DATA TO
DECISIONS CRC

ANNUAL REPORT

2015/16

DATA TO
DECISIONS
CRC

UNLOCKING THE VALUE
OF AUSTRALIA'S DATA

CONTENTS

5 HONOURS SCHOLARSHIPS PROVIDED

14 PHDs COMMENCED

18 PROJECTS COMMENCED

36 EXTERNAL PRESENTATIONS

40 TECHNICAL REPORTS

23 MEDIA MENTIONS

28 FORMAL PUBLICATIONS

HOSTED INTERNS 9

60.3 FTE EMPLOYEES

204 DATA SCIENTISTS TRAINED

ABOUT THE D2D CRC

Established with a grant of $25 million in July 2014, the Data to Decisions Cooperative Research Centre (D2D CRC) is part of the Cooperative Research Centres Programme where, with funding from the Australian Government, researchers and industry are brought together to be a leading provider of Big Data capability resulting in a safer and more secure nation and a sustainable Big Data workforce for Australia.

VISION

A leading provider of Big Data capability resulting in a safer and more secure nation and a sustainable Big Data workforce for Australia.

MISSION

To undertake impactful research, development, education and training that delivers outcomes to national security and other data intensive sectors.

CHAIRMAN'S REVIEW

The past year has been one of 'visible achievement' for the Data to Decisions Cooperative Research Centre (D2D CRC). In our first year we carried out critical studies to deepen our knowledge of the data analytics needs of the agencies that comprise the National Security Community. These studies underpinned the establishment of four major programs in 2015-2016, which culminated in our 'Demo Day' in Canberra where we displayed the significant achievements our project teams have made.

Through extensive collaboration with agency personnel, we have made significant, rapid progress on our four major programs, which continue to mature very quickly. Based on user feedback from the agencies, the programs have evolved to focus on developing, integrating and evaluating technology for the following capabilities:

– The *Beat the News*™ Program, through analysis of open source information, and importantly the combination of structured and unstructured data from a diverse range of sources, will automatically and accurately predict the occurrence of future population-level events such as civil unrest, political crises, election outcomes, disease outbreak and more.

– The *Apostle*™ Program will allow analysts to search and interrogate open source multimedia data (text, image, video) to quickly identify all relevant data and present it in a clear, comprehensible manner.

– The *Integrated Law Enforcement* Program (formerly Integrated Policing) will provide investigators and analysts with uniform access to integrated information derived from diverse data sources held by different agencies. It will allow them to aggregate data, resolve and link entities and identities, identify and react to unusual patterns and build and maintain threat models related to events and entities. This program has application across many agencies, not just those involved in policing, hence the recent change in name.

– The *Law & Policy* Program will develop a governance framework enabling the use of data-based decision-support technologies for law enforcement and national security in Australia. This is based on the program's foundation study of Australian, UK and Canadian policies, regulations and strategies for use of Big Data for law enforcement and national security. This foundation study is an exemplar of collaboration between end-users and numerous university teams.

While we and our partners are very happy with this rapid progress, there is still a lot to do in a relatively short time. We are already two years into an ambitious five-year program, so it is imperative that we continue to collaborate closely with agency personnel at a range of levels. And the nature of this engagement will necessarily change.

While some agencies have unique data analytics needs, we have recognised that the agencies have in common many data storage, analysis, visualisation and sharing challenges. Our work with people from a diverse range of agencies has shown that there is a broad spectrum of maturity and sophistication in understanding and using data analytics. This disparity presents a challenge for the D2D CRC that necessitates engagement at a number of levels.

At the highest level, engagement of senior executives at the SES Band 2/3 levels remains important to ensure we are aligned with the strategic intent of the Government and agencies' current and future data analytics programs. Guidance from these executives ensures we remain on track to realise the Australian Government's considerable investment in the CRC without duplicating effort across agencies. Continued visibility of the CRC's work by these senior executives also facilitates targeted engagement of people at the lower levels of an agency who can best guide our work. A recent, very positive engagement involved me and the senior executives of three agencies to discuss common data analytics challenges and needs. More cross-agency collaboration at this level will be most welcome.

Not surprisingly, our main engagement to date has been with the agencies' technical capability developers. These people understand the art of the possible as far as technical capabilities are concerned. However, they must be in close, continuous communication with their agencies' users, namely the analysts and investigators, who are the most important influencers of the CRC's work. These people will ultimately use the capabilities to inform decision makers more accurately and faster. Now is the time in our development life-cycle for these analysts and investigators to engage deeply with the CRC in tandem with their internal capability development people.

It is not hard to discern from the above that vertical and horizontal communication with the CRC and within agencies remains one of the most critical enablers of our ability to build the data analytics capabilities that the National Security Community needs.

It is not unusual that our industry partners do not yet have a high profile in the CRC's work. As with the early stages of most CRC's, they tend to sit behind the scenes as capabilities are developed. We continue to have great support from our industry partners. We also appreciate their perseverance over what is a comparatively fast research and development program.

We have also acknowledged that the D2D CRC Board must adapt to the CRC's fluid development phases. We recognised the need for higher level skills and experience to engage with the defence and intelligence communities, and to make stronger commercialisation connections between academia and industry. To that end, we welcomed Steve Merchant and Professor Hugh Durrant-Whyte to the Board in November last year. Sadly, we farewelled Suzanne Campbell, a founding director who was instrumental in helping us guide the establishment of the CRC and make critical connections across industry.

In May this year, we received very pleasing feedback from the Australian Government's CRC Advisory Panel who reviewed all CRCs following the Miles Review. The Panel commended the CRC for "its excellent progress against the achievement of its outcomes" and noted "its strong governance and the breadth of collaboration, including with other CRC's."

So, finally, I would like to thank all of our government, academia and industry participants, as well as our strong management team and researchers, who have driven the CRC's success to date. I also encourage you, especially analysts and investigators, to stay engaged – talk with us, tell us what you think and what you need, and help us to build it.

Tim Scully, Chairman

01/
EXECUTIVE
SUMMARY

EXECUTIVE SUMMARY

The second year of operation of the D2D CRC was focussed on establishing key projects and beginning to deliver capability to the national security end-users. To reinforce this aim, I internally tagged FY 2015-16 as the "year of visible achievement". This culminated in a highly successful 'Demo Day' in Canberra in late June – over 100 end-users attended the day to see:

1. demonstrations of initial capabilities for the *Beat the News*™, *Apostle*™ and *Integrated Law Enforcement* programs;

2. videos and presentations outlining the overall plans for these programs and their supporting research streams; and

3. posters for the research projects and PhD projects.

The feedback from the 'Demo Day' was overwhelmingly positive and it has resulted in several requests for user trials with various national security agencies.

Some of the key research and education achievements for FY 2015-16 include:

– delivery of the Big Data Reference Architecture to Defence, resulting in excellent feedback from the Defence Chief Technology Officer;

– completion of the foundational Law and Policy project, *Comparative International Perspectives on Strategy, Policy and Law in Australia, the United Kingdom and Canada*, with excellent feedback from the Attorney-General's Department;

– establishment of the *Apostle*™, *Beat the News*™ and I*ntegrated Law Enforcement* programs and supporting university research streams and the demonstration of initial capability for these programs at the 'Demo Day';

– development of a *Data Science Platform* that is being used by the above 3 programs and their supporting research streams;

– completion of the *Topic Mining & Temporal Trend Monitoring* project with Genix Ventures and La Trobe University;

– development of a new visualization technique in the *Immersive Intelligence Pod* project with the Attorney-General's Department and the Australian Geospatial Intelligence Organisation;

– recruitment of the second cohort of PhD students, taking the total number of students to 28;

– support of several interns and honours students through vacation scholarships;

– delivery of several seminars and workshops to the end-users and the general market; and

– delivery of several '*Innovation Exchange*' projects involving small-to-medium enterprises and other research groups in sectors such as agriculture, manufacturing and digital marketing.

Several 'operational' achievements were also made during the D2D CRC's second year of operation, namely:

– receiving extremely positive feedback from a review conducted by the CRC Advisory Committee;

– receiving excellent feedback from the CRC programme's review of the CRC's annual report and transition plan;

– including Basis Technology, Office of National Assessments, University of Technology Sydney and the Australian National University as participants in the CRC;

– Professor Hugh Durrant-Whyte (University of Sydney) and Mr Stephen Merchant (former Deputy Secretary, Defence Intelligence Security Group) joining the D2D CRC Board;

– gaining senior executive representation on the Defence and National Security Advisory Committee from several additional national security agencies;

– successfully conducting the Annual General Meeting and annual conference;

– conducting several media, conference and industry presentations; and

– continuing to grow the online presence of the CRC (web, Twitter, LinkedIn).

Despite all these significant achievements, the CRC still faces some challenges. The most significant still revolves around resourcing. In particular, it has taken more time

than expected to recruit suitable candidates for many of the research projects. This has largely been due to the fact that the marketplace for data scientists and high-calibre researchers is extremely competitive. While this has resulted in a delay to some projects, the CRC is still confident that future milestones will not be impacted due to risk mitigation actions that are being undertaken. As reported last year, the high operational tempo in national security continues to impact on the ability of some of our government participants to release staff as in-kind contributions into the CRC. We have attempted to work-around this by soliciting their input and guidance through other means, but it has resulted in an in-kind shortfall that will need to be addressed with the agencies concerned.

