

UNCLASSIFIED



Australian Government

Department of Defence

Science and Technology

Partnering with Joint and Operations Analysis Division

DR Brian Hanlon – a/Chief JOAD

DST
GROUP

Science and Technology for Safeguarding Australia

Major Science & Technology Capabilities

- Maritime Mathematical Science
- Maritime Simulation, Experimentation & War-gaming
- Maritime Systems Analysis
- Australian Maritime Warfare Centre

Maritime
Capability
Analysis



- Joint Warfare Mathematical Science
- Joint Organisation & Social Science
- Joint Simulation, Experimentation & War-gaming
- Defence Systems Integration
- Defence Operations Support Centre
- Scientific Adviser CJOPS

Joint Capability
Analysis



- Land Mathematical Science
- Land Organisation & Management Science
- Land Simulation, Experimentation & War-gaming

Land Capability
Analysis



- Strategic Analysis
- Force Design
- Technology Forecasting & Futures
- Strategic Security Risk Assessment

Strategic
Capability
Analysis



- Aerospace Mathematical Science
- Aerospace Organisation & Management Science
- Aerospace Simulation, Experimentation & War-gaming
- Aerospace Systems Analysis

Aerospace
Capability
Analysis



- Planning and Logistics
- Situation Assessment
- Command Intent
- Behaviour and Control

Decision Sciences



Trusted Autonomy,
Behavior, Complexity and
Control

Principal
Scientist



Joint & Operations Analysis Division – Partnering Highlights

- Signed a collaborative research funding and review program with U.S. AFOSR in May.
- Partnered with RMIT to develop an advanced Helicopter Aircrew Training System assessment tool.
- Partnering with USAF Headquarters A9, AFRL, US Navy (NAVAIR) and Australian academia (University of Melbourne and RMIT University) to develop the next generation air combat modelling and simulation
- Invitational Symposium on Trusted Autonomous Systems (ISTAS) with world-class national universities and international academic and Defence partners in May.



100
Agreements
 Last 5 years

45
Research Agreements
 Last 5 years

14
Types of Agreements
 Last 5 years

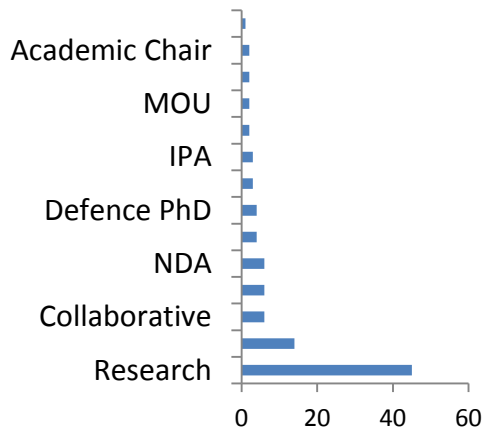
31
External Parties
 Last 5 years

8.3 mil Total
Budget Last 5
 years

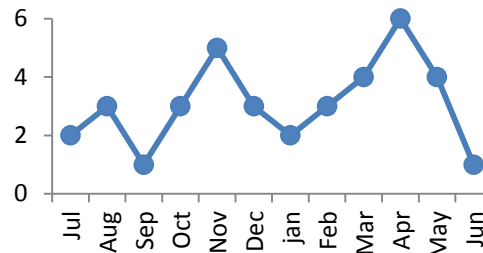
2 business days
Average Sign off time
for CJOAD Last
 1 year

