

DATA TO DECISIONS CRC

ANNUAL REPORT
2017/18

CONTENTS

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D2D CRC 2017/18 HIGHLIGHTS

7 HONOURS
SCHOLARSHIPS
PROVIDED

2 SPINOUT
COMPANIES CREATED

10 PROJECTS COMMENCED



26
EXTERNAL
PRESENTATIONS

121 TECHNICAL REPORTS
AND PUBLICATIONS

54
MEDIA
MENTIONS



HOSTED
INTERNS **10**

103.4
FTE

315 DATA
SCIENTISTS
TRAINED



4 THESIS
SUBMISSIONS

17 ACTIVE
USER TRAILS

ABOUT THE D2D CRC

The Data to Decisions Cooperative Research Centre (D2D CRC) was established in July 2014 with a grant of \$25 million from the Australian Government and is part of the Cooperative Research Centres Programme. D2D CRC brings researchers and industry together to be a leading provider of capability resulting in a safer and more secure nation, and a sustainable big data workforce for Australia.

VISION

The D2D CRC's vision is to be a leading provider of capability resulting in a safer and more secure nation and a sustainable big data workforce for Australia.

MISSION

Its mission is to undertake research, development, education and training that delivers outcomes to national security and other data-intensive sectors.

CHAIRMAN'S REVIEW

As we enter our fifth and final year, the deep engagement we have enjoyed with our partners has yielded impressive results. The level of collaboration with our partners in the national security community, academia and industry has been an exemplar for the CRC concept.

As analysts in our partner agencies have been immersed in the D2D CRC through our 'co-creation' activities, their expertise has helped us to build world class tools to help them make decisions faster and more accurately.

This effort has seen the launch of a second spinout company, NQRY®, which manages the commercialisation of the Investigation Management System. And our first spinout company, Fivecast®, launched the first commercial product, *Insight*, based on the *Apostle™* program. Additionally, based on the *Beat the News™* program, the D2D CRC has developed an indicators and warnings minimal viable product, which will also be commercialised by Fivecast®.

The Law and Policy program continues to support agencies with projects aimed at enabling government frameworks to support national security activities and challenges. In the past year, the team launched two new projects; the first being *Using 'Open Source' Data and Information for Defence, National Security, and the second being Law Enforcement and Compliance by Design and Compliance Through Design Solutions to Support Automated Information Sharing*.

While all of these achievements will make law enforcement and intelligence analysis more effective as intended, the quality of the D2D CRC's work has also been recognised with two significant national awards. The Narrative Visualisation project was awarded the South Australian Research and Development Project of the Year Award at the 2018 Australian Information Industry Association (AIIA) iAwards, and Fivecast® was awarded the Civil Security Congress and Exposition (CIVSEC) 2018 Innovation Award for Cyber Security.

In addition to working with our national security partners, our developers and researchers have worked closely with people from other sectors to translate know-how into those sectors through the Innovation Exchange program. The Innovation Exchange has successfully delivered projects into the manufacturing, health and agriculture sectors.

For example, they have:

- produced a ground-breaking study on cardiovascular care;
- collaborated with four manufacturing companies to help local manufacturers explore opportunities for big data as part of the Big Data Connect Program; and
- launched a revolutionary mental health care application, Actionable In-time Insights (AI²), which offers real-time digital updates on patient status to clinicians.

These three initiatives continue to demonstrate the fluid portability of D2D's data analytics capabilities to other sectors in Australian society.

The Education and Training team has also been very productive. Through seminars and other forums, the D2D CRC has fostered discussion on important topics and the challenges faced by the national security community. Topics have included:

- Trust in Artificial Intelligence;
- Societal Influences on National Security;
- Risk Profiling; and
- Aligning Privacy and National Security.

For those who like statistics, the Education and Training program has supported 54 PhD research projects; presented 13 seminars, workshops and short courses thereby training 315 data scientists; provided seven Honours scholarships; and hosted and mentored 10 successful internships.

Looking at the rate of effort more broadly, the D2D CRC has seen 10 PhDs started, 10 projects completed, 26 external presentations shared, 81 technical reports produced, 28 formal publications developed, 54 mentions in the media, 17 active trials completed with the national security community, and four PhD theses submitted.

The Data Science Competency Framework has been trialled by several government agencies and has received positive feedback. The framework has been the basis for the Data Science Development Planning Tool, which is an online self-assessment system that identifies gaps in a person's competency. The tool then provides development options for data scientists, data engineers and data analysts of any level. Furthermore, it allows managers and organisations to get an aggregated picture of their data science team, which can help to inform training or recruitment plans.

Our CEO, Sanjay Mazumdar, has described our final year as the "year of delivery" during which we will transition data analytics capabilities into our partner agencies. We will continue to support the spinout companies, and we expect 15 students to submit their thesis over the next year. We will also encourage students to engage more deeply with agencies, so they can explore data science employment opportunities and learn about careers in the national security sector.

To share our experience and expertise, the development and promotion of our workshop and seminar portfolio will remain a focus. We will make the Data Science Competency Framework available via open source channels, promoting it as the recognised Australian standard for data science in the public sector. Finally, we will deploy the Data Science Development Planning Tool with the help of a partner agency.

The achievements above could not be realised without the tireless efforts of many people including our headquarters

management team and support staff, our development operations people, our PhD students, our Board of Directors, our interns, our academic partners, and the analysts and leaders in our partner agencies in the national security community.

I am confident that the spirit of co-creation and collaboration underpinning our success in meeting or exceeding all of the D2D's goals so far will hit new bounds in the coming year.



Tim Scully, Chairman

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The fourth year of operation for the D2D CRC has continued to focus on delivering capability to national security end users. This has been exemplified by 17 active user trials during the year with very positive feedback to date.

The year has also seen the first cohort of PhD students graduate with four students submitting their thesis. This is an exciting milestone for the CRC and we eagerly await further PhD completions this year.

I have been incredibly proud of the achievements of our team, and would particularly like to recognise the awards that D2D CRC teams have won. Fivecast® received the CIVSEC 2018 Innovation Award for Cyber Security. The team has continued to work tirelessly on the tool and as result launched their first commercial product, *Insight*. The Narrative Visualisation project received the South Australian Research and Development (R&D) Project of the Year Award, as well as a Merit for the National Award at the 2018 AIIA iAwards.

On the commercialisation front, we launched our second spinout company, NQRY®. This company will commercialise the *CaseWalls™* Investigation Management System (IMS), a tool that is receiving significant interest across the law enforcement community.

The Innovation Exchange (IX) program has received a lot of media coverage over the past year for the solutions it has developed for the agriculture, health and manufacturing sectors. The IX program has been an important part of the D2D CRC as it has enabled us to transition big data analytics knowledge and solutions to other sectors, a key tenet of CRCs in general.

The Education and Training (E&T) program continued to deliver a suite of training courses, seminars and workshops to help develop the data science community. In addition, the team continued to refine the Data Science Competency Framework (DSCF) and Development Planning Tool (DPT).

We are now part way through our final year of the CRC. It is going to be a busy eight months finishing all the research

projects, integrating the research outputs into the Fivecast® *Insight* and NQRY® *CaseWalls™* products, winding up the D2D CRC and supporting our two spinout companies.

In addition, engagement between our end users and PhD students will be a key focus this year. We are particularly keen to facilitate close interaction between our students and national security agency partners, which will ideally lead to future employment. To that end, events are being organised over the next few months to allow students to meet with national security staff and present their research.

The key challenge for the remainder of the CRC will be to ensure we can retain staff critical to delivering the projects and transitioning the capabilities to the national security agencies. The CRC is employing several strategies to retain key staff, but the reality is with the end of the CRC approaching quickly, this becomes more difficult.

On a final note, I'd like to offer my thanks to CRC staff, researchers, Board and advisory committee members for their efforts over the past year. The D2D CRC is focused on areas of national importance and this is reflected in the commitment and contribution of everyone involved.



Sanjay Mazumdar, CEO

ACHIEVEMENTS

RESEARCH

The below summarises key research achievements from financial year (FY) 2017-18.

Integrated Law Enforcement

The program executed further R&D of the *CaseWalls™* IMS – a system to revolutionise investigations management practice for law enforcement practitioners. As a result of extensive user engagement and workshops, the system has matured and is nearing commercial deployment. The base platform addresses the immediate needs of investigators across Australia and also enables the integration of leading-edge capabilities derived from the research activities of the D2D CRC – including data curation, and narrative visualisation.

Apostle™

The program delivered trials to several law enforcement and national security agencies. The platform provides leading-edge collection and analysis capabilities using automated techniques to extract meaning from unstructured data. The platform delivers a solution to an immediate capability need from users, but also enables integration of the research outputs from a range of D2D CRC research projects including text, image and video understanding.

Beat the News™

The program pivoted to provide tools that assist with analytic tasks undertaken by intelligence analysts – including the automated production of indicators and warnings from streams of open source data.

Law and Policy

The program delivered several targeted projects that focus on the business needs of end users. These include projects to evaluate the issues related to use of advanced data analytics for identity verification, information sharing and governance processes within the national criminal intelligence system.

Two provisional patent applications were either filed or are under development as part of these programs.

COLLABORATION

All projects at the D2D CRC must demonstrate collaboration between researchers and end users (government and/or industry). Notable collaboration includes:

- co-created the *CaseWalls™* IMS involving the Australia-New Zealand Counter-Terrorism Committee (ANZCTC), the D2D CRC and several of its research participants. The IMS continues to undergo extensive trialling and workshops to ensure it meets user's expectations;
- co-created the *Apostle™* system with various national security agencies – the system incorporates leading edge research outcomes with the processes and tools required for effective use by agencies;
- completed several Law and Policy projects, which were a direct result of business needs identified by the Attorney-General's Department (AGD) and the Australian Criminal Intelligence Commission (ACIC);
- worked on projects with several small to medium-sized enterprises in the Big Data Connect Program – delivering data analytic solutions to manufacturing companies in South Australia;
- developed Health Analytics projects with SA Health, Flinders University, University of Adelaide and Queen Elizabeth Hospital;
- worked with several Commonwealth departments to develop, pilot and evaluate the Data Science Competency Framework and the Development Planning Tool; and
- developed and delivered data science training with national security agencies.

COMMERCIALISATION & UTILISATION

The D2D CRC has undertaken a variety of actions to ensure that there will be effective and appropriate utilisation and/or commercialisation of the CRC's outputs. The specific milestones for FY 2017-18 include:

- formed the spinout company NQRY® to commercialise the Integrated Law Enforcement technology;
- executed commercialisation plans for all the research projects, through the spinout companies Fivecast® and NQRY®;
- continued engagement of several agencies in trial and evaluation of the *Beat the News™*, *Apostle™* and Integrated Law Enforcement programs, including development and delivery of a federated search tool (FST) prototype;
- released first commercial product Fivecast® *Insight*, and achievement of first commercial sales in Australia;
- delivered live trials of the NQRY *CaseWalls™* IMS, and tender responses provided and pending decision with multiple agencies;
- filed two new provisional patent applications; and
- gained successful funding from TechInSA for Fivecast® to undertake business development in the USA.

EDUCATION & TRAINING

In FY 2017-18, the E&T program continued to build upon the strong foundations established in previous years. A summary of the E&T program's significant achievements include:

- created a community of 54 PhD students from seven universities;
- achieved four thesis submissions;
- provided seven Honours scholarships;
- hosted ten internships; six from Carnegie Mellon University, one from Defence, one from the University of Adelaide, one from Flinders University and one group project;
- supported nine PhD students to travel internationally to enhance their studies;
- strengthened the engagement and educational experiences of PhD students by offering additional opportunities to meet with D2D CRC staff and present at seminars;
- finalised the Data Science Competency Framework and refining the associated planning tool in consultation with industry and government partners;
- launched a bespoke data science short-course training program with high levels of participation;
- updated the entry-level data analytics course in partnership with Deakin University; and
- shared expertise through a variety of well-attended seminars, training over 300 professionals.

RISKS AND IMPEDIMENTS

The D2D CRC employs an active process involving regular assessment of risks and opportunities by the management team, the Audit and Risk Committee and the Board.

In last year’s annual report, key risks included the D2D CRC’s ability to transition capabilities to national security agencies, as well as employment of a commercialisation strategy that could meet the long-term needs of these agencies. The success of the CRC in undertaking several evaluation trials and operationally deploying the *Insight* system through the Fivecast® spinout company highlights that these risks have been mitigated.

The main risks for the CRC going forward are the retention of key staff to complete the research projects, successfully transitioning capabilities to the spinouts, supporting the deployment of the systems to the agencies, and wind-up of the CRC. The CRC has employed several strategies to encourage retention of key staff members, but the reality is with a buoyant employment market and the impending completion of the CRC, this will need to remain an active focus of the management team and Board.

