shaping the key priority areas identified in the White Paper for further development into game-changing capabilities. These included integrated intelligence, surveillance and reconnaissance, space capabilities, enhanced human performance, medical countermeasure products, multidisciplinary material sciences, quantum technologies, trusted autonomous systems, cyber, advanced sensors, hypersonics and directed energy capabilities.

Autonomous systems

DST Group is exploring the likely benefits that may be realised from adopting potential game-changing technologies within the logistics capabilities of the Army. An evaluation program is examining the technological potential and military application of automation and autonomous systems for achieving logistic effects in tactical land operations as well as advanced manufacturing technologies that provide a different approach to manufacturing parts and repairing equipment for deployed land forces.

During the year, the Strategic Research Initiative in Trusted Autonomous Systems (Program Tyche) gathered further momentum with an important Invitational Symposium on Trusted Autonomous Systems (ISTAS). The symposium brought together 120 minds from Defence, industry and academia, including a number of eminent researchers to discuss the implications of operating autonomous systems in unbounded and uncertain environments.

Hypersonics

On the hypersonics front, the seventh HIFiRE flight test was launched at the Woomera Test Range in May 2016. Following a perfect countdown, the HIFiRE 5b rocket ascended to an apogee of 278 kilometres, reached a velocity of Mach 7.5 and landed 390 kilometres down range after having closely followed the flight path required by the experiment and by safety considerations.

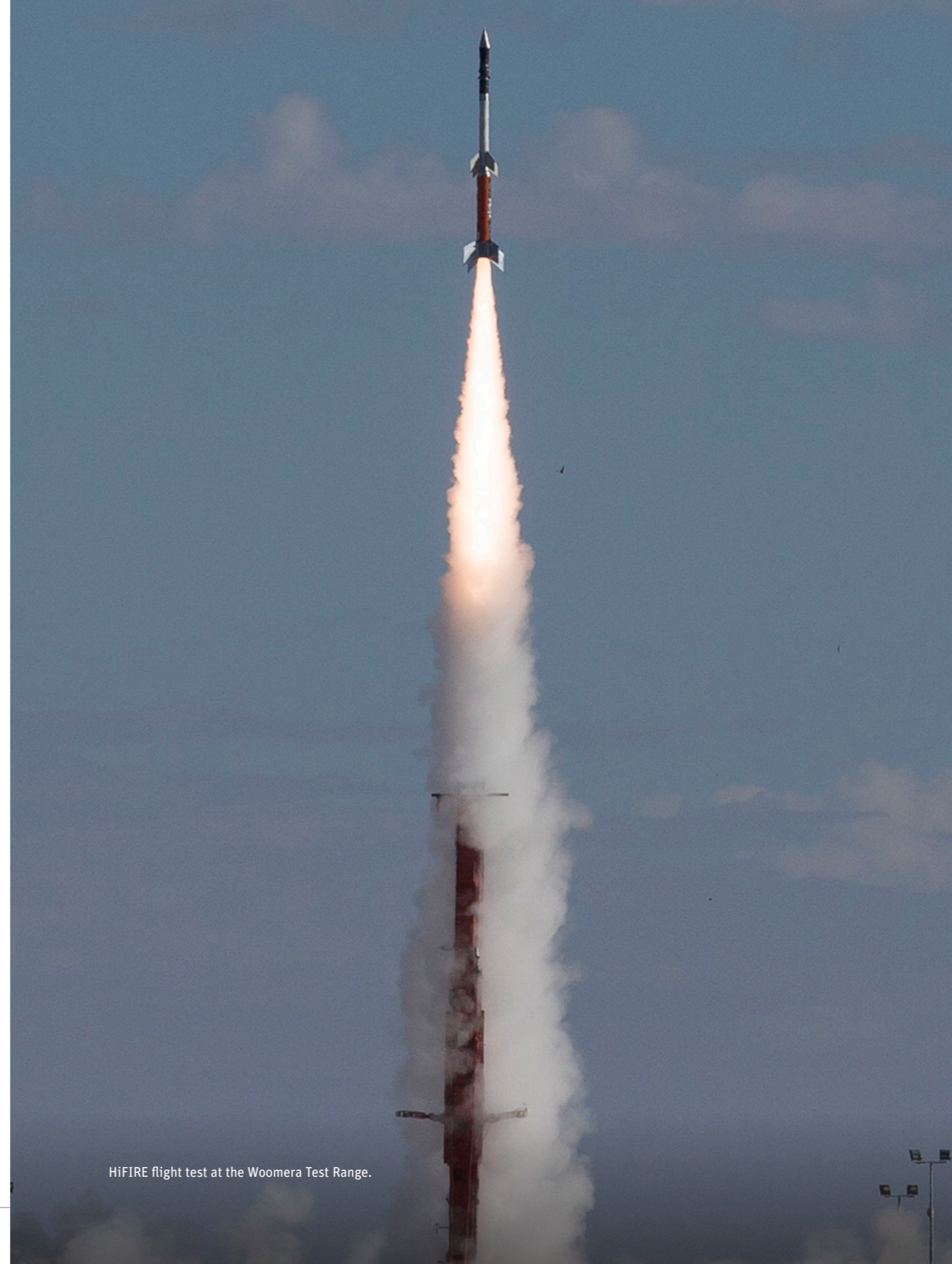
The trial objective was to collect data on airflow over the flight vehicle's surfaces at hypersonic speeds above Mach 7. By all standards, the trial was a complete success, with the telemetry system having worked flawlessly and high-quality flight data being collected throughout the flight.