10 business days
Average Sign off time
for External Parties Last
 1 year

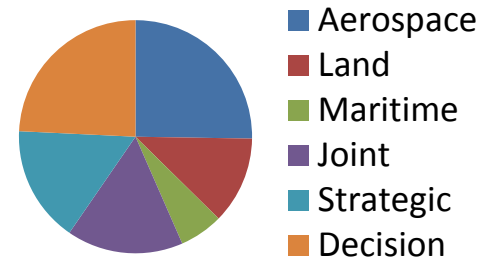
Agreement Types



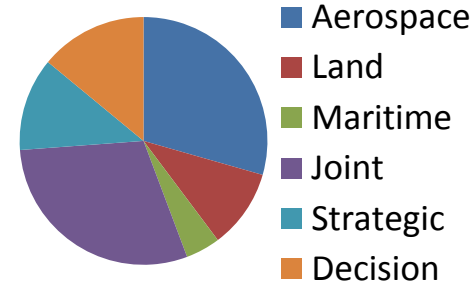
Executed Agreements 2015-16



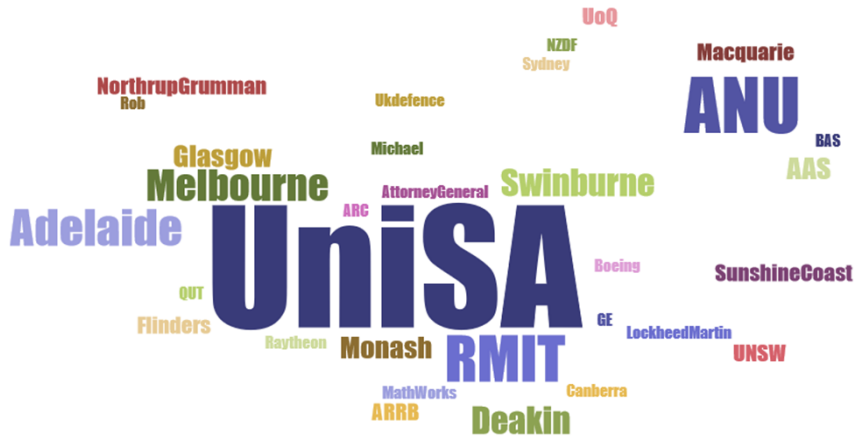
MSTC Agreement Distribution



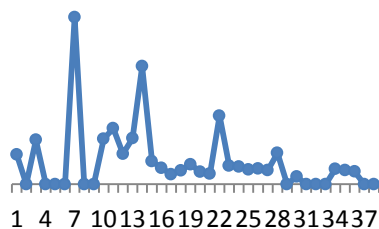
MSTC Budget(\$)
Distribution



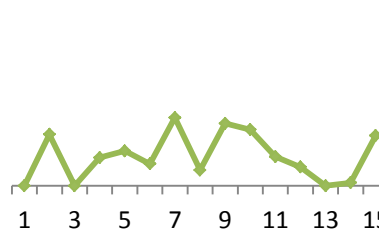
External parties



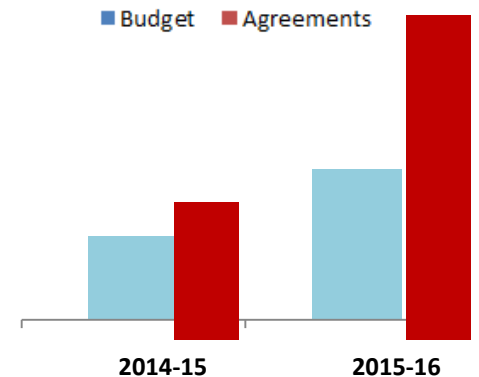
Budget (\$) for each Executed Agreement 2015-16



Budget (\$) for each Executed Agreement 2014-15



Budget (\$) and Agreement Distribution



Joint & Operations Analysis Division – Partnering Opportunities

- Operations Analysis
- Capability Analysis
- Wargaming
- Complex System Evaluation
- Visualisation
- Machine Learning
- Autonomy
- Technology Futures



To support the S&T Acquisition within Defence, the future force, along with the force-in-being, and S&T Support to Operations.





DR Dale Quinn

a/RL Aerospace Capability Analysis

INTEGRATED AEROSPACE OPERATIONS



The Changing Face of Australian Air Power



Joint Strike Fighter F-35
Lightning II



P-8



F/A-18F Super Hornet



ARH Tiger



Wedgetail AEW&C



MRH-90



C-17 Globemaster

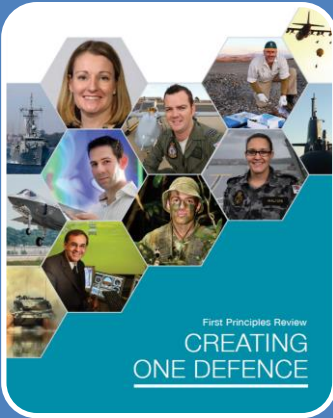


KC30B Multi-Role Tanker
Transport

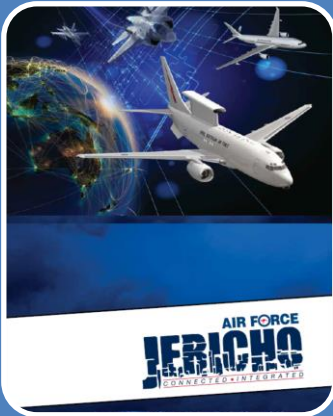


C-27J





A strong, strategic centre to strengthen accountability and top level decision-making



Plan Jericho is Air Force's plan to transform into a fully integrated force that is capable of fighting and winning in the information age.



Opportunities for Collaboration



- Advanced Metrics
- Advanced Methodologies
- Multi-Resolution Modelling
- Advanced Visualisation





DR Jim Smelt

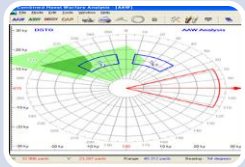
RL Maritime Capability Analysis

MARITIME CAPABILITY ANALYSIS



MARITIME CAPABILITY ANALYSIS

Uses the techniques of operations research and analysis (mathematical modelling, simulation, experimentation, wargaming, systems analysis, data analytics) to support evidence-based decisions on Navy's Force structure, warfighting concepts, acquisition of systems, operational effectiveness and capability management