IMPACTS

The D2D CRC has already achieved many of the impacts and outcomes identified in the Commonwealth Agreement. The current focus is on delivering additional impact to end user partners. A significant achievement in FY 2017-18 was the establishment of the second commercial spinout, NQRY®, and initial commercial sales for Fivecast®. FY 2017-18 also saw the first cohort of PhD students graduate.

The projected impacts of the D2D CRC are:

- improved security for Australians and their interests;
- reduced acquisition risk for national security projects;
- reduction in national security operating costs;
- royalties from the exploitation of D2D CRC intellectual property (IP);
- growth of small to medium enterprises (SMEs);
- economic benefits in other sectors;
- commercial spinouts leveraging D2D CRC IP;
- approximately 20 innovation disclosures, 350 publications, 48 PhD graduates and 1,000 trained data scientists;
- improved balance between privacy laws and national security; and
- an overall benefit:cost ratio of 3.31.

These are being materialised by the D2D CRC.

RESEARCH

THE NARRATIVE
VISUALISATION PROJECT
RECEIVED THE SOUTH
AUSTRALIAN R&D PROJECT
OF THE YEAR AWARD AT
THE 2018 AIIA iAWARDS

PERFORMANCE AGAINST THE ACTIVITIES

BEAT THE NEWS™

The program's key research areas are to deliver a multi-year, multi-stream R&D project to provide predictive models that forecast socially disruptive events from a variety of data sources. New-use cases have been developed that focus on analysts having the ability to generate insights from data by easily creating signals from the data feeds.

Key achievements within the various program streams for the reporting period are listed below.

BUILDING CLASSIFICATION AND PREDICTION SYSTEM FOR CIVIL UNREST

- Enriched the existing models for socially disruptive event prediction by inferring event types from automatically labelled Tweets and extracting summaries to uncover semantic meanings.
- Developed a topic modelling-based risk analysis model, with the aim of estimating and reporting the risk levels of topical social events of interest by identifying how topics evolve on social media.
- Developed an evolution tree-based risk analysis model, which issues alerts for events of interest at various risk levels by tracking the evolution of conversational structures driven by social media users.
- Published two conference papers on the topic of socially disruptive event detection and prediction.

TOPIC MINING AND TREND MONITORING IN TEMPORAL TEXT SOURCES

- Researched and developed an ensemble of data wrangling techniques that address the void of existing methods by treating structured and unstructured data in separation, which leads to integrated, wrangled data for machine learning.
- Researched and developed an unsupervised learning approach for integration of structured and unstructured data based on time, space and semantics.
- Developed information retrieval methods for identification of entities, relationships and semantic meanings from the integrated machine learning outcomes above.

- Formulated an integrated solution for *Intelligent Extraction, Visualisation, Fusion and Semantic Understanding of Structured and Unstructured Data*, in collaboration with software expertise of industry partner Genix Ventures.
- Published three papers on knowledge extraction from social media, cognitive situation modelling for social media and research into an integrated platform for clinical decision support.

CIVIL UNREST AND ELECTION PREDICTION

- Delivered a report on 'Pachinko Prediction'; a Bayesian method for event forecasting based on Twitter data and accounting for uncertainty.
- Produced a dashboard demo product demonstrating the Bayesian method on events in Australian cities through FY 2017-18.
- Developed a method for real-time detection of social media content polluters and bots, presented at The Web Conference 2018 (WWW2018) in Lyon.
- Produced a case study on echo chambers in social media discussion around the 2017 Australian same-sex marriage survey and mapped discussion versus echo chambers in online social networks.
- Explored the use of network structures in related Tweets for use in event prediction.

DISEASE PREDICTION

- Published a paper on characterising seasonal influenza in Australia.
- Delivered a report outlining an Approximate Bayesian Computation (ABC) method to forecast influenza in Australia.
- Developed new techniques for validating disease forecasting methods in the presence of multiple sources of uncertainty, including the validation data (e.g. peak weak timing).
- Developed a prototype model for individual behaviour for application in web-based disease forecasting systems.

No changes to future research directions are envisaged for this program.

INTEGRATED LAW ENFORCEMENT

The program's key research areas are to deliver a multi-year, multi-stream R&D project to provide information architectures for access and analysis of diverse, distributed data as well as augmented intelligence and visualisation capabilities for investigators in the national security community.

The ANZCTC IMS working group has previously identified a national investigations management system as a high priority need. The D2D CRC continues to work with the ANZCTC IMS working group and has undertaken successful pilots and trials of the D2D CRC IMS with several law enforcement agencies.

Achievements within the various program streams for the reporting period are listed below.

DATA CURATION FOUNDRY

- Developed novel matching techniques to support linking of offenses to evidence log items. The technique leverages state of the art open information extraction, deep learning and knowledge graphs to build representations of offences, allegations, evidence items and event types.
- Developed novel matching techniques for the automated curation of event types (e.g. bank transactions). These techniques also leverage open information extraction, deep learning and knowledge graphs for building representations of events that are relevant in an investigation.
- Developed event entity extraction techniques to support the extraction of entities relevant to an event (e.g. bank transactions). An Application Programming Interface (API) has been implemented and made available to CRC partners to provide support to other streams of the project.
- Developed a digital assistant to support natural language in-task search for offences. An extended version of the digital assistant is being developed that will leverage on the entity-based indexing techniques.

- Developed a digital assistant to support linking of allegations, offenses and evidence items. The digital assistant provides support for annotating evidence items with entities and events.
- Integrated the above investigation analysis techniques into the *CaseWalls™* platform prototype.
- Submitted and published a number of research papers and a patent application.

NARRATIVE VISUALISATION

- Held workshops with various federal and state government departments to refine vertical narrative visualisation.
- Developed a virtual reality immersive visualisation of a geo-referenced entity link-chart.
- Started collaboration with Defence Science Technology (DST) Group to look at managing the case data in a graph structure and begin to explore incorporation of different parts of the case.
- Worked with DST Group to examine how to automatically rate the importance of different parts of a case to aid the filtering process, for example provide a 'summary' view of a case.
- Worked with DST Group on applying temporal tension approaches to change the order in which a case is presented, allowing facts from cases to be presented in the most logical order, not just a chronological one.
- Extended the visualisation for use as a touchscreen briefing tool.
- Received the South Australian AIIA Award for the Research and Development Project of the Year, as well as a Merit Award at the national award ceremony.
- Two PhD students were awarded best paper at the 2018 Big Data Visual and Immersive Analytics Conference.

FEDERATED DATA PLATFORM

- Developed a new machine learning technique for relationship disambiguation in schema matching.
- Developed a multi-table schema matching method supported by online graph matching.
- Applied machine learning to ontology matching. Experiments show significantly improved performance on publicly available large data sets.
- Extended implementation of the open source KARMA ontology matching tool, based on the new relational matching algorithm.
- Developed Rule-Based Model Transformation for bidirectional translation between relational and text indexable (Elasticsearch) data. Implemented and tested the data exchange between Elasticsearch installation and the available law enforcement test data.
- Implemented linking between model transformation and the new ontology matching framework by generation of rules for the model transformation framework.
- Implemented an optimised version of the federated query engine.
- Designed a query transformation and execution method based on the Datalog deductive database language.

ENTITY LINKING AND RESOLUTION

- Added a text-oriented function to the entity linking pipeline.
- Designed, implemented and evaluated a graph functional dependency-based method to improve linking precisions. A high-quality paper describing this method was completed.
- Improved efficiency on the performance of the entity linking pipeline in the text parsing and start-up linking areas. This includes the selection of a text parser for faster parsing, optimising the data structure, the blocking and the entity linking pipeline processes for faster start-up linking time.

Development of tools and techniques for integrated information access and analysis within the law enforcement community will necessarily require access to real data sets, but access to these data sets is challenging within the end user community. Close engagement with several agencies is underway to provide a pathway for data access and system evaluation.

No changes to future research directions are envisaged for this program.

APOSTLE™

The program's key activities are to deliver a multi-year, multi-stream R&D project to provide effective search, interrogation and understanding of open source multi-media (text, image and video) data for users in the defence and law enforcement community.

Extensive engagement with end users including the ANZCTC and state and federal law enforcement will be ongoing to develop a series of detailed case scenarios for the *Apostle™* program. Successful concept demonstrators have been deployed and systems are now in operational use with a range of agencies.

Achievements within the various program streams for the reporting period are listed below.

DISTRIBUTED EVENT MINING

- Completed and evaluated a software tool to assist an analyst to extract, annotate and code conflict-related events.
- Developed a new framework for event extraction using relational rule learning combined with a domain-specific ontology.
- Developed a new method to improve event extraction by automatically splitting a text stream into multiple sub-streams and using an ensemble classifier.
- Created a gold standard dataset for political orientation and topics for issue motivated groups on social media.
- Developed methods to cluster issue motivated groups using social network analysis to find similarities and differences between groups.
- Developed methods to automatically identify issues of interest to a group from social media data.
- Developed methods to identify political orientation of a group towards an issue from social media data.
- Created an initial set of threat indicators for evaluating the likelihood of violence of an event.
- Designed and started implementing a system to allow users to highlight relevant features and rank events based on likelihood of violence.

KNOWLEDGE GRAPH CONSTRUCTION, CURATION, MANAGEMENT AND QUERY

- Constructed an integrated, highly efficient and automatic document annotation system that recognises important entities, disambiguates them, and links them to the central knowledge graph or database.
- Developed a new distance supervision-based relation extraction system.
- Designed a new deep-learning based concept graph/taxonomy construction system.
- Developed a new question answering system based on deep reinforcement learning-based sentence selection.

SEMANTIC INDEXING OF VIDEO

- Developed an efficient and effective system for hand gesture detection.
- Developed a logo retrieval system.
- Produced 13 papers for conferences in the areas of computer vision and multimedia analysis.
- Stream lead named as one of two Gold Disruptor winners in the ICT Researcher of the Year category at the Australian Computer Society (ACS) Digital Disruptors Awards.

PICTURING EVERYDAY KNOWLEDGE

- Developed the first linguistic style-transfer system for image captions, which learns to write story-like captions from a collection of romance novels.
- Developed software for visualising representative images and entities of a user.
- Implemented a system that extracts images and contents from the ongoing social media stream and clusters the collection based on image feature or text similarities.
- Developed graph visualisations of extracted entities and relationships from social media content, represented as graphs among people, places and organisations.
- Developed software to compare snapshots of knowledge graphs over time by highlighting the changes.
- Developed the first system to comparatively summarise multimedia content, by posing content summarisation as a classification problem.
- Developed neural architectures for open-domain relation extraction.

While not a specific impediment, it is acknowledged that there is a need for continuing engagement and input from end users to guide R&D activities, in particular to develop effective tools and techniques for users and analysts in the national security community.

No changes to future research directions are envisaged for this program.

LAW AND POLICY

During this reporting period the Law and Policy program added to its body of work from prior years by commencing and making substantial progress on one project, and commencing a second. Both projects are being undertaken for specific government end users and respond to specific business cases prepared by those end users. The projects are summarised below:

- *Using 'Open Source' Data and Information for Defence, National Security and Law Enforcement* project is being undertaken for the Defence Science and Technology Group and the Department of Home Affairs. The legal and policy analysis for this study has been completed and focus group and survey results will be delivered in the first quarter of the next financial year.
- *Compliance by Design (CbD) and Compliance through Design (CtD) Solutions to Support Automated Information Sharing* project commenced. This study by program researchers, joined by researchers of Data61, University of South Australia and the Autonomous University of Barcelona, is being undertaken for the Department of Home Affairs.

Increasing collaboration between law and policy researchers and technologists is a welcome result of relationship building during the earlier years of the program. As in previous years, project teams have been joined by new members, broadening the academic expertise in this field in Australia. The increased involvement of early career researchers is particularly positive as an investment for the future. In addition, the four PhD candidates in the program have also been making good progress.

No changes to future research directions are envisaged for this program.

END USER ENGAGEMENT

Extensive end user involvement provides evidence that research is meeting needs. In particular, each of the *Beat the News™*, *Apostle™* and Integrated Law Enforcement programs undertakes regular demonstrations to representatives selected from the end user community. Each

program is also governed by a project steering committee consisting of senior executives from the end users, whose role is to ensure that the projects are meeting end user needs.

INNOVATION EXCHANGE

Through the Innovation Exchange (IX) program, the D2D CRC proactively works with industry (particularly small to medium-sized enterprises), other research institutes, government agencies and industry associations on big data challenges in sectors other than national security. This program is aimed at exchanging technology and know-how from national security-focused R&D activities to other sectors through activities like seminars and workshops, contract R&D projects and technical advice.