This trial was the culmination of years of work undertaken by DST Group along with the US Air Force Research Laboratory, the German Aerospace Center and the University of Queensland.

The scientific experiment for the flight was designed by the US Air Force Research Laboratory while the German Aerospace Center provided the second stage rocket motors. DST Group designed and built the flight vehicle, complete with all instrumentation and flight control systems, and integrated the vehicle to the rocket and launch system.

The HIFiRE (Hypersonic International Flight Research Experimentation Program) involves a series of 10 experimental flights with US Air Force Research Laboratory, the University of Queensland, Boeing and BAE Systems as the principal partners with DST Group.

Through its work on the HIFiRE series over the past ten years, DST Group has developed world-class expertise in hypersonic flight development and testing. This program enables Defence to evaluate hypersonic concepts and contribute to the development of future platforms, putting the ADF at the forefront of this game-changing technology.

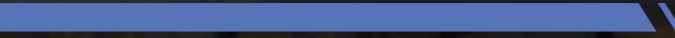


HIFiRE flight test at the Woomera Test Range.



SECTION 6

APPENDICES



Appendix A : Public release science and technology reports

Title	Author/s	Report No.
Assembly and Initial Analysis of a Database of the Characteristics of Fixed-Wing Unmanned Aircraft Systems	Jennifer L Palmer	DSTO-TR-2952
Automation of Sensor Control in Uninhabited Aerial vehicles.	Jason Thomas, Susan Cockshell, Greg Denehy, Jason Pennock, Paul Farr, Doug Scott Wessling, Ashley McMahon and Ashley Arnold	DSTO-TR-2953
Validation Studies of the Numerical Tool PANSHIP for predicting the Calm Water Resistance of the Armidale Class Patrol Boat	Terry Turner and Frans van Walree	DSTO-TR-3072
Work Domain Analysis of Australia's Air Power System: Purpose-related Functions of Combat; Transport; and Intelligence, Surveillance, and Reconnaissance Subsystems	Ashleigh Brady and Neelam Naikar	DSTO-TR-3085
Modelling Alternate Crew Configurations in the Seahawk MH-60R 'Romeo' Helicopter: Part Two – FIAC Scenario	R. King, P. Blanchonette and G.Eberle	DST-Group-RR-0410
Shape Optimisation of Holes in Loaded Plates by Minimisation of Multiple Stress Peaks	Witold Waldman and Manfred Heller	DSTO-RR-0412
A study of fatigue variability in aluminium alloy 7050-T7451	B. Dixon, L. Molent and S. Barter	DST-Group-RR-0425
Design and Evaluation of an Energy-Dense, Light-Weight Combat Ration to Sustain Land Forces Involved in High-Intensity, Short-Duration Operations	Tracey McLaughlin	DSTO-TR-3109
Issues regarding the Future Application of Autonomous Systems to Command and Control (C2)	Michael John Pilling	DSTO-TR-3112
Oxyacetylene Flame Testing of Carbon Fibre Composite and Graphite Material	R. Djugum, P. K. Sharp and C. Wood	DSTO-TN-1409
Low-temperature Film Adhesives for Broad Area Application of distributed Fibre Optic Strain Sensors	Claire Davis, Patrick Norman, Peter Lombardo and Steve Galea	DSTO-TN-1432
Improving the Quality of Freeze Dried Rice: Initial Evaluations	Lan Bui and Ross Coad	DSTO-TN-1434
A Review of Shared Vision and its Application within an Army Context	Tiffany Fischer	DSTO-GD-0887
The Impact of Temperature and Humidity on Bonded Repairs Performed in the Field-Hot / Wet Environment	A. Charles, I. Stoyanovski and J. Wang	DST-Group-TR-3064
Examining the Effects of a Modified Symbology Design in the MRH 90: Part Two	E. Tracey, R. King, G. Eberle and P. Blanchonette	DSTO-TR-3122

Title	Author/s	Report No.
Determination of Minimised Kt Values and Boundary Shapes for a Class of Quasi-Rectangular Holes in Infinite Plates	Witold Waldman	DST-Group-TR-3125
Measurement of surface strains from a composite hydrofoil using fibre Bragg grating sensing arrays	Claire Davis, Patrick Norman, Andrew Phillips and V Nanayakkara	DST-Group-TN-1438
Linear-elastic 2D and 3D Finite Element Contact Analysis of a Hole Containing a Circular Insert in a Fatigue Test Coupon	Witold Waldman	DST-Group-TR-3134
Creating RAN Standard Operating Procedures using Flow Diagrams	Sandra Tavener and Peter Asenstorfer	DST-Group-TR-3137
Modelling Phase Transition Phenomena in Fluids	Leonid K Antanovskii	DST-Group-TR-3139
Elasto-Plastic 3D Finite Element Contact Analysis of a Hole Containing a Circular Insert in a Fatigue Test Coupon	Witold Waldman	DST-Group-TR-3140
A Discussion of Dempster-Shafer Theory and its Application to Identification Fusion	E. El-Mahassni and K. White	DST-Group-TN-1443
Examining the Effects of a Modified Flight Symbology Design in the MRH 90: Part Three	G. Eberle, R. King, P. Blanchonette and J. Yildiz	DST-Group-TR-3146
Influx1: A Tool and Framework for Reasoning under Uncertainty	Van Nguyen and Michael Docking	DST-Group-TR-3142
Non-Indigenous Marine Species (NIMS) in Biofouling on RAN Vessels: Threat Analysis	Luciana Montelli	DST-Group-TR-3149
CFD RANS Simulations on a Generic Conventional Scale Model Submarine: Comparison between Fluent and OpenFOAM	D. A. Jones	DST-Group-TN-1449
A Family of Reference Hugoniot for Two-Phase Porous Materials	A. D. Resnyansky	DST-Group-TR-3152
Trusted Autonomy: Conceptual Developments in Technology Foresight	Scott Wheeler	DST-Group-TR-3153
Recent Advances in Source Localization Using Range Measurements	Hatem Hmam and Kutluyil Dogancay	DST-Group-TR-3158
A Review of Australian and New Zealand Investigations on Aeronautical Fatigue During the Period April 2013 to March 2015	Editors: Phil Jackson and Chris Wallbrink	DST-Group-TN-1460
Extreme Vertical Gusts in the Atmospheric Boundary Layer	Douglas J Sherman	DST-Group-TR-3160