On a final note, I'd like to offer my thanks to CRC staff, researchers, Board and advisory committee members for their great work in helping to deliver "visible achievements". The CRC has been established to primarily address the needs of national security and the feedback to date, based on the achievements of the past year, is that we are well on the way to delivering against these needs.

Sanjay Mazumdar, CEO

ACHIEVEMENTS

RESEARCH

The following key research achievements have been made:

– Three major programs of work have been established with each focussed on user needs elicited in the future studies. These programs - *Beat the News*™ (BTN), *Apostle*™ and I*ntegrated Law Enforcement* (ILE) – are multi-year, multi-stream work programs that will form the foundation for integrating, demonstrating and evaluating the research outputs from the D2D CRC.

– The D2D CRC Big Data Reference Architecture developed and delivered, including use cases, reference architecture, example system architectures and product ontology. Provides tools, guidance and advice to architects, designers and managers when building big data solutions.

– Online footprinting capability under the *Apostle*™ program was prototyped and demonstrated to several law enforcement and national security agencies.

– Under the ILE program, a first demonstrator was prototyped and delivered for the 'Investigator's Case Wall' – a system to revolutionise investigations management practice for law enforcement practitioners.

– Under the ILE program, the concept of data curation foundry was successfully demonstrated to multiple law enforcement agencies including 'nano-apps' that will enable investigators and analysts to easily undertake data analytics tasks.

– Under the *Beat the News*™ program, large scale data analytics platform was built. It can process millions of records daily, and execute prediction algorithms. The BTN system correctly predicted multiple high-profile events, in some cases months in advance.

– Novel visualisations of spatio-temporal data were developed and demonstrated in close collaboration with end users.

– World-leading approaches to content based search and retrieval of video were developed.

– World-leading approaches to large-scale object classification from images, and the ability to automatically caption images were developed.

– A tied-research project that has been established with Genix Ventures to develop and integrate topic modelling and trend monitoring in the CaseGenix case management system was delivered.

– A tied research project that has been established with Semantic Sciences to deliver architectures and techniques for a scaled-out platform for multi-source information analysis was delivered.

– The first law and policy focussed project was completed. It examined the policies, regulatory approaches, processes and strategies used to balance confidentiality and privacy against the need for analysis and exploitation of data in the context of national security. The project considered approaches in Australia, the United Kingdom and Canada.

COLLABORATION

All projects at the D2D CRC must demonstrate collaboration between researchers and end-users (government and/or industry). Specific collaboration of note included:

– close involvement from a number of national security agencies in the *Apostle*™ and *Beat the News*™ programs and associated research streams, particularly via the project steering committee and working group meetings;

– close involvement with Basis Technology on the *Beat the News*™ and *Apostle*™ programs;

– the secondment of an AFP staff member to lead the *Integrated Law Enforcement* program and associated research streams;

– working closely with the Attorney-General's Department on the law and policy projects;

– working with several Commonwealth departments on the Data Science Competency Framework project;

– the secondment of Defence Science Technology Group (DST Group) staff to support the research and development projects;

– close involvement on *Beat the News*™ with the US government's Intelligence Advanced Research Project Activity (IARPA) agency and Virginia Tech University;

– developing data science training with national security agencies;

– activities under the *Innovation Exchange*, including:
  » several projects with the Sheep CRC involving the development of Big Data solutions for prediction of wellbeing of sheep;
  » several projects with manufacturing SMEs via the Big Data Connect Program;
  » a digital marketing project with the Centre for Digital Video Intelligence, University of South Australia; and
  » a project to investigate unwarranted variation in cardiac therapeutic procedures and diagnosis tests with the Queen Elizabeth Hospital.

COMMERCIALISATION & UTILISATION

A key focus for the D2D CRC is to establish a culture where all staff and researchers recognise that they are developing valuable intellectual property and must consider up-front all of the potential exploitation paths for that intellectual property (IP). This has been important to ensure that the CRC is best placed to maximise the value of the IP for Australia. To that end, the D2D CRC has:

– deployed mandatory IP awareness training;

– developed a set of IP principles defined by the Board and encapsulated in the CRC's IP policy and procedure;

– deployed an IP register and innovation disclosure system within the Information Management System;

– established the Commercialisation and IP Advisory Committee with representation comprising IP and commercialisation experts;

– engaged Madderns Patent and Trademark Attorneys to provide IP (particularly software IP) advice and expertise;

– established an IP strategy process in consultation with NICTA to help develop IP exploitation strategies;

– engaged a cohort of commercialisation experts to support IP strategy development;

– established an initial catalogue of potential foreground IP from the projects and activities; and

– developed an initial IP strategy for the *Beat the News*™ program identifying the market opportunities, value and pathways for exploitation of the IP.

EDUCATION & TRAINING

Over the past year, the Education and Training program has focussed on building upon the strong foundations previously established. This includes:

– creating a community of 28 PhD students with students from five universities including new partner University of Technology Sydney;

– increasing the engagement of PhD students with the D2D CRC through participation in Demo Day and Tech Day and starting an online instant communication channel;

– supporting seven honours scholarships, both through the Defence Teaming Centre and the D2D own program;

– hosting nine successful internships, three from Carnegie Mellon University (CMU) and six through the D2D program, a number of whom have also taken up employment with the CRC;

– deploying the Data Science short-course training program with high levels of participation; and

– sharing staff expertise through a variety of well-attended seminars.

RISKS AND IMPEDIMENTS

The D2D CRC employs an active risk and opportunity management process which involves regular assessment of risks and opportunities by the management team, the Audit and Risk Committee and the Board. As with last year, two of the high impact risks which continue to be managed by the CRC relate to in-kind contributions and ensuring the CRC is generating a return on investment for the industry and national security participants. While these risks have not affected the CRC's ability to deliver against milestones and outputs, they are being actively mitigated to ensure they remain under control.

IN-KIND CONTRIBUTIONS

The ability for national security agencies to release their staff to participate in CRC activities is still difficult given the high operational tempo in this sector. The CRC continues to work closely with the agencies to mitigate this risk. Some workarounds have included, first, the secondment of Australian Federal Police and Defence Science Technology Group staff into the programs and, secondly, conducting project steering committee and working group meetings either in Canberra or via teleconference to minimize the need for travel. Even with these actions, there has been a shortfall in in-kind contributions from the agencies, so further workarounds will be discussed with the agencies in the new financial year.

INDUSTRY AND NATIONAL SECURITY RETURN ON INVESTMENT (ROI)

As identified last year, the D2D CRC was very focussed on ensuring that its programs were closely aligned to priority capability needs in the National Security Community. This resulted in the establishment of the *Apostle*™, *Beat the News*™ and *Integrated Law Enforcement* programs. Feedback from the Demo Day and other workshops and demonstrations with end-users has reaffirmed that these programs are very much aligned to high priority needs. This has been further confirmed by the interest shown by agencies who were not part of the original group of participating agencies. Therefore, the CRC is confident that a significant ROI for national security will be achieved if it successfully delivers these programs.

The ROI for industry participants in the CRC will largely be driven by the opportunity to use their products in the CRC's solutions and also their ability to be involved in the commercialisation of resulting IP. To help address this expectation, the CRC is constantly looking for opportunities to leverage its industry participant's capabilities where it represents the best solution for national security. An example of this is the use of Basis Technology's Rosette platform on Beat the News™. CRC staff are also planning a visit to the US headquarters of many of the industry participants to discuss potential commercialisation pathways for the programs.

END–USER ENVIRONMENT

The events of the past year have reaffirmed that the need for national security agencies to effectively analyse and exploit data to undertake their activities has increased. The main programs that have been established by the CRC, namely *Beat the News*™, *Apostle*™ and *Integrated Law Enforcement*, are focussed on providing the agencies with capabilities that they will require to deal with this ever increasing need.

A key focus for the CRC over the next 12 months will be to begin trialing the capabilities in national security agencies to ensure that the research activities are guided by the key needs of this community. It is this focus on 'co-creation' that will help to ensure that the CRC delivers capabilities that are of benefit to the national security end-users.

The *Law & Policy* Program has also benefited from the crystallization of needs in the above three programs. The new set of *Law & Policy* projects are focussed on very specific business problems identified through the scoping of the technical projects, namely identity assurance and information sharing for serious and organized crime.

IMPACTS

02/
RESEARCH

The projected impacts of the D2D CRC are:

- improved security for Australians and their interests;
- reduced acquisition risk for national security project;
- reduction in national security operating costs;
- royalties from the exploitation of D2D CRC IP;
- growth of SMEs;
- economic benefits in other sectors;
- commercial spin outs leveraging D2D CRC IP;
- approximately 20 patents, 350 publications, 48 PhD graduates and 1000 trained data scientists;
- improved balance between privacy laws and national security; and
- an overall benefit : cost ratio of 3.31.

The D2D CRC remains on track to meet the vast majority of these impacts. The one area where the CRC will look to deviate from the original plan is around the number of patents it will produce. For commercial reasons, the CRC has decided to focus its patent strategy on novel concepts at the 'system-level' rather than at the individual technology level. This will mean fewer, but potentially more significant, patents will be generated.