The major accomplishments of the program during the reporting period are detailed below.

HEALTH

- Completed four health analytics projects utilising funding from the South Australian Department of State Development (DSD). These projects surpassed expectations and received positive feedback from DSD and the project steering committee, including SA Health's Chief Medical Officer. Several projects continued beyond DSD funding on a consulting basis.
- Developed the *Observing Recurrent Incidence of adverse Outcomes following hospitalisation*s (ORION) project, with several papers published and abstracts submitted to conferences (including two nominations for prizes at the Cardiac Society of Australia and New Zealand conference). A Statistical Analysis System (SAS) pack was created to automate the analysis allowing for extension across multiple areas.
- Received additional funding for the ORION project, allowing it to be extended to include all conditions/procedures (not just cardiac-related conditions). The project was renamed *SAFety, Effectiveness of care and Resource use among Australian Hospitals* (SAFER Hospitals) project.

- Continued the AI² project on a consulting basis with several improvements made to the alerts algorithm. The project also extended to an application that monitors user behaviour to flag any signs of possible mental health issues.
- Delivered the Emergency Waiting Time application to health organisations for further development.

MANUFACTURING

The Big Data Connect Program attracted some interesting projects involving big data analytics. The following four projects were approved for this program:

PROMET VALVES

- This project was successfully completed and involved developing a user-friendly data capture system for ship valve audits. This mobile application captures ship data and uploads to a database for further analysis. This was designed with the eventual goal of stock management, sales predictions and valve ordering.

FRONTIER MICROSCOPY

- This project involved exploration of several image analysis techniques for detecting asbestos fibres from microscopic images. A final report detailed these methods, and the source code was handed over to the client for further development.

COOPERS BREWERY

- The D2D CRC commenced a project with Coopers to refine their production of high-quality beer. Using past data on raw ingredients and final product quality, the D2D CRC worked to develop models that can make recommendations about production of high-quality pale ale based on characteristics of the raw ingredients.

SENTEK

- The D2D CRC worked on a model that can use moisture absorption data at several soil levels to predict the depth of a plant root. This informs development of optimal watering methods to save resources and improve harvest.

AGRICULTURE

- Completed the Precision to Decision (P2D) Agriculture project, with D2D CRC providing a detailed Big Data Reference Architecture. This report, funded through the Department of Agriculture and Water Resources Rural R&D, details the requirements for 15 industry Research Development Corporations (RDCs) to successfully leverage big data analytics to provide decision support within their industries.

EDUCATION AND TRAINING

PILOTED THE
DEVELOPMENT
PLANNING TOOL TO
SUPPORT THE DATA
SCIENCE COMPETENCY
FRAMEWORK

The E&T program focuses on the D2D CRC's objective of increasing the sustainability of the data science workforce. A large component of this involves engaging with, and developing the future workforce through PhD scholarships, Honours scholarships and internships.

STUDENT ENGAGEMENT AND DEVELOPMENT

This financial year, the D2D CRC reached its PhD milestone of 48 commencements after 10 new students started, bringing the total to 54 PhD students. Many students achieved great outcomes including presenting at international or national conferences, receiving awards, publishing on high-level platforms and completing industry internships.

The past year saw the first cohort of PhD students submit their theses. In total, four students submitted a thesis in early 2018. Seven additional students are expected to submit in late 2018, eight in early 2019 and 32 post 30 June 2019.

The D2D CRC is closely monitoring the progress of all students and stands ready to offer additional support in the final months of the CRC until 30 June 2019. This financial year, due to students gaining full-time employment, 11 PhD students were granted scholarship extensions, and one thesis submission was postponed. This means the D2D CRC did not achieve its thesis submission milestone of 12 in FY 2017-18, but is confident this will be made up in FY 2018-19.

The D2D CRC also sought to enhance PhD student knowledge sharing experiences through the following opportunities:

- attendance at the D2D CRC Annual Conference in September;
- attendance at aligned project meetings with the D2D CRC development operations teams;
- participation in a 'Perfect Pitch' challenge at the D2D CRC Showcase Dinner;
- presentation at seminars;
- submission of proposals to receive travel grants;
- attendance at catch-up meetings at universities;
- networking with other scholarship recipients across all of D2D CRC university partners; and
- creation of close relationships with the D2D CRC end users and industry partners.

Finally, the D2D CRC focused on supporting Honours students and undergraduates. Across FY 2017-18, the D2D CRC provided seven Honours scholarships and hosted 10 internships. Through internal mentoring and access to real

world challenges, students have been able to gain workplace experience and develop professional relationships.

DATA SCIENCE COMPETENCY FRAMEWORK PROJECT

The D2D CRC continued to develop the Data Science Competency Framework (DSCF) and is planning to launch the framework in late 2018. By describing the skills, knowledge, experience and personal attributes relevant to working in the data science industry, the DSCF aims to support the development of the big data workforce. In particular, the framework can be utilised to support workforce planning, develop individuals and teams, highlight career pathways and enable competency recognition.

The framework analyses job families across key competency areas aligned to the Australian Public Service (APS) levels of proficiency. The aim is to make this framework the recognised public sector data science framework, and have it accessible to the general public through open source channels.

To support the deployment of the framework, in FY 2017-18 the D2D CRC commenced work on an associated Development Planning Tool (DPT). This tool allows people to undertake self-assessment to identify gaps in their competencies. In turn the tool provides development options for data scientists, data engineers and data analysts of any level. The tool has been tested by over 100 participants across several public sector departments. The D2D CRC is aiming to have the tool ready for commercialisation by 30 June 2019.

TRAINING

In FY 2017-18, nine seminars and four short courses were undertaken by the D2D CRC. Seminars were a mix of public and closed sessions with topics drawn from the expertise of the D2D CRC's R&D staff, as well as pertinent participant capabilities.

The D2D CRC's Big Data Leaders Series continued to attract strong numbers of participants and offered attendees differing insights into the challenges facing the big data community.

The demand for short courses in the big data space continues to be strong and is driven primarily by public sector agencies looking at upskilling their staff. A bespoke course is being developed by one of the CRC's government participants for delivery in FY 2018-19.



Big Data Leaders Series



Code Like a Girl Workshop



RESULTS

LAUNCHED SECOND
SPINOUT COMPANY, NQRY®
TO COMMERCIALISE
THE INVESTIGATION
MANAGEMENT SYSTEM

SME ENGAGEMENT

Through the IX, the D2D CRC continued to engage with several SMEs. In FY 2017-18, the D2D CRC successfully completed four projects with manufacturing SMEs (Promet, Frontier Microscopy, Coopers Brewery and Sentek) under the Big Data Connect Program. These projects enabled the CRC to transition its expertise in big data to enable the aforementioned SMEs to realise business benefit from the application of data analytics.

The CRC also completed a project with RDCs looking at the future of precision agriculture. This project enabled the CRC to work with several SMEs to transition the Big Data Reference Architecture to the agriculture sector.

The CRC will continue to engage with SMEs in the health sector as part of the health analytics projects being undertaken in the IX. Discussions are occurring with the Digital Health CRC to investigate whether one of their SME partners can be the commercialisation partner for some of the D2D CRC health program IP.

Semantic Sciences and Genix Ventures, both from the D2D CRC participant group, continue to be very active in the CRC's projects. Semantic Sciences contribute to the *Multi-source Information Analysis Platform* project, while Genix Ventures and La Trobe continue to collaborate on the *Cognitive analytics for autonomous predictions in CT policing* project.

In addition, the CRC and its spinouts engaged with other SMEs with capabilities relevant to specific projects. For example, Elasticsearch's technology stack is used in both the *Apostle™* and Integrated Law Enforcement programs, and NQRY® engaged with Canberra-based SME, Intellidox, on a commercial opportunity building on the *CaseWalls™* IMS system.

COMMERCIALISATION

The D2D CRC executed a variety of actions to ensure effective and appropriate utilisation and/or commercialisation of the CRC's outputs. In FY 2017-18, the D2D CRC achieved the following milestones:

- Formed spinout company NQRY® to commercialise the Integrated Law Enforcement technology. NQRY® will initially focus on deploying *CaseWalls™*, an innovative and modern investigation management system, to the Australian law enforcement and national security market.
- Executed commercialisation plans for all of the research projects, through spinout companies Fivecast® and NQRY®. Both spinout companies are working to utilisation plans which are approved by the D2D CRC Board.
- Continued engagement with several agencies in trial and evaluation of the *Beat the News™*, *Apostle™* and Integrated Law Enforcement software. These trials not only led to further refinement of the software, but also caused transition from trial to operational licences through Fivecast®, as well as delivery of a federated search tool prototype now being used operationally.
- Released first versions of *CaseWalls™* IMS, enabling a series of live user trials and customer workshops. NQRY® has since provided tender responses to multiple agencies for the IMS product, currently pending decision.
- Released the first commercial product, Fivecast® *Insight*, which was developed by the *Apostle™* program. In addition, Fivecast® achieved the first commercial sales of Fivecast® *Insight* in Australia. This is a significant step for the D2D CRC as outputs are now being used operationally.
- Fivecast® was successful in receiving a TechInSA South Australia Early Commercialisation Fund grant, allowing the Fivecast® team to undertake two business development missions to the USA, leading to the establishment of US-based software trials.
- Fivecast was awarded the CIVSEC 2018 Innovation Award for Cyber Security in May 2018.



INTELLECTUAL PROPERTY MANAGEMENT

The D2D CRC has the essential mechanisms in place to ensure adherence to the National Principles of IP Management for Publicly Funded Research. Provisions within the Commonwealth and Participants' Agreements provide the key elements for IP management. In addition to the Agreements, the D2D CRC has implemented appropriate policies, procedures and systems, including those for:

- mandatory IP awareness training;
- identification and disclosure of IP;
- assessment of existing IP;
- protection of IP; and
- record keeping via an IP register.

The D2D CRC established an IP strategy process and developed commercialisation plans for all of the research projects. All programs have an established IP strategy and review the strategy on a regular basis. Regular patent scrubs are conducted with the development teams and intellectual property architectures for each of the software products have been created.

NQRY® and Fivecast® are working to utilisation plans which are approved by the D2D CRC Board, and these include requirements around protection of the D2D CRC IP.

In FY 2017-18, D2D CRC filed two provisional patent applications:

- New Australian Provisional Patent Application: METHOD AND SYSTEM FOR DATA CURATION, filed 14 March 2018.
- New Australian Provisional Patent Application: COMPUTER IMPLEMENTED SYSTEM AND METHOD FOR GEOGRAPHIC SUBJECT EXTRACTION FOR SHORT TEXT, filed 20 June 2018.

The first filing in March 2018 arose from an innovative method for data curation from the *Integrated Law Enforcement – Data Curation Foundry* project which aims to provide unified abstractions, languages and tools to support the entire data curation pipeline – all the way from data ingestion, to analysis, to insight discovery and leverage.

The second filing in June 2018 arose from technology developed by the D2D CRC *Beat the News™* headquarters team. The invention conveys the ability to identify geographical mentions from short text posts. Clearly, understanding location information associated with social-media posts is key to many applications, such as searching and event forecasting. However, on most social media platforms, less than three per cent of posts are actually annotated with location metadata. This location metadata only identifies a user's current location, but in many domains we are interested in the geographic location the user is discussing, rather than where they currently are.

Nine new innovation disclosures were recorded during the year, many of which remain under review by patent attorneys. The D2D CRC intends to file an additional patent in the second half of 2018.

In addition to the registered IP, the D2D CRC developed a large amount of IP which is not registered. Many of these key innovations and capabilities, which are licensed to the start-up companies, will be kept highly confidential. Not only is this attractive to national security, law enforcement and defence clients who do not want to publicise their capabilities, but also strategically important to the protection of confidential IP such as trade secrets and know-how. Further, the IP in the software products marketed by the spinout companies is protected by the copyright in the source code.

COMMUNICATIONS

The D2D CRC's communication program is intended to:

- increase awareness of the D2D CRC and its capability;
- showcase research outcomes and impacts via mainstream media, targeted publications and award nominations to demonstrate that D2D CRC is undertaking world-leading research;
- recognise D2D CRC as a thought leader and build reputation in the industry through on-point blogging and executive events;
- publicise D2D CRC's contribution to developing a sustainable data science workforce;
- promote and support women in STEM;
- publicise the CRC's achievements via the company website, electronic newsletters and social media channels; and
- continuously increase social media following and engagement:
 - » Twitter @D2DCRC
 - » LinkedIn linkedin.com/company/data-to-decisions-crc
 - » Facebook – facebook.com/d2dcrc/
 - » YouTube – Data to Decisions CRC.