Title	Author/s	Report No.
Doppler Compensation for Airborne Non-Side-Looking Phased-Array Radar	Yunhan Dong	DST-Group-TN-1461
Acquisition of Turbulence Data Using the DST Group Constant-Temperature Hot-Wire Anemometer System	Lincoln P. Erm	DST-Group-TN-1467
Calibration of the Flow in the Test Section of the Research Wind Tunnel at DST Group	Lincoln P. Erm	DST-Group-TN-1468
A Practical Heuristic for Reasoning with Linguistic Ratings in High Level Information Fusion	Lewis Warren	DST-Group-TN-1471
Satellite Laser Ranging Photon-budget Calculations for a Single Satellite Cornercube Retroreflector: Attitude Control Tolerance	Philip C. L. Stephenson	DST-Group-TR-3172
Topology Model of the Flow around a Submarine Hull Form	Soon-Kong Lee	DST-Group-TR-3177
Bigger Not Necessarily Better in Participant Evaluations of Synthetic Training Exercises	C. Best and C. Francis	DST-Group-TR-3184
Quantitative Methods for Analysing Joint Questionnaire Data: Exploring the Role of Joint in Force Design	David Kernot and Tim McKay	DST-Group-TN-1474
A Study of Fatigue Variability in Aluminium Alloy 7050-T7451	B. Dixon, L. Molent and S. Barter	DST-Group-RR-0425
Report Australia's Joint Approach	BRIG Tim McKenna and Tim McKay	DST-Group-TR-3200
The Effect of Chevron Shaped Notches on the Tensile Strength of Composite Laminates used on the F35	A.B. Harman	DST-Group-TR-3230
Conversion of DST Group shape optimisation software for increased portability across computing platforms	R. Kay and W. Waldman	DST-Group-TR-3251
Modelling Alternate Crew Configurations in the Seahawk MH-60R 'Romeo' Helicopter: Part Three – FIAC Engagement Scenario	R. King, P. Blanchonette and G. Eberle	DST-Group-TR-3261
Exploring the Use of Task Network Modelling and Human-In-The-Loop Experimentation as Complementary Methods for Understanding Driver Cognitive Workload	Gary Coombs, Mark N. Antoniadis, Martin Wong, Michael Balin and Victor Demczuk	DST-Group-TN-1483
Operationalising United Nations Security Council Resolution 1325 within the Australian Defence Force	Susan Hutchinson	DST-Group-GD-0909
Radar Detection Performance in Medium Grazing Angle X-band Sea-clutter	Luke Rosenberg and Stephen Bocquet	DST-Group-TR-3193
Improving Target Detection using a Material Pattern Matching Technique in Hyperspectral Images	Paul Dawson and Vittala Shettigara	DST-Group-TR-3199

Title	Author/s	Report No.
RANS Simulations using OpenFOAM Software	D. A. Jones, M. Chapuis, M. Liefvendahl, D. Norrison and R. Widjaja	DST-Group-TR-3204
Large Eddy Simulations using noodles	D. A. Jones, C. Fureby, D. Norrison, C. Troeng and R. Widjaja	DST-Group-TR-3205
Auxiliary Library Explorer (ALEX) Development	Alex Bunting, Stephen G McAteer and Justin Beck	DST-Group-TN-1492
The PC9A Filter Screening Tool	Andrew Becker	DST-Group-TR-3210
A Study of Bistatic Doppler Radar Tomographic Imaging	E. L. Heading and H. T. Tran	DST-Group-TR-3211
Effect of Camera Arrangement on Stereoscopic Particle-Image-Velocimetry Performance	S. K. Lee and M. Giacobello	DST-Group-TN-1496
Projective Reconstruction of World Points and Camera Matrices from a Sequence of Images with MATLAB	Leonid K. Antanovskii	DST-Group-TR-3213
Mathematical Aspects of Computer Vision	Leonid K. Antanovskii	DST-Group-TR-3214
Application of a Dynamic Programming Algorithm for Weapon Target Assignment	Lloyd Hammond	DST-Group-TR-3221
MiTE Version 1.2 User Manual	Chris Brooks and Nik Rajic	DST-Group-TN-1505
A Computational Fluid Dynamics Study of the Flow around a MRH-90 Helicopter using OpenFOAM as a Precursor for IR Signature Modelling	Stefano Wahono	DST-Group-TR-3237
Future Trends in Military Anthropometry: Summary of workshop held at International Ergonomics Association Congress 2015	Alistair Furnell and Jemma Coleman	DST-Group-GD-0918
Measures, Metrics, Decision Points and Analysis Techniques for Australian Fuel Security: Secretary of Defence Fellowship Thesis	Greg Calbert	DST-Group-RR-0432
Development of GPS Receiver Kalman Filter Algorithms for Stationary, Low-Dynamics and High-Dynamics Applications	Peter W. Sarunic	DST-Group-TR-3260