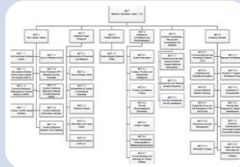
Modelling and simulation tools



Partnerships



Warfare domain knowledge



Maritime Force Assessment Framework



Access to the warfighter

- Experimentation facilities
- Expert elicitation tools



Operational Data



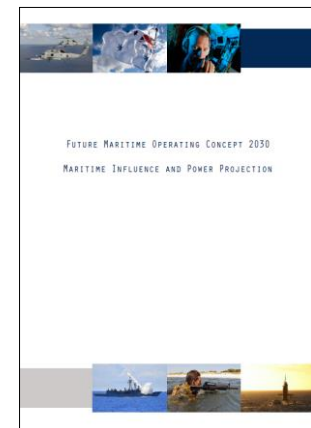
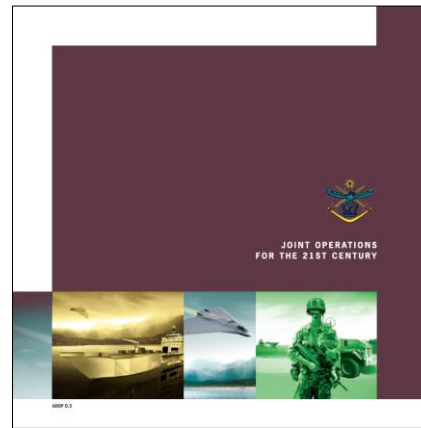
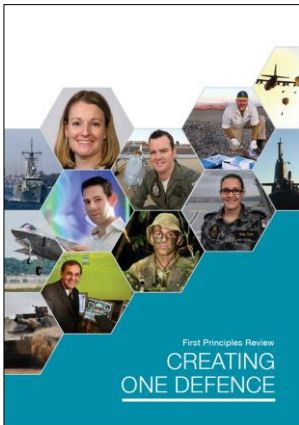
Skilled Research Staff



Creating and Shaping the Future Force – Strategy and Concepts Phase

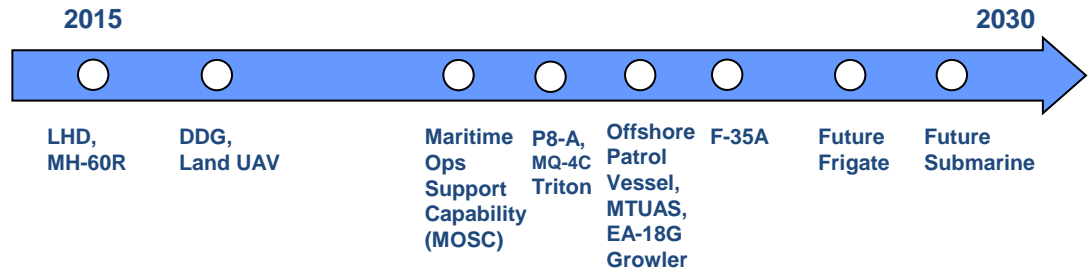
Conduct maritime force analysis and maritime experimentation to provide

- Future concept development, exploration and testing leading to future task group operating concepts
- Analysis of options for the Future Maritime Force to inform Defence's Force Design process



Creating and Shaping the Future Force

- Risk Mitigation, Requirement Setting & Acquisition Phases



Support Maritime Capability Acquisition

- Analysis to generate requirements
- Analysis and evaluation of options



Maritime Capability Analysis - Partnership Opportunities

- Support improvement in scope, flexibility and responsiveness of our modelling and simulation toolbox
- Research and develop expert elicitation tools to improve accuracy and efficiency of interactions with the warfighter
- Assistance with options for better capture, storage, management and exploitation of exercise and operational data
- Provide specialist training for research staff in new tools and techniques
- Student placements/internships, e.g.
 - Data analytics
 - Simulation
 - Mathematical modelling





DR Lin Zhang

a/Research Leader Land Capability Analysis

LAND CAPABILITY ANALYSIS

Land Capability Analysis: Modelling combined arms close combat



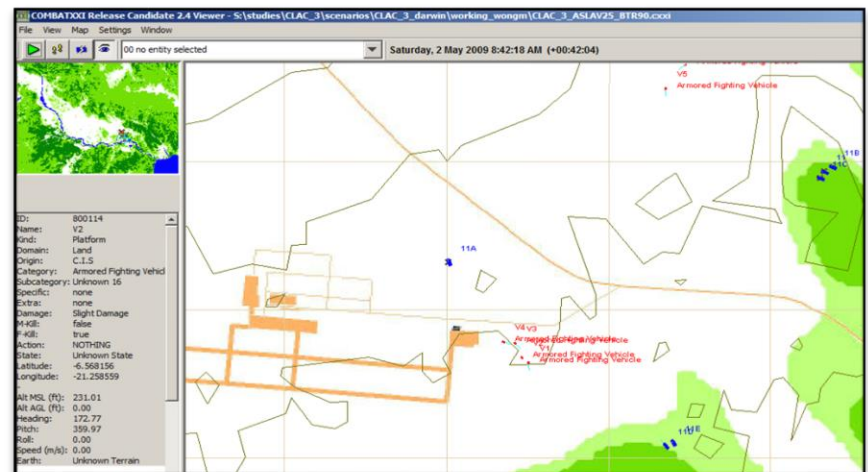
Close combat is Army's core capability. Success in close combat depends on having the right mix of elements in the Combined Arms Team in the fight.