SUCCESSFULLY DEMONSTRATED INITIAL CAPABILITIES FOR APOSTLE, BEAT THE NEWS AND INTEGRATED LAW ENFORCEMENT PROGRAMS

RESEARCH PROGRAMS	PROJECTS	HIGHLIGHTS
Security Analytics for Counter Terrorism and Policing Delivery of integrated capability demonstrators to address identified needs from the law enforcement and intelligence community.	**Integrated Law Enforcement** Access, linking and analysis of distributed law enforcement data.	Initiated a multi-year, multi-stream project to address priority use cases identified by law enforcement. Delivered first demonstrator for the 'Case Wall' – a system to revolutionise investigations management practice for law enforcement practitioners.
	Beat the News™ Predict events such as social disruption, disease outbreak and election outcomes from analysis of open data sources.	Initiated a multi-year, multi-stream project to address priority use cases identified by national security agencies. Built a large scale data analytics platform, that can process millions of records daily, and execute prediction algorithms. Correctly predicted multiple high-profile events, in some cases months in advance.
	Multisource Information Analysis Platform	Prototyping and further development of scale-out approaches for Sintelix platform from Semantic Sciences.
Defence Intelligence, Surveillance and Reconnaissance Delivery of integrated capability demonstrators to address identified needs from the defence community.	**Big Data Reference Architecture** Guidance to architects, designers and managers to be used when building Big Data systems.	Developed and delivered the D2D CRC Big Data Reference Architecture, including use cases, reference architecture, example system architectures and product ontology. Provides tools, guidance and advice to architects, designers and managers when building big data solutions.
	Apostle™ Develop, integrate and evaluate technology to search, interrogate and understand open source multi-media data (text, image and video).	Initiated a multi-year, multi-stream project to address priority use cases identified by national security agencies. Developed detailed use case scenarios based on end user input. Prototyped and demonstrated online footprinting capability to several law enforcement and national security agencies.
Data Storage and Management Improving our capacity to access, transform, search and query data that is held by multiple, distributed organisations.	**Data Curation Foundry** Methods for user-driven analytics	Prototyped Case Wall, nano-apps and the data curation techniques. Successfully demonstrated to multiple law enforcement agencies. Developed first prototype of the Data Curation Foundry and 'nano-apps' that will enable investigators and analysts to easily undertake data analytics tasks.
	Federated Data Platform Access and analysis of distributed data	Outline of a federated data platform architecture in collaboration with the Australian Federal Police.

RESEARCH PROGRAMS	PROJECTS	HIGHLIGHTS
	Entity Linking and Resolution Methods for entity recognition and linking across diverse data sets	Developed initial prototype of an entity linking system.
	Distributed Event Mining Extraction of events across multiple streams of data	Prototype of streaming event mining systems.
	Knowledge Graph Construction, Curation and Management	Constructed the prototype system to perform knowledge graph construction from social media data.
	Knowledge Graph Query	Constructed a prototype system to perform relatedness queries in large scale knowledge graphs.
Analytics and Decision Support Improving our ability to extract, search, understand and visualise relevant information from vast heterogeneous data sets.	**Large Scale Image Classification** Automated ability to identify objects found within an image.	Participated in the large scale visual recognition challenge. Extremely successful results.
	Exploiting Context in Machine Learning Use existing knowledge to aid in the identification of objects in an image and the interpretation of scenes.	Best-in-class results achieved for image captioning (Microsoft Common Objects in Context) and image segmentation (Pascal Visual Object Classes) competitions.
	Immersive Intelligence Pod Effective visualisation of spatio-temporal data.	Developed and demonstrated novel visualisations of spatio-temporal data, in close collaboration with end users.
	Topic Mining and Trend Monitoring in Temporal Text Sources Extracting topics, monitoring topic evolution and anomaly detection in temporal text sources such as Twitter and news feeds.	Completed integration of research outputs into the CaseGenix platform.
	Building Classification and Prediction Systems for Civil Unrest Events Building interpretable event forecasting systems.	Implemented and evaluated baseline and time series models for forecasting social disruption.
	Civil Unrest and Election Prediction Bayesian network models for social disruption and election prediction.	Designed theoretical framework for the application of Bayesian Networks to forecasting social disruption events. Evaluated keyword volume models for event prediction.
	Disease Prediction Data assimilation methods for disease forecasting	Developed a real-time influenza prediction model based on GP surveillance data for Australian capital cities.

RESEARCH PROGRAMS	PROJECTS	HIGHLIGHTS
	Semantic Indexing of Video Content based approaches to video search and retrieval.	Developed a fast and efficient video concept detection toolkit.
Policy for Big Data Analysis Assess and develop policy frameworks, regulation and practices to address the tension between the protection of civil rights and liberties, and the use of Big Data analytics to advance national security interests.	**Big Data Technology and National Security: Comparative International Perspectives on Strategy, Policy and Law in Australia, the United Kingdom and Canada** Examination of policies, regulatory approaches, processes and strategies used to balance confidentiality and national security analysis and exploitation of data.	Completed the project, delivering six technical reports to the Attorney-General's Department as well as presenting a seminar on the project results for D2D CRC stakeholders in Canberra
Innovation Exchange Application of data analytics techniques in adjacent market sectors and industries	**Agriculture** Collaboration with the Sheep CRC, applying data analytics to sheep wellbeing.	Designed and developed a platform for sheep wellbeing. Developed a suite of machine learning models for predicting live weight, body condition score, and disease susceptibility for individual sheep.
	Manufacturing Data analytics for SME manufacturing businesses.	Delivery of multiple projects under the South Australian Big Data Connect Program.
	Health Data analytics for improved healthcare delivery and outcomes.	Established a research program to address data analytic needs in healthcare. Co-developing predictive analytics to help reduce unwarranted variation in cardiac therapeutic procedures and diagnosis tests with the Queen Elizabeth Hospital.
	Digital Marketing Data analytics for improved measurement and targeting of digital marketing campaigns.	In collaboration with UniSA Center for Digital Video Intelligence delivered a system to evaluate the success and engagement of video marketing campaigns for a large multinational consumer goods company.

PERFORMANCE AGAINST THE ACTIVITIES

APPLICATION RESEARCH PROGRAM: SECURITY ANALYTICS FOR COUNTER TERRORISM AND POLICING

The program's key activities are to research, develop, integrate and evaluate concept demonstrators that address the data analysis and exploitation needs of users in the law enforcement and intelligence community. Specifically, the program focus is:

– prediction of events such as social disruption, disease outbreak and election outcomes from analysis of open data sources (*Beat The News*™); and

– Integrated access, linking and analysis of distributed law enforcement data *(Integrated Law Enforcement)*.

Key research achievements and evidence of research quality is demonstrated in each of the projects as follows:

BEAT THE NEWS™:

– A multi-year, multi-stream research and development program was initiated to forecast social disruption events from analysis of publicly available data.

– A large-scale data analytics platform has been prototyped and deployed. The analytics platform is able to process millions of records per day, can execute a variety of predictive algorithms and is used by multiple research teams.

– A variety of predictive models have been developed that forecast social disruption events from open source data. A subset of the predictive models have been integrated into a live system, operating on real data and producing live forecasts of events. The system has correctly predicted multiple high-profile events, in some cases months in advance.

INTEGRATED LAW ENFORCEMENT:

– A multi-year, multi-stream research and development program was initiated to provide integrated access, linking and analysis of law enforcement data.

– A prototype Investigations Case Wall, which has been successfully demonstrated to several law enforcement audiences, was developed and delivered.

– The *Integrated Law Enforcement* program will be evaluated by the Australian New Zealand Counter Terrorism Committee (ANZCTC) Investigations Management System Working Group for suitability as a national investigations management tool.

The following specific impediment will be addressed:

– 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 for the D2D CRC. Close engagement with several agencies is underway to provide a pathway for data access and system evaluation.

Extensive end-user involvement provides evidence that research is meeting their needs, in particular:

– initial plans have been developed to deploy the *Beat The News*™ event forecasting system, as an operational concept demonstrator, to a number of law enforcement agencies;

– working groups and project steering committees composed of representatives from a range of end user agencies have been established; and

– end user participants have been extensively consulted throughout the problem scoping and architectural design activities for the *Integrated Law Enforcement* system.

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

APPLICATION RESEARCH PROGRAM: DEFENCE INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE

The program's key activities are to research, develop, integrate and evaluate concept demonstrators that address the data analysis and exploitation needs of users in the defence community. Specifically, the program is focussed on:

– techniques to enable the effective search, interrogation and understanding of open source multi-media (text, image and video) data (*Apostle*™); and

– guidance to architects, designers and managers to be used when building Big Data systems (Reference Architecture).

The following list provides key research achievements and evidence of its quality:

BIG DATA REFERENCE ARCHITECTURE:

– Developed and delivered the Big Data Reference Architecture – a guide to design of big data analytic systems. The Reference Architecture was used to generate a systems architecture for open source intelligence system. The Reference Architecture was published in a leading international conference.

APOSTLE™:

– A multi-year, multi-stream research and development program was developed to provide effective search, interrogation and understanding of open source multi-media (text, image and video) data.

– Extensive engagement was conducted with end users to develop a series of detailed use case scenarios for the *Apostle*™ program.