Appendix B : Papers delivered or published externally

July 2015-June 2016

Title	Author/s	Publication
Effect of body-borne equipment on injury of military pilots and aircrew during a simulated helicopter crash.	Aggromito, D., Thomson, R., Wang, J., Chhor, A., Chen, B. and Yan, W.	<i>International Journal of Industrial Ergonomics</i> 50 November 2015 130-142
Real-time driver drowsiness feedback improves driver alertness and self-reported driving performance.	Aidman, E., Chadunow, C., Johnson, K. and Reece, J.	<i>Accident Analysis & Prevention</i> 81 August 2015 8-13
Analysis of HMAS <i>GLENELG</i> 's Onboard Structural Monitoring Data.	Aksu, S., Magoga, T. and Riding, B.	<i>Pacific 2015: International Maritime Conference</i> , Sydney, Australia: 6-8 October 2015, Royal Institute of Naval Architects/Institute of Marine Engineering, Science and Technology/Engineers Australia
Mathematical techniques to aid the Australian Army in selecting new defence vehicles.	Albrecht, A. R., Belchamber, E. R. G., Bradford, E. V., Galapitige, A. H. N., Mills, S. J., Nguyen, T. T. T., Sargent, A. M., Ward, K., Ward, L. A. and Williams, P. B.	<i>21st International Congress on Modelling and Simulation, MODSIM 2015</i> , Gold Coast, Qld.: 29 November-4 December 2015, Modelling and Simulation Society of Australia and New Zealand
Emulating avian orographic soaring with a small autonomous glider.	Fisher, A., Marino, M., Clothier, R., Watkins, S., Peters, L. and Palmer, J.	<i>Bioinspiration & Biomimetics</i> 11 (1) December 2015 016002
Exploring the Intrinsic Dimensionality of Survey Responses.	Ali, I., Ivancevic, V., Macleod, I. and Yue, Y.	<i>21st International Congress on Modelling and Simulation, MODSIM 2015</i> , Gold Coast, Qld.: 29 November-4 December 2015, Modelling and Simulation Society of Australia and New Zealand
Development Of Enhancement Options For ADF Blast And Fragmentation Grenades.	Allpress, K.	<i>PARARI 2015: Australian Explosive Ordnance Symposium</i> , Sydney, NSW: 9-12 November 2015, Australian Department of Defence / Australian Munitions
Innovative biological approaches for monitoring and improving water quality.	Aracic, S., Manna, S., Petrovski, S., Wiltshire, J. L., Mann, G. and Franks, A. E.	<i>Frontiers in Microbiology</i> 6 July 2015
Anomaly detection in satellite communications networks using support vector machines.	Arbon, E. K. and Smet, P. J.	<i>33rd AIAA International Communications Satellite Systems Conference and Exhibition, ICSSC 2015</i> , Brisbane, Qld.: 7-10 September 2015, American Institute of Aeronautics and Astronautics Inc, AIAA
Fabrication of F-Inverted Compact Antenna using a 3D printer.	Audino, L. and Caldwell, A.	<i>International Symposium on Antennas and Propagation, ISAP 2015</i> , Hobart, Tas., Australia: 9-12 November 2015, IEEE

Title	Author/s	Publication
Advances in the proof test for certification of bonded repairs – Increasing the Technology Readiness Level.	Baker, A., Gunnion, A. J., Wang, J. and Chang, P.	<i>International Journal of Adhesion and Adhesives</i> 64 January 2016 128-141
Improvement in touch sensation after stroke is associated with resting functional connectivity changes.	Bannister, L. C., Crewther, S. G., Gavrilescu, M. and Carey, L. M.	<i>Frontiers in Neurology</i> 6 (JUL) July 2015
Visualisation of the surface vibration using a PVDF film array.	Bao, B., Matthews, D., Munyard, A., Sun, H. and Pan, J.	<i>Acoustics 2015 Hunter Valley</i> , Cypress Lakes, NSW: 15-18 November 2015, Australian Acoustical Society
Performance of adaptive beamformers for extracting audio signals.	Bao, C.	<i>Acoustics 2015 Hunter Valley</i> , Cypress Lakes, NSW: 15-18 November 2015, Australian Acoustical Society
Controlling fatigue crack paths for crack surface marking and growth investigations.	Barter, S., White, P. and Burchill, M.	<i>Frattura ed Integrita Strutturale</i> 10 (35) January 2016 132-141
Fatigue crack path manipulation for crack growth rate measurement.	Barter, S., White, P. and Burchill, M.	<i>Engineering Fracture Mechanics</i> DOI:10.1016/j.engfracmech.2016.04.020
Senior leadership and lessons learned in the Australian Defence Organisation.	Baskarada, S., Watson, J. and Cromarty, J.	McIntyre, S., Dalkir, K., Paul, P.Kitimbo, I. C. (eds.) <i>Utilizing evidence-based lessons learned for enhanced organizational innovation and change</i> . Hershey, PA, USA, IGI Global 234-266
Underwater vehicle depth and attitude regulation in plane progressive waves.	Battista, T., Woolsey, C., McCue-Weil, L., Paterson, E. and Valentinis, F.	<i>54th IEEE Conference on Decision and Control, CDC 2015</i> , Osaka, Japan: 15-18 December 2015, Institute of Electrical and Electronics Engineers Inc.
Embroidered Active Microwave Aerospace Composite Pre-Preg Electronics – Pregtronics	Baum, T., Ziolkowski, R. W., Ghorbani, K. and Nicholson K. J.	<i>IEEE Transactions on Microwave Theory & Techniques</i> , Dec. 2015.
A generalised labelled multi-Bernoulli filter for extended multi-target tracking.	Beard, M., Reuter, S., Granstrom, K., Vo, B. T., Vo, B. N. and Scheel, A.	<i>18th International Conference on Information Fusion, Fusion 2015</i> , Washington, United States: 6-9 July 2015, Institute of Electrical and Electronics Engineers Inc.
Sensor control for multi-target tracking using Cauchy-Schwarz divergence.	Beard, M., Vo, B. T., Vo, B. N. and Arulampalam, S.	<i>18th International Conference on Information Fusion, Fusion 2015</i> , Washington, United States: 6-9 July 2015, Institute of Electrical and Electronics Engineers Inc.
Jerry can carriage is an effective predictor of stretcher carry performance.	Beck, B., Carstairs, G. L., Caldwell Odgers, J. N., Doyle, T. L. A. and Middleton, K. J.	<i>Ergonomics</i> November 2015 1-8
On the impact of fine filtration on spectrometric oil analysis and inductive wear debris sensors.	Becker, A., Abanteriba, S., Dutton, S., Forrester, D. and Rowlinson, G.	<i>Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology</i> 230 (1) January 2016 78-85
Meltstick test method.	Bhoyro, A.	<i>13th Asian Textile Conference</i> Geelong, Vic.: 3-6 November 2015, Lightweight Structures Association of Australasia