During the reporting period, the D2D CRC:

- made 26 external presentations to end user audiences in Adelaide, Sydney, Melbourne, Canberra, Hobart, France and Italy;
- was mentioned 54 times in the media;
- received two awards (Fivecast® received the CIVSEC 2018 Innovation Award for Cyber Security and the Narrative Visualisation Project received the South Australian R&D Project of the Year Award at the 2018 AIIA iAwards);
- hosted two Code Like a Girl workshops;
- continued to promote discussion among 'thought leaders' on important topics related to Australia's national security big data challenges;
- published four articles in scholarly refereed journals and 23 full written conference papers (refereed proceedings); and
- held regular meetings and presentations with participant organisations.



SA iAwards Win

Health Analytics Seminar

MEDIA TABLE

PUBLISHED	NAME	PUBLICATION	MEDIUM
03/07/17	Tech start up builds forecasting capability for national security	Defence Connect	Online
13/07/17	Adelaide researchers will develop defences against cyber attacks, infrastructure, says Defence Industry Minister Christopher Pyne	The Advertiser	Online
14/07/17	Innovation Hub boosts Australia's Defence Industry by \$12.3 million	Department of Defence	Online
21/07/17	Defence seeks new visualisation system	Defence Connect	Online
28/08/17	Defence investment targets cyber threats	Defence Connect	Online
18/09/2017	Unlocking South Australia's copper resources	NewsMaker	Online
18/09/2017	Unlocking South Australia's copper resources	Adelaide University	Online
24/09/17	How 'bomb kit' delivery changed thinking about Australian border security	Sydney Morning Herald	Online
24/09/17	Major rethink on border security	The Standard	Online
25/09/17	How 'bomb kit' delivery changed thinking about Australian border security	The Age	Online
25/09/17	How 'bomb kit' delivery changed thinking about Australian border security	Brisbane Times	Online
29/09/17	Barriers to digital agriculture impacting on profit	Medianet	Online
09/10/17	A wake-up call for on farm telecommunications	Medianet	Online
17/10/17	P2D Telecoms and Producer Reports Released	Cotton Australia	Online
23/10/17	Big Data to illuminate national outcomes of cardiovascular care	The Heart Foundation	Online
25/10/17	Big data provides insights into cardiovascular care post-hospitalisation	LabOnline	Online
26/10/17	Big data, not big brother, the way forward in cardiac care	The Limbic	Online
3/11/17	STEM Careers	Susan Close MP Facebook (Department for Education and Child Development)	Online
20/11/17	Mental health care goes digital	Flinders University	Online
20/11/17	AI Squared Project	ABC Adelaide	Radio
21/11/17	AI Squared Project	ABC Townsville	Radio
21/11/17	AI Squared Project	2DayFM	Radio
21/11/17	Better Care For Patients As Mental Health Care Goes Digital	Women Love Tech	Online
22/11/17	Securing the future through digital agriculture	Medianet	Online
23/11/17	Big Data Leads to Big Careers	Careers with Stem	Online
24/11/17	Digital agriculture could unlock production gains of \$20.3 billion	Medianet	Online
06/12/17	Mental health care goes digital	CRC Association	Online
14/12/17	Report recommends Australian agriculture go digital	Medianet	Online

PUBLISHED	NAME	PUBLICATION	MEDIUM
14/12/17	South Australian Government Defence Strategy: 2030	DefenceSA	Print and Online
16/01/18	Cyber research centre labels Australia's counter-threat capacity 'relatively weak'	ZDNet	Online
16/01/18	Cyber research centre labels Australia's counter-threat capacity 'relatively weak'	WorldNews	Online
16/01/18	Cyber research centre labels Australia's counter-threat capacity 'relatively weak'	News Vire	Online
16/01/18	Cyber research centre labels Australia's counter-threat capacity 'relatively weak'	Leoz Tech	Online
16/01/18	Cyber research centre labels Australia's counter-threat capacity 'relatively weak'	Apanthos	Online
17/01/18	Cyber research centre labels Australia's counter-threat capacity 'relatively weak'	Defence Alert	Online
22/01/18	Former spy boss seeks new agency	Innovation Aus	Online
25/01/18	Cyber research centre labels Australia's counter-threat capacity 'relatively weak'	Ownetech	Online
06/02/18	D2D CRC to reduce burden on South Australia's emergency departments	CRC Association Newsletter	Online
07/02/18	Big Data	ABC Radio Canberra	Radio
06/03/18	New digital footprint to unleash billions of dollars in profit	Medianet	Online
06/03/18	New digital footprint to unleash billions of dollars in profit	Mirage News	Online
15/03/18	How social media can predict protests and strikes	UniSA News	Online
22/03/18	How big data tech used by Netflix and Uber can help predict flu outbreaks	The Advertiser	Online
24/03/18	Analyse this – How data gives doctors power to beat bugs	The Advertiser	Print
27/03/18	Data scientist Dennis Horton explains "big data" and disease outbreak modelling	Basil Hetzel Institute	Online
05/04/18	Sky's the limit	Careers with STEM	Print
17/04/18	Innovation Awards Shortlist Announced	CIVSEC 2018	Online
03/05/18	Tech start-up	Defence Business Magazine	Print
08/05/18	What CRC's Mean To You?	CRC Know How Magazine	Print
08/05/18	The Digital Health Revolution	CRC Know How Magazine	Print
08/05/18	Bridging Innovations Valley of Death	CRC Know How Magazine	Print
08/05/18	Are you protected?	CRC Know How Magazine	Print
18/06/18	AIIA SA/NT iAwards showcases excellence in Australian innovation	PRWire	Online
21/06/18	AIIA SA/NT iAwards showcases excellence in Australian innovation	CIO	Online

RESOURCES

GOVERNANCE – BOARD, COMMITTEES AND KEY STAFF

The D2D CRC continued to be a tax exempt, not-for-profit body that operated to the fiduciary and governance standards required of an incorporated body under Australian Law.

The D2D CRC Board was actively supported by one sub-committee and one advisory committee during the year:

- The Research Advisory Committee (RAC).
- The Defence and National Security Advisory Committee (DNSAC).

The Research Advisory Committee, while not disbanded by the Board, was not convened during FY 2017-18. They remain a source of advice for the Board on research matters as the D2D CRC enters its final year.

There were no changes to the D2D CRC Board in the reporting period.

BOARD MEMBERSHIP

The following members served on the D2D CRC Board during FY 2017-18:

NAME	ORGANISATION	CRC POSITION/ROLE	KEY SKILLS
Tim Scully	Independent	Director and Chairman	<ul style="list-style-type: none">- Public Service Administration- Strategy Development and Planning- Management Public Sector- Defence Intelligence Surveillance and Reconnaissance (ISR)- National Security and Intelligence
Fatima Beattie	Independent	Director	<ul style="list-style-type: none">- Public Service Administration- Corporate Governance- Strategy Development and Planning- Intellectual Property- Management – Public Sector
Cath Ingram	Independent	Director	<ul style="list-style-type: none">- Finance- Risk, Audit, Insurance- Public Service Administration- Corporate Governance- Director Public and Private Sector- Management Private Sector- Strategy Development and Planning
Kathryn Adams	Independent	Director	<ul style="list-style-type: none">- Public Service- Corporate Governance- Strategy Development and Planning- Intellectual Property- Research and Development- Director Public Sector- Management Public Sector- CRC- Research Provider – Industry Interface
Stephen Merchant	Independent	Director	<ul style="list-style-type: none">- Defence ISR- National Security and Intelligence- Public Service- Management Public Sector
Andrew Stead	Independent	Director	<ul style="list-style-type: none">- Information Technology- Strategy Development and Planning- Research and Development- Research within University Sector- Research Provider – Industry Interface- Intellectual Property- IP Commercialisation
Sanjay Mazumdar	D2D CRC	Director and D2D CRC CEO	<ul style="list-style-type: none">- Information Technology- Management – Private Sector- Research Provider – Industry Interface- Defence ISR- Strategy Development and Planning- Research and Development

KEY SKILLS OF BOARD MEMBERS

TIM SCULLY

Tim Scully is a senior leader with over 30 years' experience building and leading operational capabilities in government and industry. He has played lead roles in developing operational responses to national and international intelligence and security challenges. Tim's leadership roles include Director, Stoneleigh Consulting; CEO Stratsec and Head of Cyber Security at BAE Systems Australia; inaugural Head of Defence's Cyber Security Operations Centre; Head of the Defence Security Authority; Director General Support to Military Operations; and Assistant Secretary Intelligence Analysis and Production.

FATIMA BEATTIE

Fatima Beattie has over thirty years' experience in the delivery and governance of intellectual property development and commercialisation, management of compliance programs, risk management and governance of ICT programs. Fatima currently runs FatBeat Design in Canberra offering Intellectual Property, Risk and ICT Governance specialist consultancy. This follows senior appointments with IP Australia across 13 years, most recently as Deputy Director General responsible for all the registered intellectual property rights in Australia including the roles of Commissioner of Patents, Registrar of Trade Marks, Designs and Plant Breeder's Rights.

CATH INGRAM

Cath Ingram is the KPMG Chairman of Partners for the Canberra Office which is the centre of excellence for government. As the Lead Partner responsible for Federal Government, Cath has over 27 years' experience in the delivery of professional services to the Public Sector. Through these engagements she has a strong appreciation for the Australian Government accountability framework, policy drivers, inter-agency relations and the importance of collaboration.

KATHRYN ADAMS

Kathryn Adams is a microbiologist and lawyer and specialises in intellectual property management, commercial application of R&D and corporate governance. She has had extensive experience in R&D investment from the perspective of a researcher, research institute leader and as an investor. She is currently on the Boards of a number of CRCs as well as Agriculture Victoria Services Pty Ltd and PBIP Ltd.

STEPHEN MERCHANT

Stephen Merchant, currently conducts his own consultancy business, having completed almost 40 years of service with the Australian Government. During the latter part of his career, he held a variety of senior appointments in the Australian Intelligence Community and acted as Secretary of the Department of Defence on numerous occasions. Stephen holds a Bachelor of Arts (Honours) from the University of Sydney.

ANDREW STEAD

Andrew Stead has worked extensively with startup founders and early stage investors, through private and public incubators, accelerators and venture funds. As a founder, advisor and board member, he specialises in the commercialisation of technology products, creation of new businesses, capital raising, and mergers and acquisitions. Andrew's overlapping experiences between corporates, research organisations and startups provides a unique perspective on collaboration and innovation. He is currently responsible for product incubation at insurer IAG, a committee member of early stage investment group Sydney Angels and a director of Hivery. Andrew has a background in technology strategy and operations within the telecommunication industry including the British Army. He holds a BSc(Hons) (USYD) and MBA (MGSM), is a graduate of RMA Sandhurst and a Churchill Fellow.

SANJAY MAZUMDAR

Sanjay Mazumdar is the CEO of the D2D CRC. Sanjay is a proven and experienced senior leader who has worked across the defence, ICT, government and academic sectors. Sanjay has had senior roles in engineering management, general management, business development and project management. His former roles include the CEO of the Defence Systems Innovation Centre, Head of Engineering for BAE Systems Australia, Operations Manager at Motorola Australia and Research Scientist at the DSTO (now DST Group).

BOARD MEETINGS AND ATTENDANCE

The attendance of the Board members at Board meetings is outlined in the table below.

MEETING DATE AND LOCATION	27/9/17 (CANBERRA)	12/12/17 (ADELAIDE)	21/2/18 (SYDNEY)	1/6/17 (MELBOURNE)	TOTAL	ELIGIBLE TO ATTEND
Board Member						
Tim Scully	Yes	No	Yes	Yes	3	4
Sanjay Mazumdar	Yes	Yes	Yes	Yes	4	4
Cath Ingram	No	Yes	Yes	Yes	3	4
Fatima Beattie	Yes	Yes	Yes	Yes	4	4
Kathryn Adams	No	Yes	Yes	Yes	3	4
Stephen Merchant	Yes	Yes	Yes	Yes	4	4
Andrew Stead	Yes	Yes	Yes	Yes	4	4
Total	5	6	7	7	25	28

COMMITTEES

AUDIT AND RISK COMMITTEE

The Audit and Risk Committee is a sub-committee of the Board. It provides assurance and advice to the Board on the D2D CRC’s risk, control and compliance framework as well as overseeing the audit process for the D2D CRC financial statements.