This research will advance modelling and simulation of Land Close Combat in order to better understand the contributions made by elements of the Combined Arms Teams to close combat effectiveness; ensuring that Army has the required mix of capabilities to succeed at close combat into the future.

Partnership Opportunities

- Statistical design of experiments
- Simulation input data generation and representation
- Simulation scenario development and representation
- Simulation based data analytics
- Human in the loop simulation
- Simulation software development



LCA: Evaluating the impact of ground combat enablers



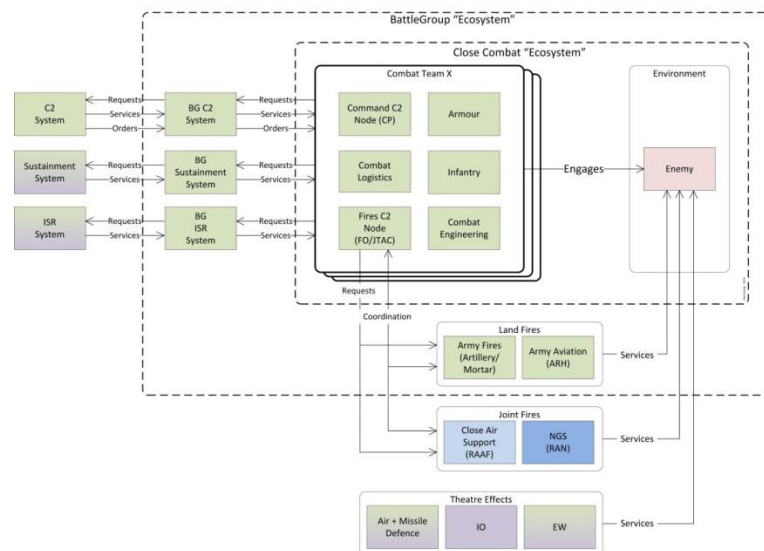
The effectiveness of ground manoeuvre warfare depends on effective and balanced combat enablers.



This research goal aims to develop operational effectiveness models, tools and techniques that provide a clear understanding of how various land combat enablers including situational understanding, C3 and combat support, as well as joint enablers, impact the operational effectiveness of the reinforced combat brigade engaged in joint land manoeuvre.

Partnership Opportunities:

- Mathematical modelling and optimisation
- Statistical experiment design
- Data mining and predictive analysis
- Systems modelling and component modelling
- Inferential statistics



LCA: Establishing Land Analytical Wargaming Capability



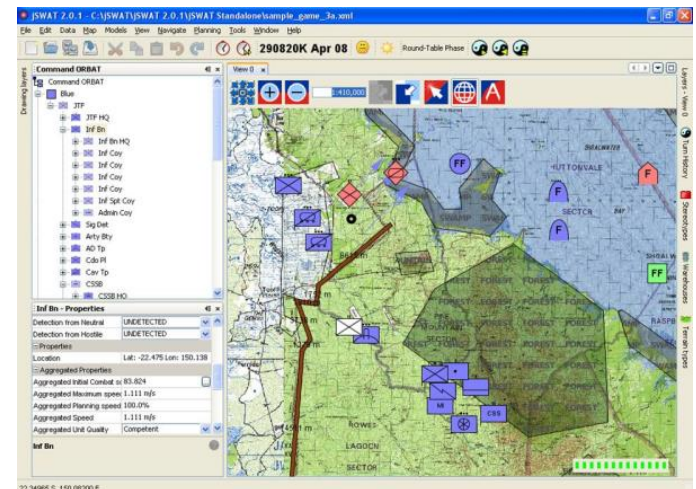
Analytical wargaming is an important tool for understanding the complexity of modern warfare that is centred around the competitive interactions of key elements within a flexible warfighting framework. This research goal aims to establish a wargaming capability that fosters the development of wargaming analytical models and techniques through internal and external collaboration.

This research will leverage JOAD's war-fighting domain knowledge and access to privileged Defence information, partnered with related industry and academic expertise.

The expected outcome of this research will develop tools and methods that will enhance the understanding of land and joint force effectiveness and so contribute to future-proofing the ADF and enhance the contestability of whole-of-force evidence based assessments.