Title	Author/s	Publication
Comparison of Visual and Logical Character Segmentation in Tesseract OCR Language Data for Indic Writing Scripts.	Biggs, J.	<i>Australasian Language Technology Workshop 2015</i> , Western Sydney University, Parramatta: 8-9 December 2015, Australasian Language Technology Association
Comparison of the Body Size of Australian Defence Force Aircrew and US Military Personnel	Blanchonette, P. and Smith, A.	<i>Defence Human Sciences Symposium</i> , Melbourne, 23-24 November 2015
Effects of Military Load Carriage on Susceptibility to Enemy Fire During Tactical Combat Movements.	Billing, D. C., Silk, A. J., Tofari, P. J. and Hunt, A. P.	<i>Journal Of Strength And Conditioning Research / National Strength & Conditioning Association</i> 29 (Suppl 11) November 2015 S134-S138
Closed-form parameter estimators for Pareto distributed clutter with noise.	Bocquet, S.	<i>Electronics Letters</i> 51 (23) November 2015 1924-1926
Digital literacy in the Australian and New Zealand defence forces: Current, levels and implications.	Bollard, L. M., Whitney, S. J., Fidock, J. J. T. and Kerry, J. T.	<i>2015 Fall Simulation Interoperability Workshop, SIW 2015</i> , Orlando, Florida USA: 31 August-4 September 2015, SISO – Simulation Interoperability Standards Organization
Spatially informed spectral unmixing.	Bongiorno, D. L., Fairley, A. J. and Williams, S. B.	<i>WHISPERS 2015</i> , Tokyo, Japan: 2-5 July 2015, IEEE
Empirical evaluation of a virtual laboratory approach to teach lactate dehydrogenase enzyme kinetics.	Booth, C., Cheluvappa, R., Bellinson, Z., Maguire, D., Zimitat, C., Abraham, J. and Eri, R.	<i>Annals of Medicine and Surgery</i> 8 June 2016 6-13
Physical mechanisms for near-field blast mitigation with fluid containers: Effect of container geometry.	Bornstein, H., Ryan, S. and Mouritz, A.	<i>29th International Symposium on Ballistics</i> , Edinburgh, Scotland: 9-13 May 2016, International Ballistics Society
Target detection in GPR data using joint low-rank and sparsity constraints.	Bouzerdoum, A., Tivive, F. H. C. and Abeynayake, C.	<i>Compressive Sensing V: From Diverse Modalities to Big Data Analytics</i> , Baltimore, Maryland, United States 17 April 2016, SPIE
Refinement of exhaust system noise from large diesel engines using one dimensional (1D) simulation.	Bowden, D. and Forrest, J.	<i>Acoustics 2015 Hunter Valley</i> , Cypress Lakes, NSW: 15-18 November 2015, Australian Acoustical Society
Feasible Scenario Spaces: a new way of measuring capability impacts.	Bowden, F. D. J., Pincombe, B. and Williams, P. B.	<i>21st International Congress on Modelling and Simulation, MODSIM 2015</i> , Gold Coast, Qld.: 29 November-4 December 2015, Modelling and Simulation Society of Australia and New Zealand
Advances in CO ₂ laser fabrication for high power fibre laser devices.	Boyd, K., Rees, S., Simakov, N., Daniel, J. M. O., Swain, R., Mies, E., Hemming, A., Clarkson, W. A. and Haub, J.	<i>Fiber Lasers XIII: Technology, Systems, and Applications</i> , San Francisco, California: 13 February, 2016, SPIE
CO ₂ laser-fabricated cladding light strippers for high-power fiber lasers and amplifiers.	Boyd, K., Simakov, N., Hemming, A., Daniel, J., Swain, R., Mies, E., Rees, S., Andrew Clarkson, W. and Haub, J.	<i>Applied Optics</i> 55 (11) April 2016 2915-2920