MEMBERSHIP

MEMBER	ORGANISATION	ROLE	KEY SKILLS
Cath Ingram	D2D CRC Director	Chairman/Director	<ul style="list-style-type: none">FinanceRisk, Audit and InsurancePublic Service AdministrationCorporate GovernanceDirector Public and Private SectorManagement – Private Sector
Kathryn Adams	D2D CRC Director	Director/Member	<ul style="list-style-type: none">Public ServiceCorporate GovernanceStrategy Development and PlanningIntellectual PropertyResearch and DevelopmentDirector Public SectorManagement Public SectorCRCResearch Provider – Industry Interface
Niall Fay (advisor only)	D2D CRC	D2D CRC advisor to Committee	<ul style="list-style-type: none">Defence, National Security and Finance

MEETING ATTENDANCE

MEMBER	7/9/17	4/12/17	1/5/18	TOTAL	ELIGIBLE TO ATTEND
Cath Ingram	Yes	Yes	Yes	3	3
Kathryn Adams	Yes	Yes	Yes	3	3
Niall Fay (advisor only)	Yes	Yes	Yes	3	3

RESEARCH ADVISORY COMMITTEE

The Research Advisory Committee provides advice to the Board on the quality, scope, effectiveness and relevance of the D2D CRC research program. The Committee also provides advice and recommendations to the Board on proposed new projects with a specific focus on their alignment with the D2D CRC’s Strategic Plan, Capability Roadmap, Technology Roadmap and linkage to the D2D CRC’s impacts, outputs and utilisation milestones from the D2D CRC impact tool and Commonwealth Agreement.

MEMBERSHIP

MEMBER	ORGANISATION	ROLE	KEY SKILLS
Dr Dale Lambert	DST Group	Chairman	<ul style="list-style-type: none">Defence ISRNational Security and IntelligenceManagement and delivery of end user focused research programs
Kathryn Adams	D2D CRC	Board Representative	<ul style="list-style-type: none">Management and delivery of end user focused research programsCommercialisation and utilisation strategies
Professor Paul Compton	UNSW	Member	<ul style="list-style-type: none">Data storage and managementManagement and delivery of end user focused research programsCommercialisation and utilisation strategies
Greg Wood	SAS	Member	<ul style="list-style-type: none">Data storage and managementCommercialisation and utilisation strategies
Brenton Cooper	D2D CRC	D2D CRC Representative	<ul style="list-style-type: none">Defence ISRNational Security and IntelligenceData storage and managementData analytics, decision support and data visualisationManagement and delivery of end user focused research programsCommercialisation and utilisation strategies
Anna Harmer	AGD	Member	<ul style="list-style-type: none">National Security and IntelligenceData analytics, decision support and data visualisationManagement and delivery of end user focused research programs

MEETING ATTENDANCE

No RAC meetings took place during the reporting period.

DEFENCE AND NATIONAL SECURITY ADVISORY COMMITTEE

The Defence and National Security Advisory Committee provides advice to the Board regarding the relevance of its strategic and business plan to the national security community. In addition, it provides guidance on how to best ensure the transfer of outputs from the D2D CRC into the national security community.

MEMBERSHIP

MEMBER	ORGANISATION	ROLE	KEY SKILLS
Deputy Commissioner Ramzi Jabbour	Australian Federal Police	Chairman	<ul style="list-style-type: none">National SecurityPublic ServiceManagement Public Sector
Chris Keane*	BAE Systems	Member	<ul style="list-style-type: none">Defence ISRTransition of capability from industry to end users
Deputy Commissioner Scott Tilyard	Tasmanian Police	Member	<ul style="list-style-type: none">National Security
Steve Godinho	Genix Ventures	Member	<ul style="list-style-type: none">Transition of capability from industry to end users
Dirk Klein*	SAS Institute	Member	<ul style="list-style-type: none">Transition of capability from industry to end users
Stephen Merchant	D2D CRC	Board Representative	<ul style="list-style-type: none">Defence ISRNational Security and IntelligencePublic ServiceManagement Public Sector
Dara Williams	Office of National Assessments	Member	<ul style="list-style-type: none">National Security and IntelligencePublic ServiceManagement Public Sector
Brett Greenshields	Department of Foreign Affairs and Trade	Member	<ul style="list-style-type: none">National Security and IntelligencePublic ServiceManagement Public Sector
Jane VÐ	Attorney-General’s Department	Member	<ul style="list-style-type: none">National Security and IntelligencePublic ServiceManagement Public Sector
Maria Fernandez	Department of Immigration and Border Protection	Member	<ul style="list-style-type: none">National Security and IntelligencePublic ServiceManagement Public Sector
Sanjay Mazumdar	D2D CRC	D2D CRC and Board Representative	<ul style="list-style-type: none">Defence ISRNational Security and IntelligenceTransition of capability from industry to end users
Dr Tim Pattison	DST Group	Member	<ul style="list-style-type: none">Defence ISRNational Security and IntelligenceManagement and delivery of end user focused research programs
Dr Sheridan Kearnanº	Department of Defence	Member	<ul style="list-style-type: none">National Security and IntelligencePublic ServiceManagement Public Sector

MEMBER	ORGANISATION	ROLE	KEY SKILLS
Susan Bodell	Department of Defence	Member	<div><div></div>National Security and Intelligence</div> <div><div></div>Public Service</div> <div><div></div>Management Public Sector</div>
Tony Po	Attorney-General's Department	Member	<div><div></div>National Security and Intelligence</div> <div><div></div>Public Service</div> <div><div></div>Management Public Sector</div>
Lee Walton [^]	Department of Prime Minister and Cabinet	Member	<div><div></div>National Security and Intelligence</div> <div><div></div>Public Service</div> <div><div></div>Management Public Sector</div>
Col Blanch [^]	Australian Criminal Intelligence Commission	Member	<div><div></div>Intelligence Operations</div> <div><div></div>Public Service</div> <div><div></div>Management Public Sector</div>

*Resigned as members during the reporting period
ð Replaced by Tony Po during the reporting period
°Replaced by Susan Bodell during the reporting period
^New members during the reporting period

MEETING ATTENDANCE

MEMBER	6/9/17	2/3/18	TOTAL	ELIGIBLE TO ATTEND
Ramzi Jabbour	Yes	Yes	2	2
Chris Keane	No	N/A	1	1
Scott Tilyard	Yes	Yes	2	2
Steve Godinho	Yes	Yes	2	2
Dirk Klein	Yes	N/A	1	1
Stephen Merchant	Yes	Yes	2	2
Sanjay Mazumdar	Yes	Yes	2	2
Dara Williams	Yes	Yes	1 (1)	2
Brett Greenshields	Yes	Yes	1 (1)	2
Jane V	Yes	N/A	(1)	1
Maria Fernandez	Yes	Yes	(2)	2
Tim Pattison	Yes	Yes	2	2
Sheridan Kearnan	Yes	Yes	(2)	2
Lee Walton	Yes	Yes	2	2
Susan Bodell	N/A	Yes	1	1
Tony Po	N/A	Yes	1	1
Col Blanch	N/A	Yes	1	1

* note () indicates a delegate attended

KEY STAFF

This table shows key staff as at 30 June 2018:

NAME	ORGANISATION	CRC POSITION	TIME COMMITMENT
Sanjay Mazumdar	D2D CRC	Chief Executive Officer	100%
Brenton Cooper	D2D CRC	Chief Technology Officer	100%
Niall Fay	D2D CRC	Chief Operations Officer	100%
Duane Rivett	D2D CRC	Commercialisation Manager	100%
Megan Prideaux (until March 2018)	D2D CRC	Education and Training Manager	100%
Regine Richelle (from March 2018)			
Voula Dimitrakopoulos	D2D CRC	Senior Marketing and Communication Officer	100%
Prof Markus Stumptner	University of South Australia	Research Program 1 Leader (Data Storage and Management)	54%
Prof Louis de Koker	Deakin University	Research Program 3 Leader (Policy and Law)	61%

PARTICIPANTS

This table details the Essential Participants involved in the D2D CRC during the reporting period:

ESSENTIAL PARTICIPANT	ABN	ORGANISATION TYPE
Attorney General’s Department	92 661 124 436	Australian Government
Australian Federal Police	17 864 931 143	Australian Government
Department of Defence	68 706 814 312	Australian Government
Defence SA	42 912 246 233	State Government
BAE Systems Australia	29 008 423 005	Industry
Genix Ventures	84 117 733 696	Industry
Leidos	12 001 071 239	Industry
Pivotal	97 162 413 274	Industry
SAS Institute Australia*	13 002 287 247	Industry
Semantic Sciences Research	80 132 254 089	Industry
eResearch SA	61 249 878 937	Research
Deakin University	56 721 584 203	University
The University of Adelaide	61 249 878 937	University
University of New South Wales	57 195 873 179	University
University of South Australia	37 191 313 308	University

*SAS Institute Australia withdrew from the D2D CRC during FY 2017-18.

This table details the Other Participants involved in the D2D CRC during the reporting period:

OTHER PARTICIPANTS	ABN	ORGANISATION TYPE
Department of Home Affairs	33 380 054 835	Australian Government
Office of National Assessments	87 904 367 991	Australian Government
Basis Technology	N/A	Industry
Palantir Technologies Australia	48 144 948 309	Industry
Teradata Australia	77 125 071 374	Industry
Unisys Australia	31 105 642 902	Industry
Australian National University	52 234 063 906	University
Carnegie Mellon University Australia	97 116 769 423	University
La Trobe University	64 804 735 113	University
University of Technology Sydney	77 257 686 961	University

COLLABORATION

The D2D CRC has built strong collaboration in all aspects of its research program, from proposal development through to advisory panel assessment, research development and evaluation of the programs.

The Integrated Law Enforcement Program exemplifies the collaboration established by the D2D CRC. The program enables and leverages collaboration between all participants of the ANZCTC (which represents all law enforcement agencies involved in counter terrorism), and R&D teams from the D2D CRC, University of South Australia, University of New South Wales, and Deakin University.

The team has collaborated extensively and are co-creating solutions to the needs of counter terrorism investigators across the country. These solutions have been actively trialled within the ANZCTC agencies to further refine them. The solutions from the ILE program are beginning to be commercialised through spinout company NQRY®.

The *Apostle™* program has engaged extensively across the end user participants in the D2D CRC with trials currently underway in several national security agencies. The *Apostle™* program leverages the outputs from the R&D teams at the D2D CRC, University of Adelaide, University of New South Wales, University of Technology Sydney and the Australian National University. Similarly, the *Beat the News™* program has brought together R&D from the University of Adelaide and UniSA and undertaken trial activities with several end user participants in the D2D CRC.

The D2D CRC is beginning to commercialise the outputs from *Apostle™* and *Beat the News™* through the spinout company, Fivecast®. This has resulted in operational deployments in agencies within Australia and evaluation trials in the USA. The D2D CRC agency partners have been instrumental in helping to make connections with their counterparts overseas.

The Law and Policy program has exemplified collaboration with end users and between research participants. This program involves researchers from La Trobe University, Deakin University and the University of New South Wales who have very effectively collaborated with their end-user sponsors including the Department of Home Affairs, Australian Criminal Intelligence Commission, Defence and the Attorney-General's Department to deliver well received research outputs.

Further collaboration, outside the national security domain, has been achieved through the Innovation Exchange program. The D2D CRC has collaborated with several manufacturing SMEs through the Big Data Connect Program, with RDCs and other research organisations through the P2D agriculture project, and with SA Health, Queen Elizabeth Hospital and two South Australian universities on health analytics projects.

ADDITIONAL REQUIREMENTS

CRC FUTURE PLANS AND TRANSITION ARRANGEMENTS

As reported in the last annual report, the D2D CRC was exploring three potential future states post wind-up of the CRC. These include:

- 1. a new CRC focused on new big data challenges in national security;
- 2. continuation as a directly funded R&D innovation centre; and
- 3. establishing spinout companies.

The status of activities against these three future states is as follows:

- A proposal for the INdata CRC was submitted into Round 20 of the CRC program. This new CRC proposes to build on the legacy of the D2D CRC but focus on new data analytics challenges in transnational serious and organised crime, counter terrorism and cyber-enabled foreign interference. The CRC proposal has received strong support from the national security community, particularly the Home Affairs portfolio.
- A directly funded R&D innovation centre is not being actively pursued. This will be an option to explore if the INdata CRC proposal is not successful.
- Two spinout companies, Fivecast® and NQRY® were established. These companies are beginning to pursue commercial opportunities for the CRC's IP with Fivecast® already making commercial sales in Australia and expected sales in the US very soon.

PERFORMANCE REVIEW

No performance reviews took place during the reporting period.

OTHER ACTIVITIES

As described, the D2D CRC has undertaken work in the agriculture, manufacturing and health sectors under the Innovation Exchange program. While additional funding has been obtained to undertake these activities without impacting the original Commonwealth grant, they still align to the activities specified in the Commonwealth Funding Agreement. There were no activities undertaken by the CRC outside the activities specified in the Commonwealth Funding Agreement for this financial year.