– An initial prototype of online footprinting capability developed and successfully demonstrated to a range of law enforcement agencies.

While not a specific impediment, there is a need for continuing engagement and input from end users to guide research and development activities, in particular, to develop of effective tools and techniques for users and analysts in the National Security Community.

Extensive end-user involvement provides evidence that research is meeting their needs, in particular, through:

– working groups and project steering committees composed of representatives from a range of end user agencies have been established;

– end user participants have been extensively consulted throughout the problem scoping and architectural design activities for the *Apostle*™ program; and

– initial plans have been developed to deploy the *Apostle*™ online footprinting system, as an operational concept demonstrator, to a number of law enforcement agencies.

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

FOUNDATION RESEARCH PROGRAM 1: DATA STORAGE AND MANAGEMENT

The program's key research areas are:

– information architectures for access and analysis of diverse, distributed data;

– scalable graph processing and query architectures; and

– sharing, query and mining of distributed data.

The following list provides key research achievements and evidence of its quality:

INFORMATION ARCHITECTURES, AND SHARING, MINING OF DISTRIBUTED DATA:

– An outline of federated data platform architecture was developed in collaboration with the Australian Federal Police.

– A metamodel-based flexible entity management framework was designed.

– An initial prototype of the data curation foundry, nano-apps and case wall for investigators was developed.

– The design of linked data model for entity resolution across structured and unstructured data sources was initiated.

KNOWLEDGE GRAPH ARCHITECTURES AND PROCESSING:

– A processing pipeline to extract knowledge from wikipedia infoboxes was constructed.

– A processing pipeline to perform knowledge graph construction from social media data was constructed.

– New methods to perform named entity recognition and relationship extraction were devised.

– A prototype system to perform relatedness queries in knowledge graphs, including ability for navigation and concise summarisation, was constructed.

While not a specific impediment, there is a need for continuing engagement and input from end users to guide research and development activities, in particular, to develop effective tools and techniques for users and analysts in the National Security Community.

Extensive end-user involvement provides evidence that research is meeting their needs. In particular, this foundation research program will deliver outputs to the *Beat the News*™, *Apostle*™ and *Integrated Law Enforcement* concept demonstrator programs. Each of these programs includes regular demonstrations to a working group consisting of representatives selected from the end-user community. Each concept demonstrator program is also governed by a project steering committee consisting of senior executives from the end-user organisations, whose role is to ensure that the programs are meeting end-user needs.

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

FOUNDATION RESEARCH PROGRAM 2: ANALYTICS AND DECISION SUPPORT

The program's key research areas are:

– information extraction techniques;

– search and retrieval of data;

– risk profiling and prediction; and

– visualisation techniques.

The following list provides key research achievements and evidence of its quality:

– A variety of predictive models have been developed that forecast social disruption events from open source data. A subset of the predictive models including baseline, time series and planned protest models have been integrated into a live system, operating on real data and producing live forecasts of events. A system of quality metrics has been established to assess the performance of the system.

– A real-time influenza prediction model based on GP surveillance data for Australian capital cities was developed, producing weekly predictions of the 2016 flu season. Early-season insights into influenza season peak timing using GP data on interaction between diseases.

– The CRC entered the Center for Disease Control's Dengue Forecasting Tournament, which led to an invitation to the White House.

– The integration of topic mining and trend detection research outputs into the CaseGenix platform was completed.

– A system that allows novel visualisation of spatio-temporal data in the intelligence domain was developed and demonstrated. The system was developed in close collaboration with a number of partner agencies. An innovation disclosure for the system was developed.

– An event extraction system using rules based on event type and sentence structure was developed and implemented. An initial ontology of events, actors and groups to monitor was developed identified suitable English-language data sources were identified. The current focus is on on events in Afghanistan/Pakistan region.

– A fast and efficient video concept detection toolkit was developed.

– A new hierarchical video representation method was proposed and a state of the art performance in video captioning was achieved. Most of the top performers in the ActivityNet-16 competition used our video representation and it is gradually becoming a standard methodology for video representation.

– D2D CRC researchers had nine papers accepted to the International Conference on Computer Vision and Pattern Recognition in July, which is the pre-eminent conference in this discipline.

Extensive end-user involvement provides evidence that research is meeting their needs. In particular, this foundation research program will deliver outputs to the *Beat the News*™, *Apostle*™ and *Integrated Law Enforcement* concept demonstrator programs. Each of these programs undertakes regular demonstrations to a working group consisting of representatives selected from the end-user community. Each concept demonstrator program is also governed by a project steering committee consisting of senior executives from the end-users, whose role is to ensure that the programs are meeting end-user needs.

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

RESEARCH PROGRAM 3: POLICY FOR BIG DATA ANALYTICS

The major achievement of this program was the completion of the first project (Comparative International Perspectives on Strategy, Policy and Law in Australia, the United Kingdom, the United States, New Zealand and Canada). The project started in late 2014 and was completed in June 2016 with the delivery of six technical reports to the Attorney-General's Department that were presented at a seminar for key stakeholders in Canberra on 30 June 2016.

While not a specific impediment, the nature of the expertise required to research law and policy in this field in Australia has proved challenging when trying to attract PhD students. In June 2016 two PhD candidates were working in the program and the enrolment of the third candidate was underway.

Extensive end-user involvement provides evidence that research is meeting their needs. In particular, the AGD helped facilitate user engagement for the CRC across the National Security Community, especially in relation to the first research project of the Program. They furthermore reviewed the draft Australian report, one of the technical reports prepared, and provided feedback that researchers could consider before finalising the report. The Program team also interacted with various government departments and agencies about the projects that they believe the Program should undertake in future. Business cases, formulated with input from several agencies, informed new research projects that will start on 1 July 2017.

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

INNOVATION EXCHANGE

The major accomplishments of the *Innovation Exchange* initiative are:

HEALTH

– During the last six months, the D2D CRC has obtained a grant from the South Australian Government to undertake several proof of concept projects over 18 months. Four feasible proof of concept projects will be considered for approval by the project steering committee as follows:

  » linking hospital data with external sources (e.g. MBS, PBS) to improve mental health outcomes, including reduced readmissions.

  » pandemic outbreak prediction;

  » use of ORION dataset and machine learning to improve cardiac operation outcomes; and

  » an emergency waiting time application

MANUFACTURING

– A Big Data system with predictive analytics was successfully implemented for Seeley International (Australia's largest air-conditioning manufacturer). The success of this project has led to Seeley moving towards commercialising the platform. This project used research from the Big Data Reference Architecture project to develop the architecture for Seeley.

– A research project was completed for SEAPA Pty Ltd (an oyster farming equipment manufacturing company). This prompted the traditionally hardware focussed company to start the development of a data analytics platform to give them a competitive edge.

– A price estimation tool developed for Mayfield has reduced project bid cost estimations, improved bid response times and increased pricing estimate.

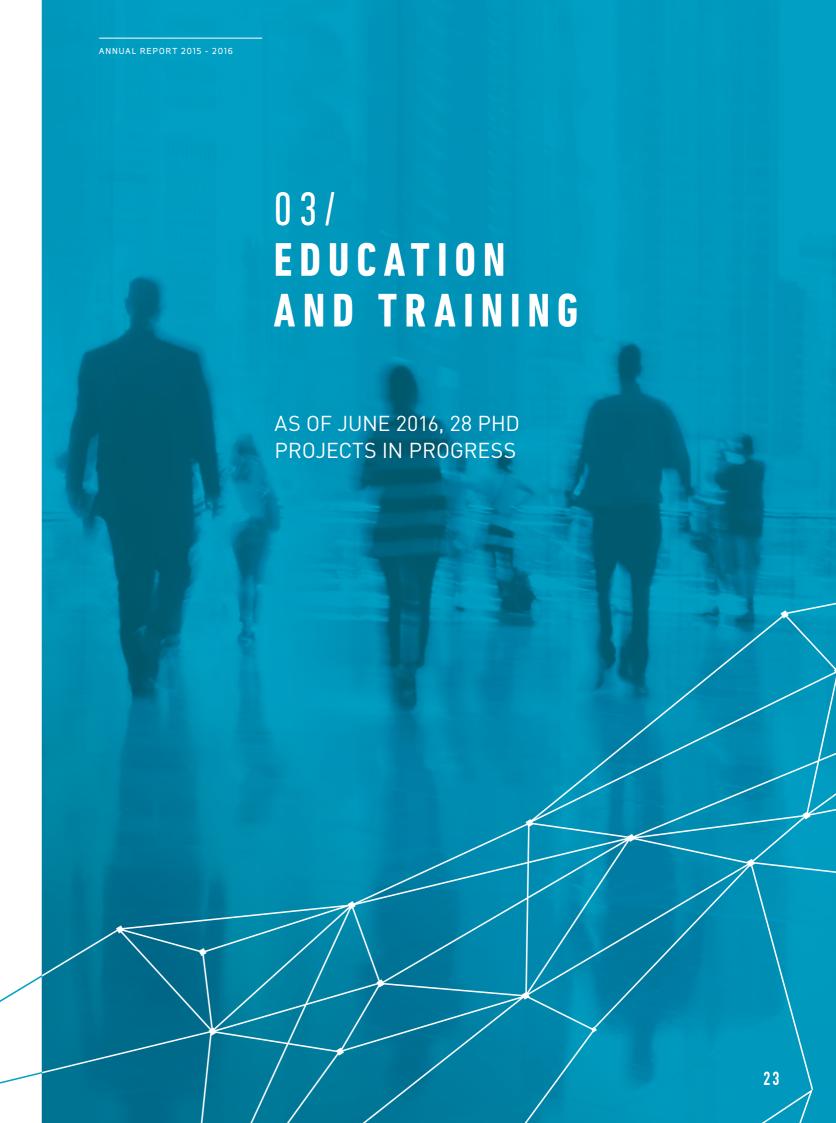– Provided education to the SA manufacturing sector on Big Data to increase adoption and create local use cases.