Title	Author/s	Publication
Real-time multiplexed digital cavity-enhanced spectroscopy.	Boyson, T. K., Dagdigian, P. J., Pavey, K. D., FitzGerald, N. J., Spence, T. G., Moore, D. S. and Harb, C. C.	<i>Optics Letters</i> 40 (19) October 2015 4560-4562
Manipulation of carbon nanotube magnetism with metal-rich iron nanoparticles	Brack, N., Kappen, P., Spencer, M. J. S. A. I., Herries, R. and Rider A. N.	<i>Journal of Materials Chemistry C</i> 2016, 4 (6), 1215-1227
Model Based Control of Submarine Diesel Generators.	Broomhead, T., Hield, P., Tregenza, O., Manzie, C., Brear, M. and Newman, M.	<i>Pacific 2015 : International Maritime Conference</i> , Sydney, Australia: 6-8 October 2015, Royal Institute of Naval Architects/Institute of Marine Engineering, Science and Technology/Engineers Australia
Robust periodic economic MPC for linear systems.	Broomhead, T. J., Manzie, C., Shekhar, R. C. and Hield, P.	<i>Automatica</i> 60 October 2015 30-37
Adjoint analysis of guidance systems with nonstandard inputs.	Bucco, D. and Weiss, M.	<i>Journal of Guidance, Control and Dynamics</i> 38 (9) September 2015 1800-1809
Conceptual Modelling and Analysis of Protection, Signature Management and Survivability: Considerations for Deployable Protected Land Vehicles.	Burgess, M. and Gaidow, S.	<i>Journal of Battlefield Technology</i> 18 (2) July 2015 1-6
Survivability for deployable protected land vehicles: Concepts, models and applications.	Burgess, M. and Gaidow, S.	<i>Journal of Battlefield Technology</i> 18 (2) July 2015 7-13
Scheduling multifunction radar for search and tracking.	Byrne, M., White, K. and Williams, J.	<i>18th International Conference on Information Fusion, Fusion 2015</i> , Washington, United States: 6-9 July 2015, Institute of Electrical and Electronics Engineers Inc.
Military inventory capacity and stock planning with surge and warning time and supplier constraints.	Calbert, G., Thiagarajan, R. and Rahman, M.	<i>21st International Congress on Modelling and Simulation, MODSIM 2015</i> , Gold Coast, Qld.: 29 November-4 December 2015, Modelling and Simulation Society of Australia and New Zealand
Twitter in crises 'data': a framework for critical reflection on the multidisciplinary research field.	Calic, D. and Resnyansky, L.	<i>2nd European Conference on Social Media ECSM 2015</i> , Porto, Portugal: 9-10 July 2015, Academic Publishing and Publishing International
Quick Atmospheric Correction (QUAC) of WorldView-3 multispectral imagery – A comparison to hyperspectral imagery results.	Carr, S. B.	<i>36th Asian Conference on Remote Sensing: Fostering Resilient Growth in Asia, ACRS 2015</i> , Manila, Philippines: 24-28 October 2015, Asian Association on Remote Sensing
The Quick Atmospheric Correction (QUAC) Algorithm for Hyperspectral Image Processing: Extending QUAC to a Coastal Scene.	Carr, S. B., Bernstein, L. S. and Adler-Golden, S. M.	<i>International Conference on Digital Image Computing: Techniques and Applications, DICTA 2015</i> , Adelaide, SA: 23-25 November 2015, Institute of Electrical and Electronics Engineers Inc.
A Box Lift and Place Assessment is Related to Performance of Several Military Manual Handling Tasks.	Carstairs, G. L., Ham, D. J., Savage, R. J., Best, S. A., Beck, B. and Doyle, T. L. A.	<i>Military Medicine</i> 181 (3) March 2016 258-264