The CRC has a very strong relationship with AustCyber, the cybersecurity growth centre. AustCyber regularly refer potential collaborators to the D2D CRC and had a strong role in shaping aspects of the INdata CRC proposal.

The D2D CRC has a strong track record of collaborating with other CRCs, such as the Sheep CRC, Capital Markets CRC, Digital Health CRC and the Cybersecurity CRC. The relationship with these CRCs ranges from collaborative research, potential commercialisation arrangements to governance and policy support.

EXIT REPORT

EXIT REPORT

The D2D CRC will wind-up on 30 June 2019 at the end of its five year Commonwealth funding period. In its final eight months of operation, the CRC will transition to consolidating its accomplishments and establishing a long-lasting legacy accessible to partners in the national security community, academia and industry. This exit report summarises the D2D CRC's impact to date.

DIRECT ECONOMIC BENEFITS

The D2D CRC has delivered several new products, services and processes for application in the national security sector. This means analysts can deliver better decisions faster, resulting in increased productivity, lower operating costs and greater national security capability.

From a commercial point of view, the D2D CRC has developed four software products during its agreement period which are described below. Three of these products are currently in market, with plans for the fourth to be licenced to industry or the public sector.

FIVECAST® *INSIGHT* SOFTWARE

Fivecast® *Insight* is a system for open source risk intelligence being commercially deployed by D2D CRC spinout company Fivecast™. The spinout company achieved first sales of Fivecast® *Insight* in Australia in FY 2017-18, generating significant commercial revenue. Fivecast® is also engaging with potential customers in the United States of America (USA).

The technology powering Fivecast® has evolved from the D2D CRC's *Apostle*™ and *Beat the News*™ Programs. Fivecast® *Insight* is based on the *Apostle*™ program.

Insight has been trialled by 12 agencies and has received excellent feedback, with agencies commending the tool on its ability to extract intelligence from large quantities of open source data. One trial partner described the improved analysis capability and efficiency gained from using the software:

“Like most national security agencies, the Department is faced with the challenge of analysing large volumes of data, and operationalising that analysis to achieve effective business outcomes. D2D CRC has developed world-leading data analysis capabilities which are assisting the Department to process, analyse, and make use of a diverse range of data. One of the core capabilities is called *Apostle*™.

The Department is benefiting from the *Apostle*™ capability as it provides the ability to extract intelligence and detect risk from enormous quantities of noise in open source information. It has enabled valuable insights to be gained, which has not been possible in the past, and information that may have previously been left undetected is now able to be quickly identified, facilitating rapid analysis and improved risk management decisions.”

Fivecast® is still an early-stage venture, but it is anticipated that the company will continue to grow, requiring a high-technology workforce in Australia. In 2018 the company received a TechInSA South Australian Early Commercialisation Fund grant, as well as an Australian Government Accelerating Commercialisation grant.

FIVECAST® DISCOVERY SOFTWARE

Fivecast® *Discovery* provides the ability for user-driven collection and thematic analysis of population-level open source information. Advanced geo-tagging and deep-learning techniques provide analysts with early indicators and warnings to understand engagement with specific narratives, detect the emergence of new topics, and even the ability to predict future events.

Several successful trials of Fivecast® *Discovery* have been completed and first sales have been achieved.

NQRY® *CASEWALLS*™ INFORMATION MANAGEMENT SYSTEM (IMS)

The *CaseWalls*™ IMS product revolutionises investigation management practice for law enforcement practitioners. The product is being deployed by D2D CRC's second spinout, NQRY®.

Successful trials of the *CaseWalls*™ system have been completed, and commercial deployments of the system are being pursued with a number of opportunities within Australia. The economic benefit of these tools is still to be determined through operational deployments; however, with tens of thousands of investigators across Australia, even small increases in productivity will result in significant savings.

DATA SCIENCE DEVELOPMENT PLANNING TOOL

To support development of the data workforce, D2D CRC utilised its Data Science Competency Framework (DSCF) as the basis for a Data Science Development Planning Tool (DPT). The tool is an online self-assessment system that enables individuals to identify gaps in their competencies, and provides development options for data scientists, data engineers and data analysts of any level.

The D2D CRC will develop a commercialisation pathway for the DPT via industry or the public sector, with IP managed via licence agreements. The D2D CRC is aiming to have a fully usable, intuitive, ready-to-customise tool ready for commercialisation by 30 June 2019.

In addition to these four products, Fivecast® were also awarded an AusIndustry Accelerating Commercialisation Grant in October 2018 which will be used to develop and commercialise a new enterprise level product, Fivecast® AI. This product will address a large, international market for very high-volume automated risk analysis, applicable in visa processing, security vetting and insider threat monitoring.

IMPACT ON COLLABORATION WITH INDUSTRY

The D2D CRC had 14 Essential Participants and 13 Other Participants over its lifetime as detailed in the below table:

	AGENCY	PARTICIPANT/OTHER PARTICIPANT	ORGANISATION TYPE	PERIOD OF PARTICIPATION
1	Attorney General’s Department	Participant	Australian Government	FY 2014-15 – current
2	Australian Federal Police	Participant	Australian Government	FY 2014-15 – current
3	Department of Defence (Federal)	Participant	Australian Government	FY 2014-15 – current
4	Department of Immigration and Border Protection	Other Participant	Australian Government	FY 2013-14 – 2018
	Department of Home Affairs			2018 – current
5	Office of National Assessments	Other Participant	Australian Government	FY 2015-16 – current
6	Defence SA	Other Participant	State Government	FY 2014-15 – current
7	BAE Systems Australia	Participant	Industry	FY 2014-15 – current
8	Genix Ventures	Participant	Industry	FY 2013-14 – current
9	Leidos	Participant	Industry	FY 2014-15 – current
10	Pivotal	Participant	Industry	FY 2013-14 – current
11	SAS Institute Australia	Participant	Industry	FY 2014-15 – 2018
12	Semantic Sciences Research	Participant	Industry	FY 2013-14 – current
13	Basis Technology	Other Participant	Industry	FY 2015-16 – current
14	Palantir Technologies Australia	Other Participant	Industry	FY 2014-15 – current
15	Teradata Australia	Other Participant	Industry	FY 2014-15 – current
16	The Boston Consulting Group	Other Participant	Industry	FY 2014-15 – 2017
17	Unisys Australia	Other Participant	Industry	FY 2014-15 – current
18	PriceWaterhouseCoopers Australia	Other Participant	Industry	FY 2014-15 only
19	eResearch SA	Participant	Research	FY 2014-15 – current
20	Deakin University	Participant	University	FY 2013-14 – current
21	The University of Adelaide	Participant	University	FY 2013-14 – current
22	University of New South Wales	Participant	University	FY 2013-14 – current
23	University of South Australia	Participant	University	FY 2013-14 – current
24	Australian National University	Other Participant	University	FY 2015-16 – current
25	Carnegie Mellon University Australia	Other Participant	University	FY 2014-15 – current
26	La Trobe University	Other Participant	University	FY 2014-15 – current
27	University of Technology Sydney	Other Participant	University	FY 2015-16 – current

Over the course of the D2D CRC, a strong focus has been placed on creating a bridge between the university participants and end user (government) participants. As a result, university participants have been able to identify and work on real-world problems relevant to the national security community.

This has resulted in the publication of many journal articles and conference papers, opportunities to present research nationally and internationally and the receipt of various highly regarded awards. At time of writing, the D2D CRC had published 95 scholarly refereed journals and full written conference papers (refereed proceedings). These are published in the appendices of each D2D CRC annual report and in the Management Data Questionnaire (MDQ). Many of D2D CRC’s reports have remained unpublished due to their confidential subject matter.

Dr. Lewis Mitchell at the University of Adelaide described the valuable research that came from his university’s engagement with industry and end users via the D2D CRC partnership:

“Being a part of D2D CRC has been an invaluable experience for me and my team. As well as having been able to employ four researchers across two projects over the last three years, we have built a team of more than half a dozen students from undergraduate to PhD, all working on diverse mathematical modelling and data science projects.

Perhaps even more importantly, the opportunity to engage with industry partners and end users and learn about the challenges they face has been a catalyst for doing interesting and valuable research which we hope will have lasting impact.

Personally, working with D2D has been a fantastic and rewarding experience. It has helped me build my network substantially, and I hope that the links formed through this CRC will persist well into the future.”

Professor Bruce H. Thomas at the University of South Australia described the partnership with D2D CRC as “immensely valuable”:

Working with the D2D CRC has been an immensely valuable relationship for our team. The D2D CRC has opened up opportunities for us to engage directly with industry and address their real-world needs, producing quality research that has impact beyond academia. As a result, we have now built several strong relationships within industry and have a clearer understanding of the direction industry is taking.

Being part of the D2D CRC has also opened up cross-discipline collaborations, with fellow Universities and research groups providing expertise to accelerate our research. The world-class Software Engineers and Data Scientists based at the D2D CRC have provided engineering support to help ensure our research can be transferred into real-world solutions.”

While university participants have benefitted from working closely and collaboratively with D2D CRC headquarters staff who have subject matter expertise and relevant industry knowledge, government participants have benefitted from the ability to tailor the D2D CRC’s solutions to meet their needs. Annual conferences and related events have allowed government participants to meet directly with university and industry participants and continue to build on collaboration with all parties.

As part of the D2D CRC’s IX program, and in collaboration with the South Australian Government, the Big Data Connect Program (BDCP) was created. The BDCP links South Australian manufacturers with the D2D CRC to explore opportunities for leveraging big data to deliver value to their business. The BDCP is a strong example of how the D2D CRC, which is primarily focused on defence and national security, has been able to transfer its R&D to benefit another core Australian industry.

Seeley International participated in the BDCP to investigate opportunities to improve the performance and efficiency of their coolers through data mining. Speaking about the program, Seely international General Manager Rob Gilbert said:

“The program has been excellent in exposing the potential for data-based business opportunities and making us aware of analytics such as machine learning. This has the potential to improve performance and efficiency on a global scale.”

Because of program, engineering company Mayfield Industries are now able to gather customer specifications faster to reduce project bid cost estimations, improve bid response times, and increase pricing estimate accuracy. Mayfield General Manager Chris Ware commented on the efficiency outcomes of the program:

“We recently utilised the budget tendering package during a presentation to a new client, and within a matter of minutes, the tool was quickly able to predict pricing for a number of Switchroom scenarios leading to the client providing us with confirmed requests for quotation and preferred supplier status.”

Former South Australian Minister for Manufacturing and Innovation the Hon. Kyam Maher also provided favourable feedback, describing the “measurable difference” on businesses after the program’s first-round results:

“Capturing the vast amount of electronic information that businesses generate is one thing; being able to use it and integrate it with open source data to identify patterns, trends, and associations to create new revenue sources, business models or enhance business performance is quite another.

I’m very pleased this program has made a measurable difference to these manufacturing companies, by using existing data, turning it in to something meaningful and delivering commercial outcomes.”

IMPACT OF EDUCATION PROGRAMS

As part of its objective to build a sustainable big data workforce, the D2D CRC developed the Australian-first DSCF. The framework defines a series of competencies specifically focused on describing the abilities, knowledge and experience required by data scientists, data engineers and data analysts.

By describing competencies, the DSCF underpins workforce development at the individual, team and organisational level. It facilitates the identification of development needs, enhances role clarity, supports recruitment and establishes of career pathways. This enables teams working in the big data space to better achieve their outcomes.

The DSCF analyses job families across key competency areas aligned to the Australian Public Service (APS) levels of proficiency. It is therefore hoped the framework will become the recognised data science framework for the public sector, available free of charge. The D2D CRC completed work on the DSCF in early 2018 and intends to launch the product in an open source format by 30 June 2019.

Based on the DSCF, the D2D CRC then produced the DPT to further support the development of the big data workforce by enabling clients to self-assess against the framework.

One of the trial partners of the framework and tool was the (former) Department of Immigration and Border Protection (DIBP) whose Director of Data and Tradecraft, Rohan Samaraweera, praised the tools' ability to create insight into the relevance of individual skillsets and identify gaps in the workforce profile:

“Over the past year, the DIBP progressed a number of collaborative initiatives with the D2D CRC in the realm of data science and analytics. A key area of enduring focus for the portfolio is ensuring our workforce has the required skills to perform a diverse range of practical roles in the data practitioner domain. These range from data management and acquisition, to data engineering, to the application and development of data analysis techniques and complex ‘cutting edge’ data science approaches.

The release of the DPT to the workforce resulted in a number of positive benefits for both management and personnel.