Partnership Opportunities:

- Methodology development for wargaming
- Red teaming and seminar wargaming tools and techniques
- Use of analytical wargames in military experimentation
- Scenario construction and analysis





DR Richard Davis and DR Nigel McGinty

STRATEGIC CAPABILITY ANALYSIS



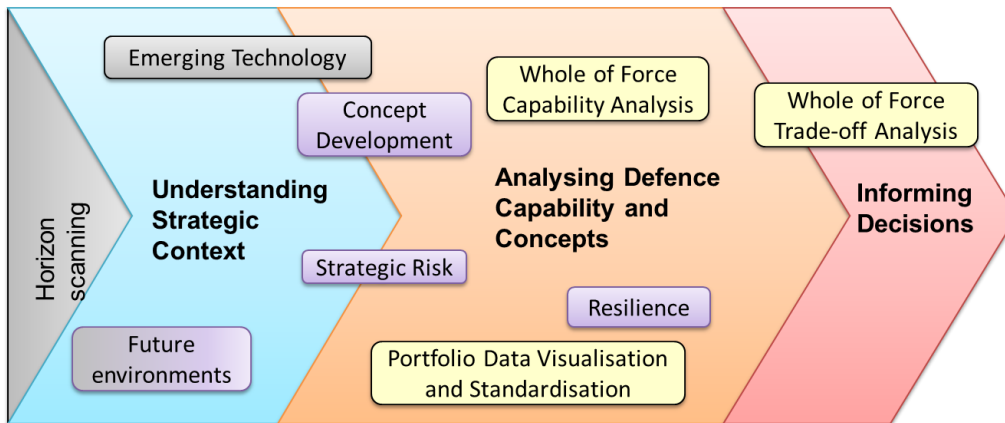
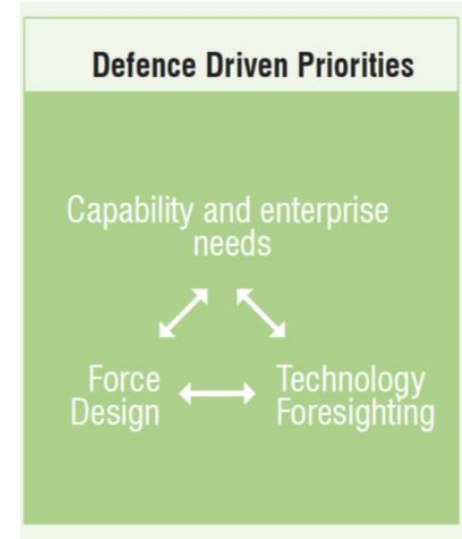
Opportunities for Collaboration:

Technology Forecasting

- Development of methods for robust future technology forecasting.

Force Design

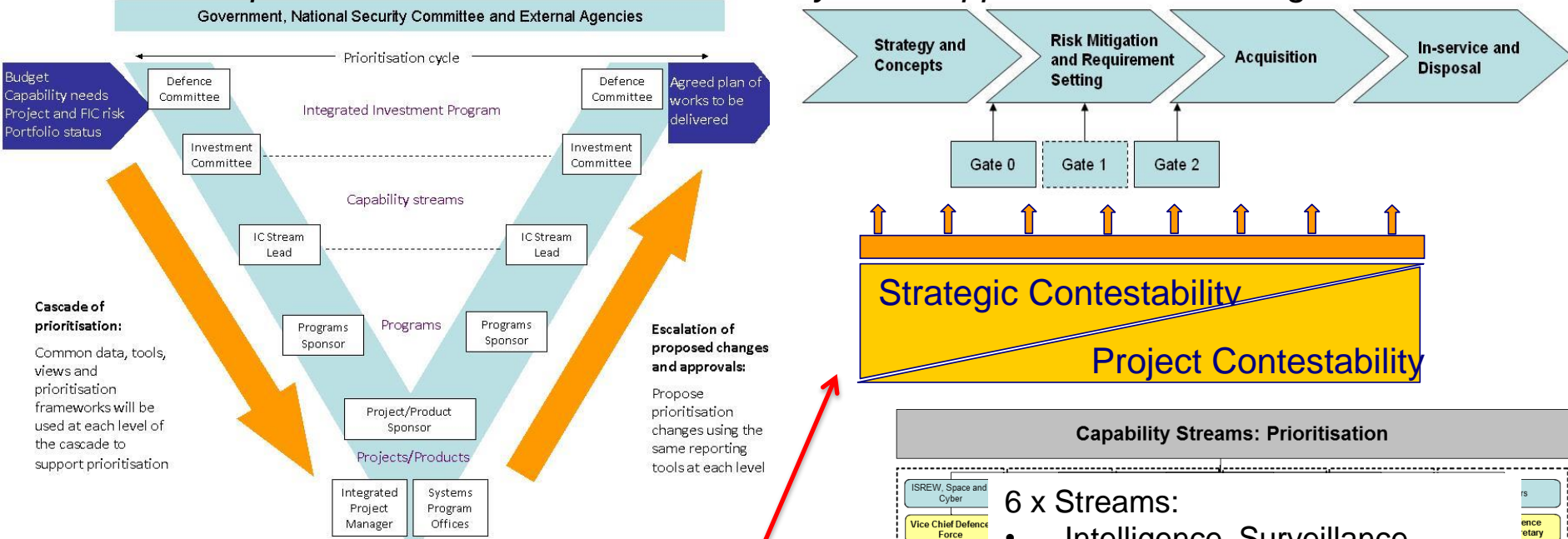
- Complex Systems Evaluation.
- Advanced visualisation.