Title	Author/s	Publication
Addressing challenges in studies of behavioral responses of whales to noise.	Cato, D. H., Dunlop, R. A., Noad, M. J., McCauley, R. D., Kniest, E., Paton, D. and Kavanagh, A. S.	<i>Advances in Experimental Medicine and Biology</i> . Vol. 875. New York, Springer 145-152
Characterisation of a Transformer Balun for a 7-15 GHz SiGe Frequency Doubler.	Chakraborty, S., Milner, L. E., Hall, L. T., Zhu, X., Sevimli, O. and Heimlich, M.	<i>2nd Australian Microwave Symposium, Adelaide, SA: 11-12 February 2016</i> , IEEE Microwave Theory and Techniques Society (MTT-S)
The use of human-in-the-loop and constructive simulation to support operations research into MH-60R tactics development.	Chandran, A., Luketic, N., Stewart, C. and Shokr, M.	<i>21st International Congress on Modelling and Simulation, MODSIM 2015, Gold Coast, Qld.: 29 November-4 December 2015</i> , Modelling and Simulation Society of Australia and New Zealand
The impact of temperature and humidity on bonded repairs performed in the field.	Charles, A. D., Wang, J. and Stoyanovski, I.	<i>Journal of Composite Materials</i> 49 (28) December 2015 3527-3538
An Exploratory Study Using Agent-Based Distillations to Investigate Reconnaissance Scenarios in Support of Higher Fidelity Combat Simulations.	Chau, W. and Grieger, D.	<i>21st International Congress on Modelling and Simulation, MODSIM 2015, Gold Coast, Qld.: 29 November-4 December 2015</i> , Modelling and Simulation Society of Australia and New Zealand
Investigation of location effects for blending induced mistuning in a blisk.	Chen, G., Attia, M. and Hou, J.	<i>7th Asia-Pacific International Symposium on Aerospace Technology (APISAT) Cairns, Queensland: 25-27 November 2015</i> , Royal Aeronautical Society (Australian Division) / Engineers Australia
Prediction of bubble generation based on acoustic emission.	Chen, L., Trinh, V., Yang, W. and Mohanarangam, K.	<i>Acoustics 2015 Hunter Valley, Cypress Lakes, NSW: 15-18 November 2015</i> , Australian Acoustical Society
Static and Fatigue Testing Thin Riveted, Bonded & Hybrid Carbon Fibre Double Lap Joints used in Aircraft Structures	Chowdhury, N. T., Chiu, W. K., Wang, J. and Chang, P.	<i>Journal of Composite Structures</i> . V121, 315-323, 2015.
Design of a flat plate specimen suitable for biaxial tensile tests on polymer materials.	Chowdhury, N. T., Wang, J. and Chiu, W. K.	<i>Polymers and Polymer Composites</i> 23 (9) September 2015 627-638
Matrix failure in composite laminates under tensile loading.	Chowdhury, N. T., Wang, J., Chiu, W. K. and Yan, W.	<i>Composite Structures</i> 135 January 2016 61-73
Experimental and finite element studies of thin bonded and hybrid carbon fibre double lap joints used in aircraft structures.	Chowdhury, N. T., Wang, J., Chiu, W. K. and Chang, P.	<i>Composites Part B: Engineering</i> 85 February 2016 233-242
Predicting matrix failure in composite structures using a hybrid failure criterion.	Chowdhury, N. T., Wang, J., Chiu, W. K. and Yan, W.	<i>Composite Structures</i> 137 March 2016 148-158
The integration of cognitive architectures and computational intelligence using the SODA methodology.	Consoli, A.	<i>International Journal of Knowledge-Based and Intelligent Engineering Systems</i> 19 (4) January 2016 235-254
A TLA+ specification of the HLA Time Management algorithm.	Cramp, A.	<i>2015 Fall Simulation Interoperability Workshop, SIW 2015, Orlando, Florida USA: 31 August-4 September 2015</i> , SISO-Simulation Interoperability Standards Organization

Title	Author/s	Publication
Texture metric that predicts target detection performance.	Culpepper, J. B.	<i>Optical Engineering</i> 54 (12) December 2015 123101(1-13)
A comparison between maritime field observations and photosimulation for developing and validating visible signature evaluation tools.	Culpepper, J. B., Wheaton, V. C., Shao, Q. T. and Furnell, A.	<i>Target and Background Signatures</i> , Toulouse, France September 21, 2015, SPIE
Effects of a near-field radio frequency interference on a marine navigational X-band radar.	Dall'Armi-Stoks, G. and Venkataraman, K.	<i>Electromagnetic Compatibility Conference (GEMCCON), 2015 IEEE Global</i> , Adelaide, SA: 10-12 November 2015
Passively cooled 405 W ytterbium fibre laser utilising a novel metal coated active fibre.	Daniel, J. M. O., Simakov, N., Hemming, A., Clarkson, W. A. and Haub, J.	<i>Fiber Lasers XIII: Technology, Systems, and Applications</i> , San Francisco, California: 13 February 2016, SPIE
Moment to moment variability in functional brain networks during cognitive activity in EEG data.	Dasari, N. M., Nandagopal, N. D., Ramasamy, V., Cocks, B., Thomas, B. H., Dahal, N. and Gaertner, P.	<i>Journal of Integrative Neuroscience</i> 14 (3) September 2015 383-402
Histogram probabilistic multi-hypothesis tracker with colour attributes.	Davey, S. J., Vu, H. X., Arulampalam, S., Fletcher, F. and Lim, C. C.	<i>IET Radar, Sonar and Navigation</i> 9 (8) October 2015 999-1008
Distributed fibre optic strain sensing for full-scale fatigue testing.	Davis, C., Knowles, M., Norman, P., Rajic, N. and Swanton, G.	<i>7th Asia-Pacific International Symposium on Aerospace Technology (APISAT) Cairns, Queensland: 25-27 November 2015</i> , Royal Aeronautical Society (Australian Division) / Engineers Australia
Monitoring the structural health of Defence platforms with optical fibres.	Davis, C., Norman, P., Knowles, M., Rosalie, C., Rajic, N., McAdam, G. and Kostecki, R.	<i>ANZCOP 2015: The Australian and New Zealand Conference on Optics and Photonics</i> , University of Adelaide, Adelaide, SA: 29 November-3 December 2015, The Australian Optical Society / Engineers Australia
Evaluation of a distributed fibre optic strain sensing system for full scale fatigue testing.	Davis, C., Rajic, N., Knowles, M. and Swanton, G.	<i>ECF21 21st European Conference on Fracture</i> , Catania, Italy: 20-24 June 2016
Automated feature engineering for HTTP tunnel detection.	Davis, J. J. and Foo, E.	<i>Computers and Security</i> June 2016 166-185
From Storyboards to S*Patterns: the Journey so Far.	Davy, J. and Harris, M. B.	<i>5th Model-Based Systems Engineering (MBSE) Symposium</i> , Sydney, NSW: 28-30 October 2015, Systems Engineering Society of Australia (SESA)
Reactive Documents for modelling and Simulaiton.	Denehy, G. D.	<i>21st International Congress on Modelling and Simulation, MODSIM 2015, Gold Coast, Qld.: 29 November 4 December 2015</i> , Modelling and Simulation Society of Australia and New Zealand
Supramolecular Agent-Simulant Correlations for the Luminescence Based Detection of V-Series Chemical Warfare Agents with Trivalent Lanthanide Complexes.	Dennison, G. H., Bochet, C. G., Curty, C., Ducry, J., Nielsen, D. J., Sambrook, M. R., Zaugg, A. and Johnston, M. R.	<i>European Journal of Inorganic Chemistry</i> 2016 (9) March 2016 1348-1358