AGRICULTURE

– The Sheep CRC Wellbeing Data Platform (WDP), which houses complete historic weather data for Australia back to 1981, was developed and is ingesting live weather observation and forecast data. The WDP also now hosts and runs biophysical risk models to further help predict sheep wellbeing.

– As part of the commercialisation pathway for this work, an agreement was reached for a common API with the three main Farm Management System suppliers in Australia.

– A suite of machine learning models was developed to predict live weight, body condition score and disease susceptibility for individual sheep.

SME ENGAGEMENT

Through the *Innovation Exchange*, the D2D CRC has engaged with several SMEs. In particular, the D2D CRC has successfully completed three projects with manufacturing SMEs (Seeley International, Mayfield Industries and SEAPA Pty Ltd) under the *Big Data Connect Program*. These projects have 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 D2D CRC continues to have two very active SMEs in its participant group, namely Semantic Sciences and Genix Ventures. Semantic Sciences continues to participate in the Multi-source Information Analysis Platform project, while Genix Ventures and La Trobe University recently completed the Topic Mining & Temporal Trend Monitoring project. The outputs of this project were recently demonstrated to national security agency representatives at the D2D CRC 'Demo Day'.

03/ EDUCATION AND TRAINING

AS OF JUNE 2016, 28 PHD PROJECTS IN PROGRESS

Over 2015-16 the D2D CRC continued to build a strong and sustainable Big Data workforce for Australia, meeting the milestone of 28 PhD students, training approximately 200 people and starting a project to develop a Generic Data Competency Framework.

Seminar at D2D CRC HQ

STUDENT ENGAGEMENT AND DEVELOPMENT

As well as increasing the number of PhD students to 28, the D2D CRC has sought to enhance student engagement and knowledge sharing through:

– attendance at the D2D CRC Annual Conference,

– an induction day for new students,

– sharing research progress and interacting with end users at Tech Day and Demo Day,

– enabling students to work at the D2D CRC Base64 headquarters,

– attendance at project meetings with the research and development teams,

– using an online method of instant communication (HipChat), and

– a D2D CRC staff member applying to be an external supervisor.

In the future, the D2D CRC will increase development opportunities available to students by:

– launching the exchange program,

– providing workshops in three key capability areas of entrepreneurship, innovation and collaboration, and

– developing closer relationships with end users and industry including internships and placements.

Unfortunately, three students withdrew from their PhDs over 2015-16; however, this is within the planned attrition rate.

Focus has also been placed on honours scholarships and interns, both to facilitate the PhD student pipeline and extend the depth of the Education and Training Program. Many of the honours students have at D2D CRC headquarters and regularly attend project meetings to share their research.

Over 2015-16, the D2D CRC:

– provided five students with $5,000 honours scholarships from UniSA, University of Adelaide and UNSW,

– partnered with the Defence Teaming Centre to offer two additional honours scholarships,

– hosted six D2D CRC summer internships, and

– hosted three Carnegie Mellon University interns.

SEMINARS

Using the expertise of D2D CRC staff, researchers and guest academics, the D2D CRC seminar series provides an opportunity to share personal experiences and expertise with the broader data science community. They have so far focussed on building on the lessons learnt and challenges experienced in developing Big Data technologies e.g. architectures and platforms. The majority of the seminars are open to the public, with a smaller number tailored specifically to end users, and have included:

– three seminars in various locations on Issues for the *Use of Data and Analytics in Decision-making*;

– one seminar on *Building a Useful Software Dependency Visualization System*;

– one seminar on *Agile Methodology for R&D*; and

– four seminars in various locations on *Big Data Architecture and Technologies*

Future seminars will continue to share the D2D CRC's

technical and legal/policy experience through both face-to-face delivery and an increasingly online presence (videos and e-books). The need for an introductory training in data science for non-technical staff has been recognised by several of our national security end users, leading to the co-creation of a course with Deakin University.

The D2D CRC has also been recognised as a Training Partner with the Department of Prime Minister and Cabinet in relation to the Australian Public Service (APS) Skills and Capability Framework and we look forward to working with agencies to meet their needs.

DATA COMPETENCY PROJECTS

A competency framework provides a profession with a foundation for workforce management across the spectrum of talent management activities, such as recruitment, development, team building and career pathways. While some agencies and industry partners have started development of organisational competency frameworks for Data Science and Analytics, the D2D CRC has identified an opportunity to develop a generic competency framework. Input has been sought from participants through a variety of workshops and exploratory work was undertaken through Deakin University.

Over the next year, the D2D CRC will lead four programs and partner with agencies to:

– further develop the generic data science/analytics competency framework;

– identify a competency recognition framework;

– develop a competency assessment tool; and

– identify the organisational factors that support data science/analytics capability.

PhD Students at Induction Day (Not all students are photographed)

Seminar at The University of Technology Sydney

04/
RESULTS

DEMONSTRATED INITIAL
CAPABILITY TO OVER 100 END
USERS AT THE D2D CRC DEMO DAY

UTILISATION AND COMMERCIALISATION

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. These include:

- ensuring that all projects are aligned to priority capability needs as defined by the national security agencies;
- ensuring active engagement of national security or industry participants in all research projects;
- undertaking *Law & Policy* projects in collaboration with the ultimate end user of their outputs, namely Attorney-General's Department; and
- structuring all technology-focussed research programs to include regular demonstrations of capabilities to national security representatives.

The specific utilisation milestones for FY2016 were to:

- conduct two industry-sector specific 'data science' workshops;
- undertake initial trials for the *Beat the News*™ and *Apostle*™ programs, which was achieved through regular demonstration of capability to end users.

Both of these milestones have been achieved.

INTELLECTUAL PROPERTY MANAGEMENT

The D2D CRC has the essential mechanisms in place to ensure adherence to the National Principles of IP Management. 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 has established an IP strategy process to help develop IP exploitation strategies for the programs. All programs are required to develop an IP strategy and review the strategy on a regular basis.

An initial catalogue of potential foreground IP from the programs and activities has been established. Several innovation disclosures were developed; however, no patent applications were filed during the reporting period. No registered IP was sold, transferred or licensed for commercialisation during the reporting period.

COMMUNICATION

The D2D CRC's communication program is intended to:

- increase awareness of the D2D CRC;
- increase awareness of the Australian Government's CRC Programme;
- promote the accomplishments of the D2D CRC;
- keep employees engaged and involved in the business;
- ensure participants are fully abreast of CRC's research and training activities through the DATACAST electronic newsletter;
- ensure research outcomes, impacts and company news are communicated beyond the D2D CRC's partners through the D2D CRC's eNews, a quarterly electronic newsletter; and
- inform the general public of the CRC's achievements via website and social media channels; and
- continuously increase the CRC's social media following via:
  - » Twitter @D2DCRC;
  - » LinkedIn www.linkedin.com/company/data-to-decisions-crc; and
  - » Facebook – Data to Decisions CRC.

During the reporting period, the CRC:

- made 36 external presentations to end user focussed audiences in Adelaide, Canberra, Melbourne, Sydney and Korea;
- was reported 23 times in the media;
- launched a Facebook account;
- held the D2D CRC Tech Day and Demo Day on 28 and 29 June 2016;
- published seven articles in scholarly refereed journals and 20 full written conference paper (refereed proceedings); and
- held regular meetings and presentations to participant organisations.