Strategic Force Design

Force Design: underpinning the new Capability Life Cycle

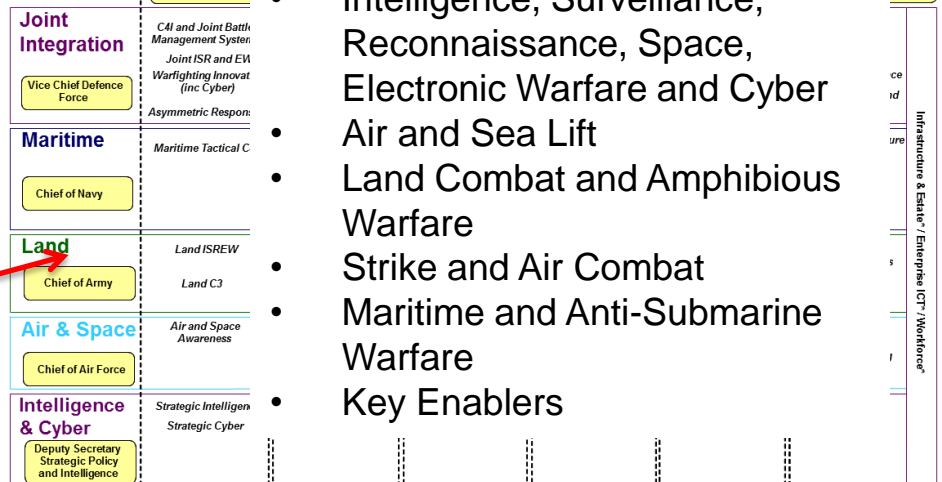
DST Group role – robust evidence based analysis to support decision making



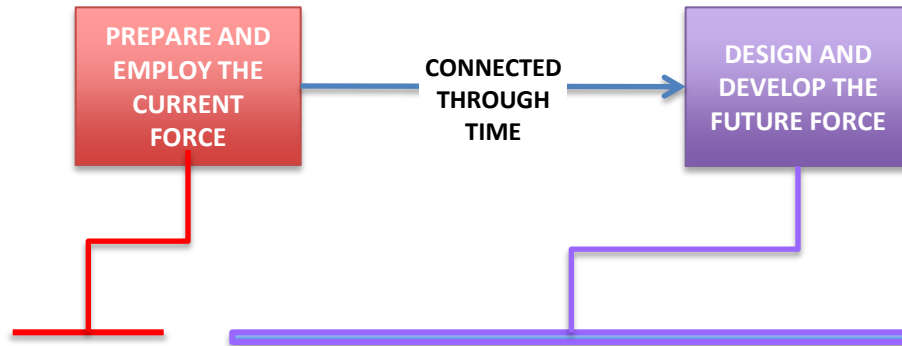
Force Design is now central to:

- Integrated Investment Program
- The CLC and Contestability
- The Capability Streams

Capability Manager Domains



Strategic Force Design



The Force Design	Current	Planned	Future	Conceptual
Force Design Testing	Observation	Assessment	Estimation	Speculation
Force Design Change Actions	Solutions	Adjustments	Initiatives	Hedges
	0yr	10yr	20yr	30yr

Our centre of gravity

Collaboration opportunities

- capability analysis
- whole-of-force design modelling
- prioritisation and resource allocation
- complex systems evaluation
- cost and benefit-cost investment analysis
- multi-dimensional visualisation

Technology Foresighting and Futures



TECHNOLOGY FORESIGHTING & FUTURES

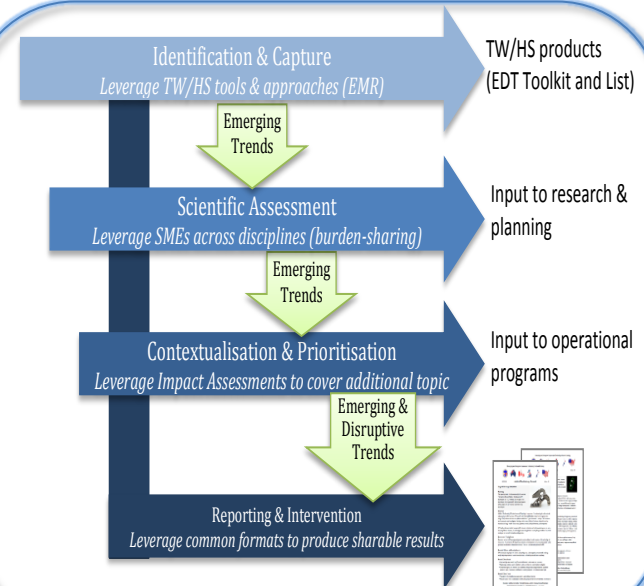
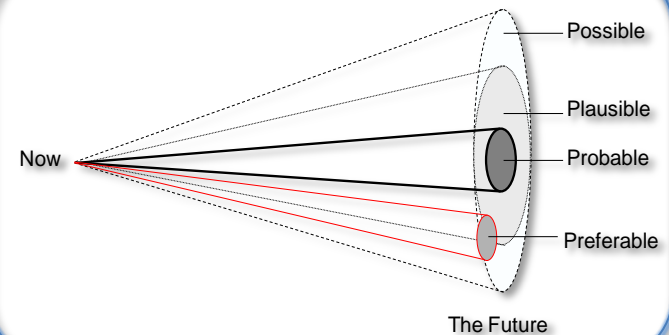
Provide input to and guidance across Defence on:

- Avoiding strategic surprise
- Future Operating Environments
- Inform Investment decisions

A systematic process of analysis to describe requirements for emergence of and prospective impact of a technology; to develop insight into possible future technological capabilities and their attributes in relevant scenarios.