For managers, the DPT provided insight into the current status of skills and capabilities within the workforce. Additionally, it provided insight into the distribution of identified data practitioner roles – data scientist, data analyst and data engineer – within the department.

For personnel, the tool provided insight into the relevance of their skills and capabilities to the field of data science. It assisted personnel to identify and prioritise gaps in their knowledge and ability. The tool also provided recommendations for further training and development.

Well over half of the APS data practitioners within our branch participated in this initiative. These resources have enabled some of our junior data analysts to raise their skill levels to a standard where they feel comfortable attending some of the other training and development opportunities provided by the D2D CRC, or recommended by the DPT.

Since the establishment of the Home Affairs department, the portfolio has engaged in a major restructure to centralise data-related areas to form a new data management division. The DSCF and DPT will be valuable aids supporting this and other initiatives to mainstream the exploitation of data in support of the broad range of roles and responsibilities of the new Home Affairs portfolio”.

The D2D CRC has a primary focus on responding to industry needs. Accordingly, the CRC’s E&T program was set up to be industry-led, with a reliance on participant contribution. The D2D CRC’s seminars are a mix of public and closed sessions, with topics drawn from the expertise of both staff and participants. The D2D CRC’s Big Data Leaders Series (BDLS) of seminars attract strong numbers of participants, offering attendees insights into challenges facing the big data community. Since its inception, the D2D CRC has run 19 structured training sessions or workshops, 19 seminars and five BDLS seminars.

The demand for short courses in the big data space continues to be strong and is driven by public sector agencies looking to upskill their staff. The CRC has developed three short courses, delivering these courses a total of seven times. These three courses are summarised below:

Introduction to Data Science - designed to introduce data science, providing an understanding of key concepts, terminology, and introducing tools and techniques. By providing insight into the complexities of working with data including constraints, challenges and risks, the course enhances the ability of participants to identify opportunities to improve utilisation of intelligence analytics and understand what is involved in such projects.

Data Science Essentials - enables participants to gain a detailed understanding of, and practice in applying, core data science concepts, techniques and tools, including insight into the latest research and practices. The course is designed for people with some prior knowledge of big data, data analytics and data science.

Introduction to Data Analytics - designed to provide an introduction to data analytics, as well as an understanding of key concepts, techniques, terminology and hands-on experience. By providing insight into the complexities of working with data including constraints, challenges and risks, the course also enhances the ability of analysts to identify opportunities to improve utilisation of intelligence analytics, understand what is involved in such projects and communicate with data science experts. This course is for people with limited knowledge or experience of data science/analytics, but who engage with data regularly as part of their roles and may draw insights from the output of data science tools and technologies.

At time of writing, work was also underway to develop an additional short course for one of the D2D CRC’s essential participants. The D2D CRC will continue to assess the outcome of its E&T program until 30 June 2019 via feedback from short courses, as well as case studies on DSCF user groups.

Across its life time, the D2D CRC supported a total of 61 PhD students, with six thesis submissions. The table below shows a breakdown of postgraduate information over the life of D2D CRC:

BREAKDOWN ON PHD INFORMATION OVER THE LIFE OF D2D CRC	
Number of PhDs	61 PhD scholarships, of which: <ul style="list-style-type: none">46 are still currentsix have made thesis submissionsnine have withdrawn
Alumni program	As part of its legacy strategy, the D2D CRC is developing an alumni program to be rolled-out before 30 June 2019.
Employment	Of the six students who completed their thesis, the D2D CRC is aware of four currently employed in relevant industry. A further three students who withdrew from the program are also employed in relevant industry.
Supervision	<ul style="list-style-type: none">24 university staff from nine universitiesSeveral D2D CRC staff members (i.e. four program leaders) mentor students on an ad-hoc basis

SNAPSHOT SUMMARY

MAJOR ACHIEVEMENTS

- Established the *Apostle™*, *Beat the News™* and Integrated Law Enforcement projects, each of which were trialled by several national security agencies.
- Launched two spinout companies, Fivecast® and NQRY™.
- Developed three commercial software products including Fivecast® *Insight*, Fivecast® *Discovery* and NQRY® *CaseWalls™*.
- Delivered three major software products under the IX Health Analytics program including the Actionable In-time Insights (AI²) project, a Statistical Analysis System (SAS) pack for the Observing Recurrent Incidence of adverse Outcomes following hospitalisation (ORION) project, and the Emergency Waiting Times application.
- Developed an Australian-first Data Science Competency Framework.
- Built the Data Science Planning Tool, an online self-assessment for data scientists, engineers and analysts.
- Delivered the Big Data Reference Architecture for Defence.
- Developed the Agriculture Big Data Reference Architecture under the Precision to Decision Agriculture project.
- Developed a proposed solution architecture for the (former) Department of Immigration and Border Protection's future operational analytics capability.
- Developed the D2D CRC Data Science Platform.

KEY RESEARCH

- The Integrated Law Enforcement program conducted research and development of the *CaseWalls™* IMS. As a result of extensive user engagement and workshops, the system has matured and is nearing commercial deployment. The base platform addresses the immediate needs of investigators across Australia and also enables the integration of leading-edge capabilities derived from the research activities of the D2D CRC – including data curation, and narrative visualisation.
- The *Apostle™* program delivered trials to several law enforcement and national security agencies. The platform provides leading-edge collection and analysis capabilities using automated techniques to extract meaning from unstructured data. The platform delivers a solution to an immediate capability need from users, but also enables integration of the research outputs from a range of D2D CRC research projects including text, image and video understanding.
- The *Beat the News™* program developed tools to assist with analytic tasks undertaken by intelligence analysts, including the automated production of indicators and warnings from streams of open source data and the automated forecasting of events from open source data.
- The D2D CRC Law and Policy program delivered several targeted projects that focus on the business needs of end users. These include projects to evaluate the issues related to use of advanced data analytics for identity verification, information sharing and governance processes within the national criminal intelligence system.

COMMERCIALISATION AND UTILISATION

- Developed three commercial software products which are being commercialised in the national security sector, including Fivecast® *Insight*, Fivecast® *Discovery* and NQRY® *CaseWalls™*.
- Delivered a Data Science Competency Framework which was trialled by over 250 APS staff and created a corresponding Development Planning Tool with the intent that they be applied as the recognised data science framework for the public sector.
- Awarded Defence Innovation Hub funding to develop cyber event prediction technology.
- Filed or commenced four provisional patent applications as part of the *Beat the News™*, *Apostle™* and Integrated Law Enforcement programs.
- Fivecast® received a TechInSA South Australian Early Commercialisation Fund grant and an Australian Government Accelerating Commercialisation grant.
- Fivecast® won the CIVSEC 2018 Innovation Award for Cyber Security.
- Fivecast® achieved first sales of Fivecast® *Insight* in Australia.
- Fivecast® commenced operational trials with US-based law enforcement and federal agencies.

Outside of national security, the D2D CRC delivered significant utilisation outcomes in the health, manufacturing and agriculture sectors:

- Received funding from the South Australian Government to deliver four health data analytics projects which had a significant impact on the health industry; specifically, decreasing pressure, understanding the magnitude and location of an outbreak, preventing hospitalisation, reducing readmissions, more efficient patient care at GPs and cost savings.
- Delivered the Big Data Connect Program and collaborated with several SMEs on projects to leverage big data and deliver value to South Australian manufacturers.
- Completed the Accelerating Precision Agriculture to Decision Agriculture project, undertaken with 14 RDCs across Australia. The project aimed at exploiting big data opportunities for the Australian agriculture industry.
- Collaborated with the Sheep CRC to develop new databased products to make sheep management easier and achieve better outcomes for sheep well-being and productivity. The application was released as ASKBILL.

SNAPSHOT SUMMARY

SME ENGAGEMENT

- As stipulated, proactively engaged SMEs, other research institutes, government agencies and industry associations to exchange technology and know-how to other sectors via the BDCP, collaborated with the Sheep CRC to deliver ASKBILL, and worked with 14 RDCs on the Precision to Decision agriculture project.
- Gained ongoing participation from Semantic Sciences in the Multi-source Information Analysis Platform project
- Genix Ventures and La Trobe University completed the *Topic Mining and Temporal Trend Monitoring* project and the *Cognitive analytics for autonomous predictions in CT policing* project.

EDUCATION AND TRAINING

- Created a community of 54 PhD students from seven universities.
- Recorded six thesis submissions.
- Supported 20 Honours students including eight from various defence agencies, and supported one Honours group project.
- Hosted 28 internships, including 12 from Carnegie Mellon University and five from various defence agencies.
- Supported nine PhD students to travel internationally to enhance their studies.
- Assigned PhD students with D2D CRC staff mentors and offered opportunities to present at seminars to enhance student engagement and experience.
- Finalised the DSCF and refined the DPT in consultation with industry and government partners.
- Deployed a bespoke data science short-course training program with high participation.
- Updated the entry level data analytics course in partnership with three universities.
- Shared expertise through a variety of well-attended seminars, training over 1,150 professionals.

SPINOUT COMPANIES

- Created two spinout companies; Fivecast® and NQRY®.
- Filed more than 20 innovation disclosures.
- Filed four provisional patent applications, with numbers expected to increase by 30 June 2019.

INTERNATIONAL ENGAGEMENT

- Awarded seven travel grants in 2018 and three in 2017, allowing PhD students to attend high-calibre international conferences, as well as visit research centres and universities.
- Developed an ongoing collaboration with Adelaide's Carnegie Mellon University, hosting international students through internships.
- Established engagement with the USA to explore commercialisation opportunities for Fivecast® *Inquiry*.



APPENDIX

LIST OF PUBLICATIONS TABLE

PUBLICATION TITLE	PROGRAM TITLE	STREAM TITLE	PUBLICATION TYPE	PUBLISHED
A Joint Human/Machine Coding Process for Extracting and Classifying Drivers of Violent Conflict	Apostle	Knowledge Mining	Conference Publication	Yes
A Unified Analysis of Stochastic Momentum Methods for Deep Learning	Apostle	Semantic Indexing	Conference Publication	Yes
Adversarial Complementary Learning for Weakly Supervised Object Localisation	Apostle	Semantic Indexing	Conference Publication	Yes
Big Data Use by Law Enforcement and Intelligence in the Natinal Security Space: Perceived Benefits, Risks and Challenges	Law and Policy	Project A	Conference Publication	Yes
Calling for Response: Automatically Distinguishing Situation-aware Tweets During Crises	Integrated Law Enforcement	Data Curation Foundry	Conference Publication	Yes
Carbon: Forecasting Civil Unrest Events by Monitoring News and Social Media	Beat the News	Building Classification and Prediction System for Civil Unrest	Conference Publication	Yes
Combining Virtual Reality and Narrative Visualisation to Persuade	Integrated Law Enforcement	Narrative Visualisation	Conference Publication	Yes
Crowdsourcing Roles, Methods and Tools for Data-Intensive Disaster Management	Law and Policy	Project B0	Journal Article	Yes
Cyber warfare and Organised Crime: A Regulatory Model and Meta-Mdel for OSINT	Law and Policy	Project B0	Book Chapter	Yes
Decoupled Novel Object Captioner	Apostle	Semantic Indexing	Conference Publication	Yes
Deep Adversarial Attention Allignment for Unsupervised Domain Adaption	Apostle	Semantic Indexing	Conference Publication	Yes
Early Active Learning with Pairwise Constraint for Person Re-identification	Apostle	Semantic Indexing	Conference Publication	Yes
Examining the affordances for multi-dimensional data videos	Integrated Law Enforcement	Narrative Visualisation	Conference Publication	Yes
Exploit the Unknown Gradually: One-Shot Video-Based Person Re-Identification by Stepwise Learning	Apostle	Semantic Indexing	Conference Publication	Yes

PUBLICATION TITLE	PROGRAM TITLE	STREAM TITLE	PUBLICATION TYPE	PUBLISHED
Few-Example Object Detection with Model Communication	Apostle	Semantic Indexing	Journal Article	Yes
Information Propagation Trees for Protest Event Prediction	Beat the News	Building Classification	Conference Publication	Yes
Mining Twitter for Fine-Grained Political Opinion Polarity Classification, Ideology Detection and Sarcasm Detection	Apostle	Knowledge Mining	Conference Publication	Yes
Neural Dynamic Programming for Musical Self Similarity	Apostle	Picturing Knowledge	Conference Publication	Yes
PatchShuffle Regularization	Apostle	Semantic Indexing	Conference Publication	Yes
Real-time Detection of Content Polluters in Partially Observable Twitter Networks	Beat the News	Predicting Civil Unrest	Conference Publication	Yes
Self-Bounded Prediction Suffix Tree via Approximate String Matching	Apostle	Picturing Knowledge	Conference Publication	Yes
SemStyle: Learning Stylized Image Captions from Unaligned Text	Apostle	Picturing Knowledge	Conference Publication	Yes
Soft Filter Pruning for Accelerating Deep Convolutional Neural Networks	Apostle	Semantic Indexing	Conference Publication	Yes
SONA: Improving Situational Awareness of Geotagged Information using Tangible Interfaces	Integrated Law Enforcement	Narrative Visualisation	Conference Publication	Yes
The Beat the News System: Forecasting Social Disruption via Modelling of Online Behaviours	Beat the News	Head Project	Conference Publication	Yes
Uncovering the Temporal Context for Video Answering	Apostle	Semantic Indexing	Journal Article	Yes
Unsupervised Person Re-identification: Clustering and Fine-tuning	Apostle	Semantic Indexing	Conference Publication	Yes
Watching a Small Portion could be as Good as Watching All: Towards Efficient Video Classification	Apostle	Semantic Indexing	Conference Publication	Yes