D2D CRC Demo Day – June 2016

MEDIA TABLE

PUBLISHED	NAME	PUBLICATION	MEDIUM
03/07/15	Digital world is the next line of Defence	Sunday Mail	Print
		The Courier Mail	Online
23/09/15	New program helping manufacturers capture business value from Big Data	Department of State Development	Online
22/10/15	Funding to extend successful manufacturing technology programs	Manufacturing Works	Online
05/11/15	Shot in the arm for sheep data	The Land	Online
17/11/15	Stopping defence leaks	Sydney Morning Herald	Online
10/12/15	Big-data pioneers	The Australian	Print & Online
11/12/15	STEM Heroes	The Australian	Online
12/12/15	Science of better healthcare	The Advertiser	Online
12/12/15	Building a High Tech State	The Advertiser	Print
21/12/15	Member News – Sanjay Mazumdar listed in knowledge nation top 100	DTC Industry News 21 December 2015	Online
09/03/16	Big Data gives cool insights to air conditioning company	The Lead South Australia	Online
11/04/16	Data for intelligence	eResearchSA	Online
		Nectar - Impact	Print
21/04/16	Agriculture ripe for big data revolution	Sheep CRC	Online
24/05/16	Basis Technology and Data to Decisions CRC Partner to Strengthen Australian National Security	Basis Technology	Online
31/05/16	Two CRCs join forces to deliver big data solutions for live stock	Sheep CRC	Online
31/05/16	Sheep CRC turns national security science towards ewe in big data initiative	Sheep Centra	Online
02/06/16	National data entity enters rural sector	Rural News Wagga Wagga	Print
03/06/16	Interview with James Rowe, Sheep CRC, and Sanjay Mazumdar, D2D CRC.	ABC	Radio
08/06/16	Show Entries	Weekly Times (VIC)	Print
08/06/16	Farmer interest in digital agriculture technology experiencing 'extraordinary' growth this year	ABC Rural	Online
14/06/16	Streamlining the sheep industry does computer	The Advertiser	Print & Online
14/06/16	High tech support for sheep farmers coming soon	The Advertiser	Online
30/06/16	Two CRCs join forces to deliver big data solutions for livestock	CRC eNewsletter - June	Online

05/
RESOURCES

INTRODUCED FOUR
NEW CRC PARTICIPANTS

GOVERNANCE – BOARD, COMMITTEES AND KEY STAFF

The D2D CRC continued throughout 2015/2016 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.

At the November 2015 Annual General Meeting (AGM), the Board membership expanded from five to six independent, non-executive directors and retained one executive director (the CEO). As a result of this expansion and two directors' resignations (as required under the D2D CRC constitution), three non-executive director positions were available to be filled the 2015 AGM. Of the two resigning directors, Ms. Kathryn Adams and Ms. Suzanne Campbell, only Ms. Adams sought re-appointment. The D2D CRC sought nominations of suitable independent and skilled individuals from its Essential Participants to fill these positions. In addition to the one director seeking re-nomination, two other nominations were received. As a result, at the 2015 AGM, Ms. Kathryn Adams was re-elected to the Board in addition to Mr. Stephen Merchant and Professor Hugh Durrant-Whyte.

Three non-executive directors who have served their two year terms are required to resign at the AGM in late 2016.

The D2D CRC Board continues to be supported by one sub-committee and three advisory committees:

–   The Audit and Risk Committee (ARC) – Board sub-committee

–   The Research Advisory Committee (RAC) – Board advisory committee

–   The Defence and National Security Advisory Committee (DNSAC) – Board advisory committee

–   The Commercialisation and IP Advisory Committee (CIPAC) – Board advisory committee

BOARD MEMBERSHIP

The following members served on the Board during the year ended 30 June 2016

NAME	ORGANISATION	CRC POSITION/ROLE	KEY SKILLS
Tim Scully	Independent	Director and Chairman	– Public Service Administration – Strategy Development & Planning – Management Public Sector – Defence Intelligence Surveillance and Reconnaissance (ISR) – National Security & Intelligence
Fatima Beattie	Independent	Director	– Public Service Administration – Corporate Governance – Strategy Development & Planning – Intellectual Property – Management – Public Sector
Cath Ingram	Independent	Director	– Finance – Risk, audit, insurance – Public Service Administration – Corporate Governance – Director Public & Private Sector – Management Private Sector – Strategy Development & Planning
Kathryn Adams	Independent	Director	– Public Service – Corporate Governance – Strategy Development & Planning – Intellectual Property – Research & Development – Director Public Sector – Management Public Sector – CRC – Research Provider – Industry Interface
Hugh Durrant-Whyte	Independent	Director	– Information Technology – Defence ISR – National Security & Intelligence – Strategy Development & Planning – Research & Development – Research within University Sector – Research Provider – Industry Interface
Stephen Merchant	Independent	Director	– Defence ISR – National Security & Intelligence – Public Service – Management Public Sector
Sanjay Mazumdar	D2D CRC	Director and D2D CRC CEO	– Information Technology – Management – Private Sector – Research Provider – Industry Interface – Defence ISR – Strategy Development & Planning – Research and Development
Suzanne Campbell	Independent	Director (retired November 2015)	– Management – Private Sector – Information Technology

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.

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.

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.

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).

FATIMA BEATTIE

Fatima Beattie is currently the Deputy Director General of IP Australia. She joined IP Australia in 2003 as the Commissioner of Patents, in 2007 she was appointed Deputy Director General having responsibility 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.

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.

HUGH DURRANT–WHYTE

Professor Hugh Durrant-Whyte is a successful academic, engineer and entrepreneur with a proven track for successfully engaging and achieving research outcomes with industry. From December 2010 to December 2014, he was the CEO of National ICT Australia (NICTA) and while working as an academic, Professor Durrant-Whyte pioneered the field of statistical data fusion, in particular its application in autonomous robotics and in large-scale intelligent systems. Professor Hugh holds a PhD and MSE from the University of Pennsylvania and a Bachelor of Science (Engineering) from the University of London.

SUZANNE CAMPBELL (RETIRED)

Suzanne Campbell was appointed in 2011 as Chief Executive Officer, Australian Information Industry Association. Suzanne has more than 20 years of IT and telecommunications experience, which includes leading major change, transformation and growth projects for domestic and international companies to deliver significant results.

BOARD MEETINGS AND ATTENDANCE

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

MEETING DATE AND LOCATION	21/8/15 (CANBERRA)	19/11/15 (ADELAIDE)	19/2/16 (SYDNEY)	24/6/16 (MELBOURNE)	TOTAL	ELIGIBLE TO ATTEND
Board Member						
Tim Scully	Yes	Yes	Yes	Yes	4	4
Sanjay Mazumdar	Yes	Yes	Yes	Yes	4	4
Cath Ingram	Yes	Yes	Yes	Yes	4	4
Fatima Beattie	Yes	Yes	Yes	Yes	4	4
Kathryn Adams	Yes	Yes	Yes	Yes	4	4
Hugh Durrant-Whyte	N/A	Yes	Yes	Yes	3	3
Stephen Merchant	N/A	Yes	Yes	Yes	3	3
Suzanne Campbell (retired)	No	N/A	N/A	N/A	0	1
Total	**5**	**7**	**7**	**7**	**26**	**27**

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	– Finance – Risk/Audit/Insurance – Public Service Administration Corporate Governance – Director Public & Private Sector – Management – Private Sector
Kathryn Adams	D2D CRC Director	Director/Member	– Public Service – Corporate Governance – Strategy Development & Planning – Intellectual Property – Research & Development – Director Public Sector – Management Public Sector – CRC – Research Provider – Industry Interface
Niall Fay (advisor only)	D2D CRC	D2D CRC advisor to Committee	– Defence/National Security/Finance

MEETING ATTENDANCE

MEMBER	17/8/15	22/1/16	29/4/16	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
Tony Lindsay	DST Group	Chairman	– Defence ISR – National Security & Intelligence – Management and delivery of end-user focussed research programs
Kathryn Adams	D2D CRC	Board Representative	– Management and delivery of end-user focussed research programs – Commercialisation and utilisation strategies
Paul Compton	UNSW	Member	– Data storage and management – Management and delivery of end-user focussed research programs – Commercialisation and utilisation strategies
Greg Wood	SAS	Member	– Data storage and management – Commercialisation and utilisation strategies
Brenton Cooper	D2D CRC	D2D CRC Representative	– Defence ISR – National Security & Intelligence – Data storage and management – Data analytics, decision support and data visualisation – Management and delivery of end-user focussed research programs – Commercialisation and utilisation strategies
Anna Harmer	AGD	Member	– National Security & Intelligence – Data analytics, decision support and data visualisation – Management and delivery of end-user focussed research programs
Daniel McMichael (Retired May 2016)	Semantic Sciences	Member	– Defence ISR – National Security & Intelligence – Data storage and management – Data analytics , decision support and data visualisation – Management and delivery of end-user focussed research programs – Commercialisation and utilisation strategies

MEETING ATTENDANCE

MEMBER	26/8/15	13/10/15	24/5/16	16/6/16	TOTAL	ELIGIBLE TO ATTEND
Tony Lindsay	Yes	Yes	Yes	Yes	4	4
Brenton Cooper	Yes	Yes	Yes	Yes	4	4
Kathryn Adams	Yes	Yes	Yes	Yes	4	4
Paul Compton	Yes	Yes	Yes	Yes	4	4
Greg Wood	Yes	No	No	Yes	2	4
Anna Harmer	Yes	No	Yes	No	2	4
Daniel McMichael	No	No	N/A	N/A	0	2

DEFENCE AND NATIONAL SECURITY ADVISORY COMMITTEE

The Defence and National Security Advisory Committee provides advice to the Board regarding its strategic and business plan's relevance to the National Security Community. In addition, it provides guidance on how to best ensure the transfer of outputs from the D2D CRC into National Security Community. Deputy Commissioner Ramzi Jabbour (Australian Federal Police) replaced Deputy Commissioner Michael Phelan as Chairman of the Committee in March 2016.