•Partnership Opportunities:

- Universities – EDTAS, methodologies & technology assessments.
- Industry – EDTAS & technology assessments
- Academy of Sciences: Joint Foresight Assessments



EDTAS 2015 – TRUSTED AUTONOMY



- *Objective:* to understand and shape the long term vision for Trusted Autonomous Systems to influence national dialogue and guide longer term investments by Defence.
- *Focus:* on Trusted Autonomous Systems to support humanitarian assistance and disaster relief (HADR).
- Partnered with UNSW & Noetic Group to deliver the event.
- *Strengths of the symposium:* Senior and strategic focus, interactive and multi-disciplinary approach to a specific technology sector.



EDTAS 2017

- The theme for EDTAS 2017 will be:

Information, Knowledge and Digital Disruption



- Future topics will consider:
 - **Biotechnologies**
 - **Future Manufacturing and Advanced Materials**
- We are seeking event partners to host the event and develop program.
 - academic and industry partners are being sought.





DR Duncan Craig

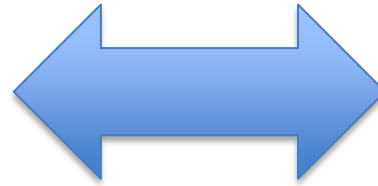
RL Joint Capability Analysis

“JOINT FORCE INTEGRATION BY DESIGN”

Joint Force Operations – anticipating the future



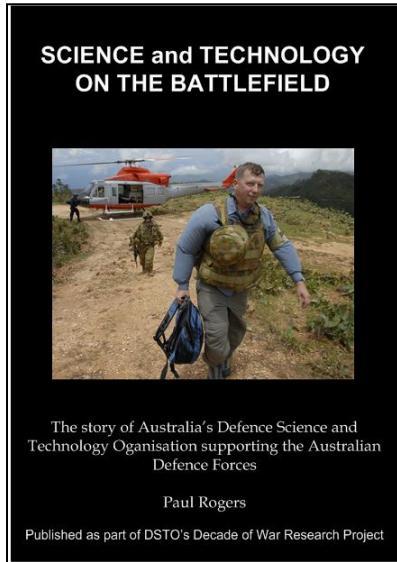
Learning Lessons
Operational Evaluation



Understanding Emerging
Operational Risks
Technology Forecasting
& Red Teaming

- Data mining and filtering
- Lessons analysis
- Organisational learning techniques (to help exploit the value of lessons learned)
- Links to the DST Group technology Divisions
- Risk analysis techniques
- Modeling and Simulation tools

Joint Force Operations - urgent S&T support to current operations



Mission

To enhance ADF operational effectiveness and mitigate operational risk.

Figures (15 years)

- 121 operations analysts within deployed HQs
- 166 on 'Fly Away Teams' for specific field studies
- 11 embedded specialist S&T staff
- 165 Operational Urgent S&T Projects conducted

Joint Capability Analysis - Partnership Opportunities

- Research and development of system-of-systems techniques and tools that can support the CLC / achievement of Joint Force by Design
- Development and application of organisational psychology techniques in support of culture change that enables “Joint” / leverages lessons learned
- Research and develop expert elicitation tools tailored to ‘program-level’ capability integration
- Assistance with options for better capture, storage, management and exploitation of exercise and operational data
- Simulation environments that support decision making in the joint capability arena