EDUCATION AND TRAINING TABLE

PHD STUDENT	COMMENCEMENT DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	EXPECTED COMPLETION DATE
Adam Drogemuller	February 2018	Integrated Law Enforcement	Visualising and Interacting with Large Graphs of Big Data Using Virtual Reality	University of South Australia	Australia	February 2021
Alasdair Tran	July 2017	Apostle	Active Learning with Multimedia Knowledge Graphs	Australian National University	Australia	July 2020
Alex Mathews	January 2017	Apostle	Automatic Sentence Re-Writing/Generation and Building Visual Knowledge Graphs	Australian National University	Australia	COMPLETED
Alexander Long	February 2017	Apostle	Adaptive Querying for Knowledge Graph Construction via Deep Reinforcement Learning	University of New South Wales	Australia	February 2020
Alireza Tabordbar	July 2016	Integrated Law Enforcement	End User Big Data Analytics - Integrating Analyst Curation Tasks into Case Management	University of New South Wales	Iran	July 2019
Andrew Feutrill	February 2018	Associate	Techniques for Cyber Exploit Prediction	University of Adelaide	Australia	February 2021
Ang Yang	August 2014	Beat the News	An Information Quality Model for Big Data	University of South Australia	China	August 2018
Asif Ali (Muhammad)	August 2016	Apostle	Personal Profiling via Interlinked Spatiotemporal Networks--Crime Prevention and Control	University of New South Wales	Pakistan	August 2019
Caitlin Gray	March 2017	Beat the News	Modelling Information Cascades: Creating Predictive Models on Temporal Networks	University of Adelaide	Australia	March 2020
Carolyn Riechherzer	December 2016	Integrated Law Enforcement	Briefing Tool for Law Enforcement with Narrative Visualisation	University of South Australia	Germany	December 2019
Daniel Cater	March 2015	Law & Policy	Mass Data Analysis; National and International Implications for Data with Limited Protections	University of New South Wales	Australia	September 2018
Dennis Liu	October 2017	Beat the News	The Interaction of Social Media with Vaccination and Disease Outbreaks	University of Adelaide	Australia	October 2020
Dinithi Jayaratne	February 2016	Beat the News	Advanced Predictions in Social Media by Incorporating User Generated Content	La Trobe University	Sri Lanka (PR)	February 2019
Edwin Tongoi	July 2016	Law & Policy	Mobile Financial Services: Regulatory Responses in Australia, Kenya and South Africa	La Trobe University	Kenya	July 2019
George Stamatescu	June 2014	Apostle	Modelling Intelligent Behaviours with Stochastic Processes	University of Adelaide	Australia	December 2018

PHD STUDENT	COMMENCEMENT DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	EXPECTED COMPLETION DATE
Hayden Faulkner	March 2015	Apostle	Scene Interpretation from Video	University of Adelaide	Australia	September 2018
Jeff Ansah	April 2016	Beat the News	Discovery and use of Twitter Network Structural Features for Civil Unrest Prediction	University of South Australia	Ghana	April 2019
John Steven Calvo Martinez	March 2015	Apostle	Distributed Stream Mining	University of New South Wales	Brazil	September 2018
John Wondoh	February 2014	Integrated Policing	Bi-temporal Event Driven Process Interoperability	University of South Australia	Ghana	COMPLETED
Li Sun	June 2017	Integrated Law Enforcement	Linking Entities by Connection Inferences	University of South Australia	China	June 2020
Linchao Zhu	March 2016	Apostle	Semantic Indexing of Large Scale Video	UTS	China	March 2019
Madhura Jayaratne	February 2016	Beat the News	Scalable Big Data Analytics Techniques for the Integration of Structured and Unstructured Information	La Trobe University	Sri Lanka (PR)	February 2019
Maisie Badami	July 2017	Integrated Law Enforcement	Curating and Analysing Social Networks for Suicide Prevention Including Automated Summarisation Techniques	University of New South Wales	Australia	July 2020
Manqing Dong	September 2016	Integrated Law Enforcement	Algorithmic Data Curation for Spam Detection	University of New South Wales	China	September 2019
Mark Carman	September 2017	Integrated Law Enforcement	New Authorship Attribution Methods to Detect and Manage Social Manipulation and Fake News in Social Media	University of South Australia	Australia	September 2020
Matthew Heather	February 2016	Affiliate	Ethics of Big Data and Artificial Intelligence for Law Enforcement and National Security	Charles Sturt University	Australia	February 2019
Max Glonek	March 2016	Beat the News	A Census of Social Media Users: Statistical Techniques for Quantifying and Correcting Biases in Big Open Data Sources	University of Adelaide	Australia	March 2019
Miah Hammond-Errey	February 2017	Law & Policy	Improving Strategic Direction and Implementation of Big Data (Technologies and Analytics) in Australian National Security Agencies: A New Framework to Inform Decision Makers	Deakin University	Australia	February 2020
Nam Truong	November 2017	Beat the News	Using Causal Based Methods, such as Bayesian Networks, for Fraud Detection	University of South Australia	Vietnam	November 2020

PHD STUDENT	COMMENCEMENT DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	EXPECTED COMPLETION DATE
Peter Mathews	January 2015	Beat the News	Trend Detection from Social Media Using Probabilistic Graphical Models	University of Adelaide	Australia	July 2018
Pingbo Pan	July 2016	Apostle	Efficient and Effective Logo Detection in Large Scale Images and Videos	University of Technology Sydney	China	July 2019
Robin Hamper	June 2018	Law & Policy	Legal Issues in Coordinated Vulnerability Disclosure Programs and Bug Bounties	University of New South Wales	Australia	June 2019
Ruochen Cao	March 2017	Integrated Law Enforcement	A Semi-Automatic Tool for the Creation of a Data Video	University of South Australia	China	March 2020
Ruth Frimpong	February 2016	Integrated Policing	Ontology Matching Algorithms for Data Model Alignment in Big Data	University of South Australia	Ghana	February 2019
Samudra Herath	January 2018	Beat the News	Privacy Preserve Record Linkage Techniques for Dynamic/Streaming Data	University of Adelaide	Sri Lanka	January 2021
Sandeepa Kannangara	July 2015	Apostle	Opinion Polarity Classification Using Unstructured Texts	University of New South Wales	Sri Lanka	January 2019
Seung Youb Ssin	February 2015	Integrated Law Enforcement	Assistance of Natural User Interface, Sensor Tracking in Real Time for Robot Teleoperation	University of South Australia	Korea	COMPLETED
Sha Lu	July 2017	Beat the News	Risk Assessment Using Causal Based Methods	University of South Australia	China(PR)	July 2020
Shayan ZamaniRad	February 2016	Integrated Law Enforcement	Query Answering and Predictive Techniques for Analyst Tasks in End User Big Data Analytics	University of New South Wales	Iran	February 2019
Shifeng Liu	September 2016	Apostle	Fine Grained Named Entity Recognition in Social Networks	University of New South Wales	China	September 2019
Stanley Shanapinda	July 2014	Law & Policy	The Dynamic Relationship Between National Security Intelligence and Law Enforcement Powers, Communication Technologies and Oversight in Australia	University of New South Wales	Namibia	COMPLETED
Tharindu Bandaragoda	June 2015	Beat the News	Real-time Cognitive Analysis for Capturing Suspicious Behaviours	La Trobe University	Sri Lanka	December 2018
Umanga Bista	February 2017	Apostle	Learning Knowledge Graph on Massive Data Streams	Australian National University	Nepal	February 2020
Xiaodong Ning	September 2016	Integrated Law Enforcement	Algorithmic Data Curation for Offensive Content Detection	University of New South Wales	China	September 2019

PHD STUDENT	COMMENCEMENT DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	EXPECTED COMPLETION DATE
Xuanyi Dong	March 2017	Apostle	Logo Detection	University of Technology Sydney	China	March 2020
Xuying (Ada) Yao	July 2016	Beat the News	Precursor Pattern Analysis and Interpretable Classification	University of South Australia	China (PR)	July 2019
Yanbin Liu	March 2017	Apostle	Efficient Object Detection and Vision-Language Joint Modeling	University of Technology Sydney	China	March 2020
Yufei Wang	July 2017	Apostle	Improving Information Extraction Using Linguistic and Knowledge Base Information	University of New South Wales	China	July 2020
Yujie Wang	April 2015	Beat the News	New Multi-Dimensional Knowledge Base to Capture and Store Patterns in Evolving Text Streams	La Trobe University	Australia	October 2018
Yukai (Kevin) Miao	January 2017	Apostle	Open Relation Extraction and Refinement	University of New South Wales	China	January 2020
Zahidul Islam	July 2016	Beat the News	Civil Unrest Events Detection from Multiple Credible Sources	University of South Australia	Bangladesh	July 2019
Zhedong Zheng	January 2017	Apostle	Face Detection and Recognition	University of Technology Sydney	China	January 2020
Zishuo Ding	August 2016	Apostle	Semantic Search with Knowledge Graphs	University of New South Wales	China	August 2019

*PR = Australian Permanent Resident

WITHDRAWALS

PHD STUDENT	COMMENCEMENT DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	DATE OF WITHDRAWAL
Christopher Targett	March 2015	Apostle	Utilising Context for Unsupervised Learning of Features and their Relationships	University of Adelaide	Australia	September 2017
Craig Jones	March 2015	Apostle	Image geolocation: Using Big Data, Deep Learning and Visual Computing for Photographic Location Prediction	University of Adelaide	Australia	July 2017
Adrian Johnston*	February 2015	Apostle	Large Scale Geospatial Image Understanding and Visualisation	University of Adelaide	Australia	May 2018

Scholarship relinquished due to employment, submission pending.

GLOSSARY OF TERMS

ACIC	Australian Criminal Intelligence Commission
ACS	Australian Computer Society
AGD	Attorney-General’s Department
AIIA	Australian Information Industry Association
ANZCTC	Australia-New Zealand Counter-Terrorism Committee
API	Application Programming Interface
Big Data	A term for any collection of data sets so large and complex that it becomes difficult to store, process and analyse using current technologies. Big Data comes from many sources (e.g. text, image, audio, social media etc.) at an alarming velocity, volume and variety.
Big Data Analytics	The process of examining large data sets containing a variety of data types -- i.e., big data -- to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful business information.
CEO	Chief Executive Officer
CIVSEC	Civil Security Congress and Exposition
CRC	Cooperative Research Centre
D2D CRC	Data to Decisions Cooperative Research Centre
DNSAC	Defence and National Security Advisory Committee
DPT	Development Planning Tool
DSTG	Defence Science and Technology Group
DSCF	Data Science Competency Framework
E&T	Education and Training
FY	Financial Year

ICT	Information and Communications Technology
IMS	Investigation Management System
IP	Intellectual Property
ISR	Intelligence Surveillance and Reconnaissance
IX	Innovation Exchange
Machine Learning	A subfield of computer science that evolved from the study of pattern recognition and computational learning theory in artificial intelligence. Machine learning explores the construction and study of algorithms that can learn from and make predictions on data.
ORION	Observing Recurrent Incidence of adverse Outcomes following hospitalisationNs
P2D	Precision to Decision
R&D	Research and Development
RAC	Research Advisory Committee
RDCs	Rural Research and Development Corporations
SMEs	Small to Medium Enterprises
STEM	Science Technology Engineering and Mathematics
UniSA	University of South Australia
UNSW	University of New South Wales

GOVERNMENT

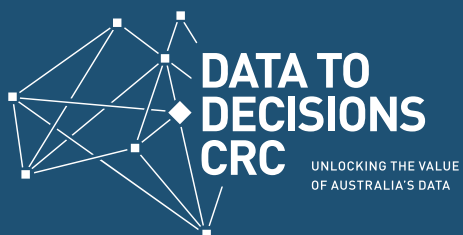


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