MEMBERSHIP

MEMBER	ORGANISATION	ROLE	KEY SKILLS
Ramzi Jabbour	Australian Federal Police	Chairman	– National Security – Public Service – Management Public Sector
Michael Phelan	Australian Federal Police	Chairman (Retired March 2016)	– National Security
Chris Keane	BAE Systems	Member	– Defence ISR – Transition of capability from industry to end-users
John Percival	DST Group	Member	– Defence ISR – National Security
Scott Tilyard	Tasmanian Police	Member	– National Security
Steve Godinho	Genix Ventures	Member	– Transition of capability from industry to end-users
Dirk Klein	SAS Institute	Member	– Transition of capability from industry to end-users
Stephen Merchant	D2D CRC	Board Representative	– Defence ISR – National Security & Intelligence – Public Service – Management Public Sector
Dara Williams	Office of National Assessments	Member (May 2016)	– National Security & Intelligence – Public Service – Management Public Sector

MEMBER	ORGANISATION	ROLE	KEY SKILLS
Brett Greenshields	Department of Foreign Affairs and Trade	Member (May 2016)	– National Security & Intelligence – Public Service – Management Public Sector
Jane V	Attorney-General's Department	Member (June 2016)	– National Security & Intelligence – Public Service – Management Public Sector
Maria Fernandez	Department of Immigration and Border Protection	Member (June 2016)	– National Security & Intelligence – Public Service – Management Public Sector
Warren Karle	Department of Defence	Member (June 2016)	– National Security & Intelligence – Public Service – Management Public Sector
Sanjay Mazumdar	D2D CRC	D2D CRC and Board Representative	– Defence ISR – Transition of capability from industry to end-users

MEETING ATTENDANCE

MEMBER	26/8/15	TOTAL	ELIGIBLE TO ATTEND
Michael Phelan (retired March 2016)	N/A	0	0
Ramzi Jabbour	Yes	1	1
Chris Keane	Yes	1	1
John Percival	Yes	1	1
Scott Tilyard	Yes	1	1
Steve Godinho	Yes	1	1
Dirk Klein	Yes	0	1
Stephen Merchant	Yes	1	1
Sanjay Mazumdar	No	0	1
Dara Williams	N/A	0	0
Brett Greenshields	N/A	0	0
Jane V	N/A	0	0
Maria Fernandez	N/A	0	0
Warren Karle	N/A	0	0

COMMERCIALISATION AND INTELLECTUAL PROPERTY ADVISORY COMMITTEE

The Commercialisation and Intellectual Property Advisory Committee provides advice to the Board regarding the development, assessment and execution of project IP strategies. In addition, it works with projects and the Board in the identification, development and assessment of IP commercialisation opportunities.

MEMBERSHIP

MEMBER	ORGANISATION	ROLE	KEY SKILLS
Fatima Beattie	D2D CRC	Chairman and Board Representative	– IP strategy and management – IP protection
Hugh Durrant-Whyte	D2D CRC	Board Representative	– Information Technology – Defence ISR – National Security & Intelligence – Strategy Development & Planning – Research & Development – Research within University Sector – Research Provider – Industry Interface
Rob Chalmers (Retired June 2016)	Adelaide Research & Innovation	Member	– IP strategy and management – IP protection – Commercialisation pathways for R&D
Jim Henderson	UNSW Innovations	Member	– IP strategy and management – IP protection – Commercialisation pathways for R&D
JC Tan	ITEK Ventures (UniSA)	Member	– IP strategy and management – IP protection – Commercialisation pathways for R&D
Brenton Cooper	D2D CRC	D2D CRC Representative	– IP strategy and management – IP protection – Commercialisation pathways for R&D

MEETING ATTENDANCE

MEMBER	3/8/15	25/2/16	TOTAL	ELIGIBLE TO ATTEND
Fatima Beattie	Yes	Yes	2	2
Hugh Durrant-Whyte	N/A	Yes	1	1
Rob Chalmers	Yes	Yes	2	2
Jim Henderson	Yes	Yes	2	2
JC Tan	Yes	No	1	2
Brenton Cooper	Yes	Yes	2	2

KEY STAFF

This table shows key staff as at 30 June 2016

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%
Megan Prideaux	D2D CRC	Education and Training Manager	100%
Voula Dimitrakopoulos	D2D CRC	Marketing and Communication Officer	100%
Prof Markus Stumptner	University of South Australia	Research Program 1 Leader (Data Storage and Management)	63%
Prof Anton van den Hengel	University of Adelaide	Research Program 2 Leader (Analytics and Decision Support)	61%
Prof Louis de Koker	Deakin University	Research Program 3 Leader (Policy and Law)	63%

PARTICIPANTS

Details of the Essential Participants involved in the D2D CRC during the reporting period are provided in this table.

ESSENTIAL PARTICIPANT	ABN	ORGANISATION TYPE
Attorney General's Department	92 661 124 436	Australian Government
Australian Federal Police	17 864 931 143	Australian Government
BAE Systems Australia	29 008 423 005	Industry
Deakin University	56 721 584 203	University
Defence SA	42 912 246 233	State Government
Department of Defence	68 706 814 312	Australian Government
eResearch SA	61 249 878 937	Research
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
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

COLLABORATION

Details of the Other Participants involved in the D2D CRC during the reporting period are provided in this table.

OTHER PARTICIPANTS	ABN	ORGANISATION TYPE
Australian National University	52 234 063 906	University
Basis Technology	N/A	Industry
Carnegie Mellon University Australia	97 116 769 423	University
La Trobe University	64 804 735 113	University
Office of National Assessments	87 904 367 991	Australian Government
Palantir Technologies Australia	48 144 948 309	Industry
PricewaterhouseCoopers Australia	52 780 433 757	Industry
Teradata Australia	77 125 071 374	Industry
The Boston Consulting Group	70 007 347 131	Industry
Unisys Australia	31 105 642 902	Industry
University of Technology Sydney	77 257 686 961	University

The Office of National Assessments, Basis Technology, the Australian National University and the University of Technology Sydney joined the CRC during FY 2015-16. PricewaterhouseCoopers (PwC) withdrew from the CRC at the end of FY 2015-16.

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 three technical programs (*Beat the News*™, *Apostle*™ and *Integrated Law Enforcement*), while still early in their lifecycle, also highlight the extent to which collaboration will be enabled. These programs have been designed to include multiple agencies from the National Security Community, numerous industry organisations and research participants. Initial plans have been developed for the deployment of the concept demonstrators to several law enforcement and national security agencies.

The *Law & Policy* Program has exemplified effective collaboration with end-users and between research participants. This program involves researchers from Deakin University and the University of New South Wales who have very effectively collaborated with their end-user sponsor (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 is currently collaborating with the Sheep CRC on the development of data analytics platforms for monitoring sheep well-being. The D2D CRC has also established the Big Data Connect Program with the South Australian Government, a data analytics capability improvement program for manufacturing SMEs. The D2D CRC intends to undertake similar activities in sectors such as health and agriculture.

OTHER ACTIVITIES

ADDITIONAL REQUIREMENTS

As described earlier, 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 Agreement.

There were no activities undertaken by the CRC outside the activities specified in the Commonwealth Funding Agreement for this financial year.

PERFORMANCE REVIEW

On 8 December 2015, the Chairman and CEO of the D2D CRC met with the CRC Advisory Committee to undertake a review of its first year activities. The D2D CRC was commended by the Advisory Committee for its "excellent progress against the achievement of its outcomes" and it was also acknowledged that the D2D CRC has a "strong, effective and independent governance structure; is generating IP of significant commercial value and working with its participants to identify commercialisation opportunities".

No specific recommendations were made by the CRC Advisory Committee that required D2D CRC actions or responses.

06/ FINANCIAL MANAGEMENT

Financials available on request

07/
APPENDIX

FORMAL PUBLICATIONS

PUBLICATION TITLE	PROGRAM TITLE	STREAM TITLE	PUBLICATION TYPE	PUBLISHED
Local Similarity for Unstructured Text	Apostle	Knowledge Graph Query	Conference Publication	Yes
Convex Sparse PCA for Unsupervised Feature Analysis	Apostle	Semantic Indexing	Journal Article	Yes
Avoiding Optimal Mean Robust PCA/2DPCA with Non-greedy 1-norm maximisation	Apostle	Semantic Indexing	Conference Publication	Yes
Less is More: Zero-shot Learning from Online Textual Documents with Noise Suppression Mechanism	Apostle	Large Scale Image Classification	Conference Publication	Yes
What's Wrong with that Object? Identifying Images of Unusual Objects by Modelling the Detection Score Distribution	Apostle	Large Scale Image Classification	Conference Publication	Yes
Pushing the Limits of Deep CNNs for Pedestrian Detection	Apostle	Large Scale Image Classification	Conference Publication	Yes
Compositional Model Based Fisher Vector Coding for Image Classification	Apostle	Large Scale Image Classification	Journal Article	Yes
Event Detection on Twitter using Unsupervised Incremental Learning Method	Apostle	Topic Mining and Temporal Trend Monitoring from Diverse Text Sources	Journal Article	Yes
Using Semantic Relatedness Measures with Dynamic Self Organizing Maps for Inproved Text Clustering	Apostle	Topic Mining and Temporal Trend Monitoring from Diverse Text Sources	Conference Publication	Yes
Microblog Analysis and Auto Event Detection using an Incremental Machine Learning Technique	Apostle	Topic Mining and Temporal Trend Monitoring from Diverse Text Sources	Journal Article	Yes
Learning Object Detectors with Very Weak Supervision for Co-localization	Apostle	Exploiting Contextual Cues in Large-Scale Machine Learning	Conference Publication	Yes
What Value High Level Concepts in Vision to Language Problems?	Apostle	Exploiting Contextual Cues in Large-Scale Machine Learning	Conference Publication	Yes
Ask Me Anything: Free-form Visual Question Answering Based on Knowledge from External Sources	Apostle	Exploiting Contextual Cues in Large-Scale Machine Learning	Conference Publication	Yes
Explicit Knowledge-based Reasoning for Visual Question Answering	Apostle	Exploiting Contextual Cues in Large-Scale Machine Learning	Conference Publication	Yes