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Appendix C : Patents granted

Patent title	Inventor	Country	Application no.	Filing date	Priority date	Granted no.	Type	Patent status	Granted
A clamp and wrapping assembly for patching a pipe rupture	Jeff Robinson	Canada	2744260		19/11/2009	G1880155/BMG	Regional	Granted	26/04/2016
Testing Mechanical Components for Wear and Tear	Darren Gerrard	USA	13/133876		09/12/2008	9335272	Regional	Granted	10/05/2016
Pyrotechnics methods of manufacture (Pyrofilm)	Ken Smit		2016900463	11/02/2016	11/02/2016		AU Provisional	Filed	N/A
An Active Optical Fibre	Nikita Simakov, Jae Daniel		PCT/AU2016/050072	08/02/2016	09/02/2015		PCT complete	Filed	N/A
Cross Domain Desktop Compositor (CDDC)	Chris North, Mark Beaumont		PCT/AU2016/000160	11/05/2016	11/05/2016		PCT complete	Filed	N/A
Integrated Circuit-Single Photon Avalanche Diode (SPAD)	Dennis Delic		TBC	08/07/2016			PCT complete	Filed	N/A
Multipurpose Lifejacket	David Drohan		2015903976	30/09/2015	30/09/2015		AU Provisional	Filed	N/A

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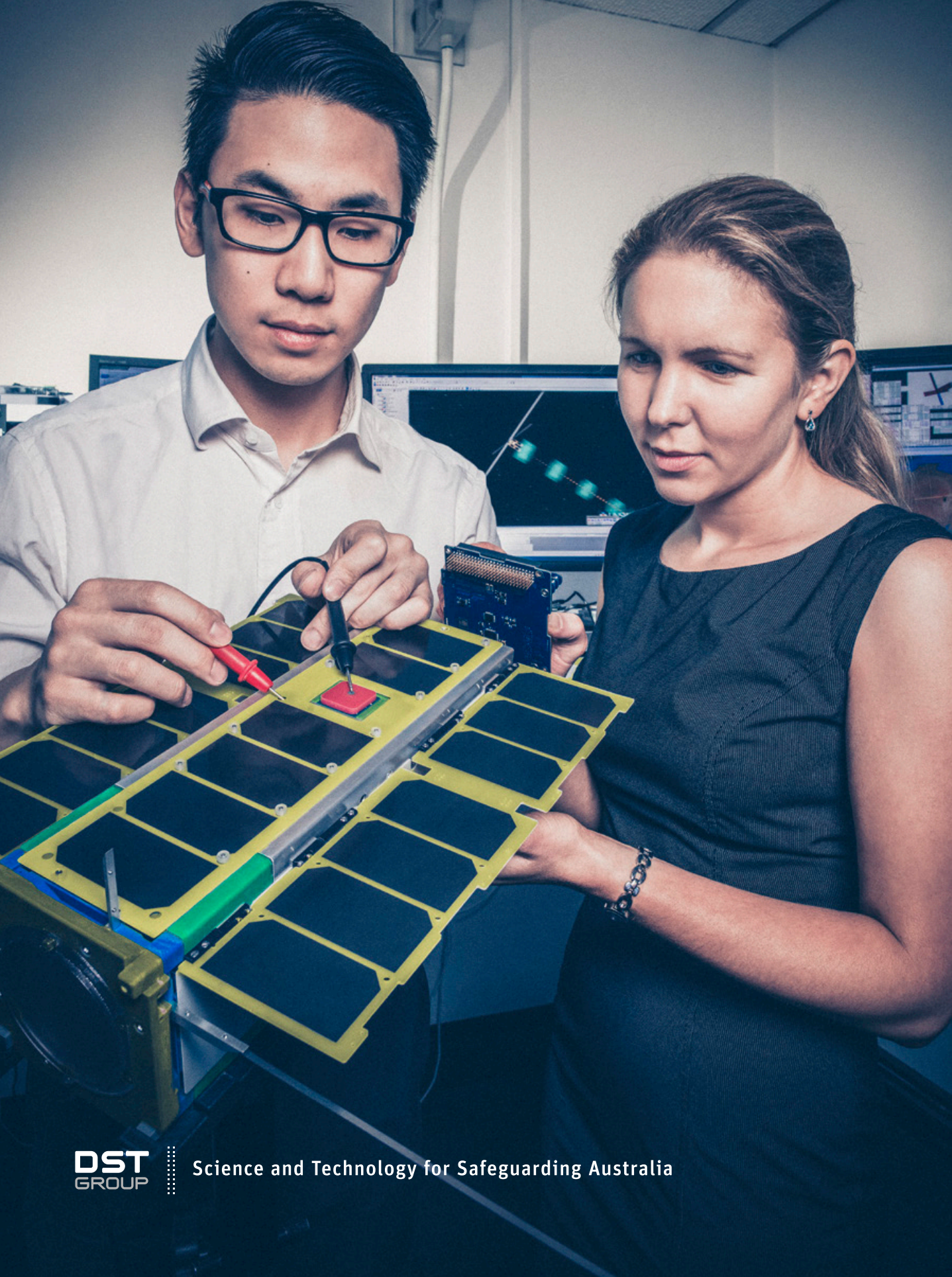
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