PUBLICATION TITLE	PROGRAM TITLE	STREAM TITLE	PUBLICATION TYPE	PUBLISHED
Exploring Context with Deep Structured Models for Semantic Segmentation	Apostle	Exploiting Contextual Cues in Large-Scale Machine Learning	Conference Publication	Yes
Big Data Architectures: Concerns and Strategies for Cyber Security	Defence ISR (ARP2)	Defence Big Data Reference Architecture	Conference Publication	Yes
A Reference Architecture for Big Data Systems in National Security Domain	Defence ISR (ARP2)	Defence Big Data Reference Architecture	Conference Publication	Yes
Towards a Data Science Competency Framework for Australia	Education & Training	Certification Framework	Conference Publication	Yes
Propagation of Event Content Modification in Business Processes	Integrated Law Enforcement	Head	Conference Publication	Yes
Galaxy: A Platform for Explorative Analysis of Open Data Sources	Integrated Law Enforcement	Data Curation Foundry	Conference Publication	Yes
A Systematic Review and Comparative Analysis of Cross-Document Coreference Resolution Methods and Tools	Integrated Law Enforcement	Data Curation Foundry	Journal Article	Yes
ProcessAtlas: A Scalable Service-based Platform for Business Process Analytics	Integrated Law Enforcement	Data Curation Foundry	Journal Article	Yes
Immersive Collaborative Analysis of Network Connectivity: CAVE-style or Head-Mounted Display	Integrated Law Enforcement	Immersive Information Pod	Conference Publication	Yes
Parallel Schedule View and the Braille Plot- Complimentary Visualizations for Temporal-Geospatial Colocation	Integrated Law Enforcement	Immersive Information Pod	Journal Article	Yes
State of the Art in Knowledge Extraction from Online Polls	Integrated Law Enforcement	Federated Data Platform	Conference Publication	Yes
Towards Customised Visualisation for Ontologies	Integrated Law Enforcement	Federated Data Platform	Conference Publication	Yes
Propagation of Event Modication in Business Processes	Integrated Law Enforcement	Federated Data Platform	Conference Publication	Yes

DOCTORATE BY RESEARCH STUDENTS

PHD STUDENT	START DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	EXPECTED COMPLETION DATE
Adrian Johnston	February 2015	Apostle	Large Scale Geospatial Image Understanding and Visualisation	University of Adelaide	Australia	August 2018
Ang Yang	August 2014	Integrated Law Enforcement	An information Quality Model for Big Data	University of South Australia	China	February 2018
Christopher Targett	March 2015	Apostle	Utilising context for unsupervised learning of features and their relationships	University of Adelaide	Australia	August 2018
Craig Jones	January 2015	Apostle	Automated knowledge representation using Big Data and natural language processing.	University of Adelaide	Australia	July 2018
Dinithi Jayaratne	February 2016	Beat the News	Advanced predictions in social media by incorporating user generated content	La Trobe University	Australia	August 2019
Daniel Cater	March 2015	Law and Policy for Big Data Analysis	Mass Data Analysis; National and International implications for data with limited protections	UNSW Australia	Australia	August 2018
George Stamatescu	June 2014	Apostle	Modelling Intelligent Targets using Hidden Reciprocal Chains	University of Adelaide	Australia	December 2017
Hayden Faulkner	March 2015	Apostle	Scene Interpretation from Video	University of Adelaide	Australia	August 2018
Hossein Mobasseri	February 2016	Integrated Law Enforcement	Uncertainty in Bidirectional Data Model Transformations	University of South Australia	Australia	August 2019
Jeffery Ansah	March 2016	Beat the News	Discovery and use of Twitter network structural features for civil unrest prediction	University of South Australia	Ghana	September 2019
John Steven Calvo Martinez	March 2015	Apostle	Distributed stream mining	UNSW Australia	Brazil	August 2018
John Wondoh	February 2014	Integrated Law Enforcement	Bi-temporal event driven process interoperability	University of South Australia	Ghana	August 2017
Linchao Zhu	March 2016	Apostle	Semantic indexing of large scale video	University of Technology Sydney	China	September 2019
Madhura Jayaratne	January 2016	Beat the News	Scalable big data analytics techniques for the integration of structured and unstructured info	La Trobe University	Australia	July 2019

PHD STUDENT	START DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	EXPECTED COMPLETION DATE
Marianne Rieckmann	February 2016	Integrated Law Enforcement	Ontology of graph-structured meta-data for uniform interoperable data access to distributed heterogeneous	University of South Australia	Australia	August 2019
Matt Heather	February 2016	Integrated Law Enforcement	Normative ethics as a foundation for the use of big data and artificial intelligence in Australian law enforcement	Charles Sturt University	Australia	August 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	September 2019
Peter Mathews	January 2015	Beat the News	Learning theory and algorithms for large scale probabilistic graphical models	University of Adelaide	Australia	July 2018
Ruth Frimpong	February 2016	Integrated Law Enforcement	Ontology Matching Algorithms for data model alignment in Big Data	University of South Australia	Ghana	August 2019
Sandeepa Kannangara	March 2016	Apostle	Opinion polarity classification using unstructured texts	UNSW Australia	Sri Lanka	September 2019
Seung Youb Ssin	February 2015	Apostle	Assistance of Natural User Interface, Sensor Tracking in real time for Robot teleoperation (or) 'Real time Spatial programming for Robot teleoperation'	University of South Australia	Korea	August 2018
Shayan ZaminiRad	February 2016	Integrated Law Enforcement	Query Answering and Predictive Techniques for Analyst Tasks in End-User Big Data Analytics	UNSW Australia	Iran	August 2019
Stanley Shanapinda	July 2015	Law & Policy	The dynamic relationship between national security intelligence and law enforcement powers, communication technologies and oversight in Australia	UNSW Australia	Namibia	February 2019
Tharindu Bandaragoda	March 2015	Beat the News	Real-time Cognitive Analysis for Capturing Suspicious Behaviours	La Trobe University	Sri Lanka	September 2018
Usama Salama	February 2016	Integrated Law Enforcement	End user data analytics	UNSW Australia	Australia	August 2019
Xuying Yao	June 2016	Integrated Law Enforcement	Interpretable classification and prediction of civil unrest events	University of South Australia	Australia	January 2020

PHD STUDENT	START DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	EXPECTED COMPLETION DATE
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
Md Zahid Islam	June 2016	Beat the News	Civil Unrest Events Detection from Multiple Credible Sources	University of South Australia	Bangladesh	January 2020

WITHDRAWALS

PHD STUDENT	START DATE	RESEARCH PROGRAM	PROJECT TITLE	RESEARCH ORGANISATION	COUNTRY	DATE OF WITHDRAWAL
Chaowen Huang	February 2015	1: Data Storage and Management	Studying Novel Methods for Event Detection and Tracking	University of South Australia	Australia	October 2015
Danqing Dong	March 2015	2: Analytics and Decision Support	Improving Reliability for Image Recommender Systems using Big Data	University of Adelaide	Australia	July 2015
Thomas Zola	February 2014	1: Data Storage and Management	A framework for bidirectional mappings over heterogeneous data sources	University of South Australia	Australia	September 2015

GLOSSARY OF TERMS

AFP	Australian Federal Police
AGD	Attorney-General's Department
AGM	Annual General Meeting
ANZCTC	Australia-New Zealand Counter-Terrorism Committee
API	Application Programming Interface
APS	Australian Public Service
ARC	Audit and Risk Committee
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.
CIPAC	Commercialisation and IP Advisory Committee
CMU	Carnegie Mellon University
CRC	Cooperative Research Centre
D2D CRC	Data to Decisions Cooperative Research Centre
DIBP	Department of Immigration and Border Protection
DFAT	Department of Foreign Affairs and Trade
DNSAC	Defence and National Security Advisory Committee
DST Group	Defence Science and Technology Group
DTC	Defence Teaming Centre
FY	Financial Year
ICT	Information Communication Technology
IoT	Internet of Things
IP	Intellectual Property
ISR	Intelligence surveillance and reconnaissance
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.
NICTA	National ICT Australia is Australia's Information Communications Technology Research Centre of Excellence
ONA	Office of National Assessment
R&D	Research and Development
RAC	Research Advisory Committee
ROI	Return on Investment
SES	Senior Executive Service

SMEs	Small to Medium Enterprises
UniSA	University of South Australia
UNSW	University of New South Wales
UoA	University of Adelaide
Virginia Tech	Virginia Polytechnic Institute and State University, Blacksburg VA, USA
WDP	Wellbeing Data Platform

GOVERNMENT

INDUSTRY

UNIVERSITY AND RESEARCH