DR Jason Scholz

Program Tyche Lead

**PROGRAM TYCHE –
TRUSTED AUTONOMOUS SYSTEMS
STRATEGIC RESEARCH INITIATIVE**

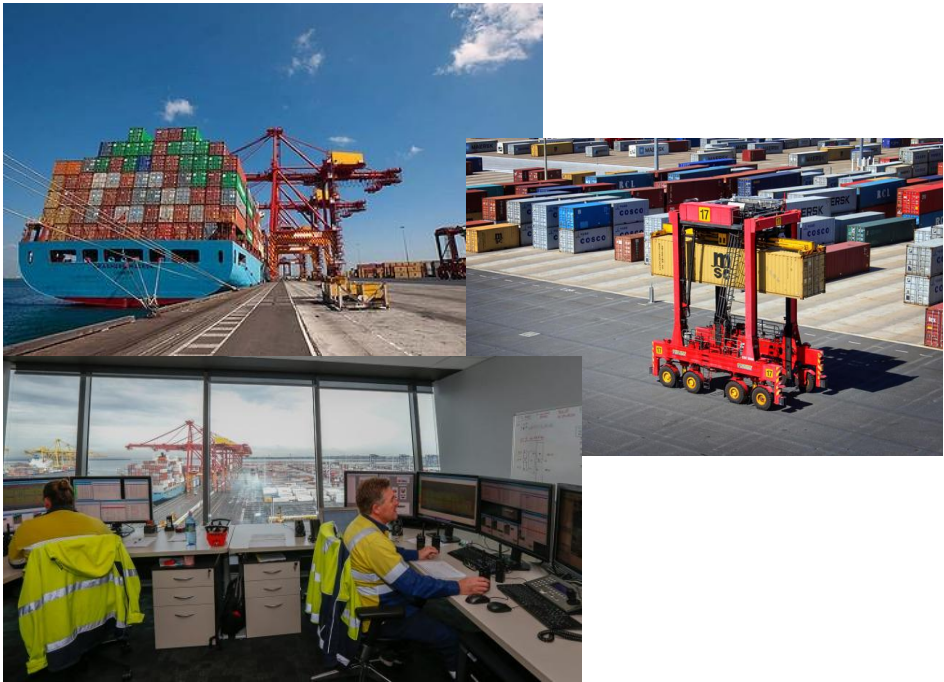


Trusted Autonomous Systems

- Started 1 July 2015
- Moving to a 'Defence CRC' model soon
- Aims to place DST Group and Partners in the World's Top Five in trusted autonomous systems (TAS) in 7 years
- Focused research question
- Smooth a path for industry and transition to Defence
- Defence White Paper NGT Funded



Australia has developed World-Class Autonomous Systems



Port Botany container handling fully automated from April 2015. (ACFR, University of Sydney, Patricks)



Rio Tinto 'Mine of the Future' Autonomous drills, trucks, train. (ACFR, Rio Tinto)



Defence Autonomous Systems



Global Hawk flies US to Australia and operates out of RAAF Edinburgh in 2001.

DSTO scientist and Project Director, Dr Jackie Craig, led the Australian R&D team.



ScanEagles 2007-2012 in AFN, flew 6,200 missions 32,000hrs

Shadow 200 deployed from March 2012

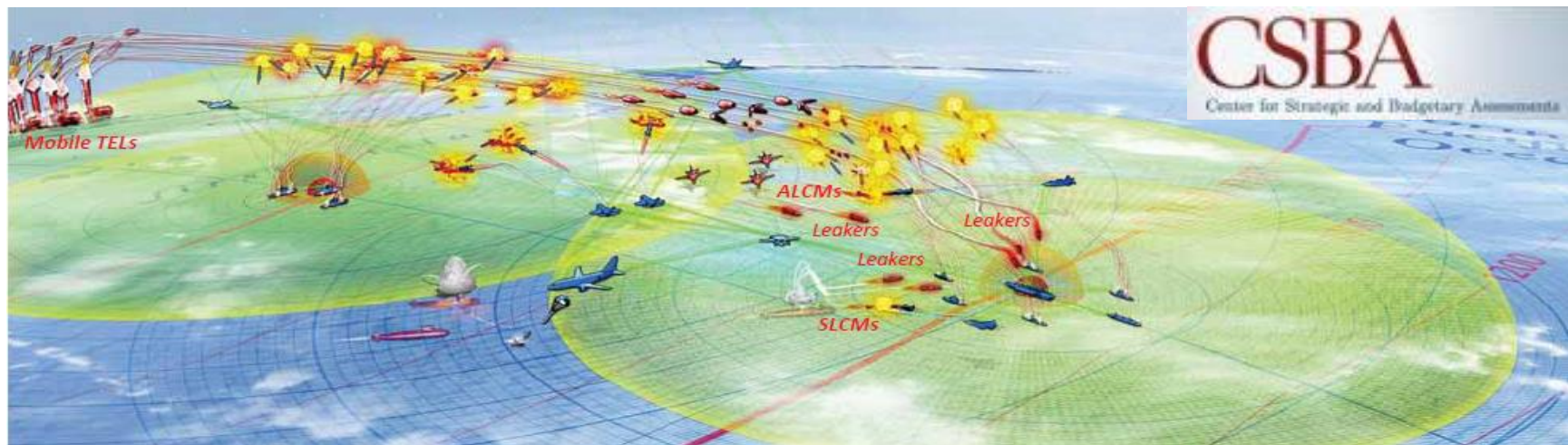


RAAF Heron 2010-2012 AFN. Since 2012 used for training prior to introduction of MQ-4C Triton



US Third Offset Strategy

- Adversaries are developing their own ISR-strike networks—with emphasis on missile systems – to challenge conventional US power projection
- Global Surveillance and Strike (GSS) network
 - UAV and UUV emphasis with submarines, stealthy deep strike, hypersonics, cyber
 - Persistent operation in denied areas (wide area, long range)
 - Access to Space degraded or denied (ISR, Communications, GPS), ships too vulnerable
 - Human-on-the-loop, minimal manned platform exposure
- ***“Premium on survivable forward presence and global responsiveness”***



Research Themes

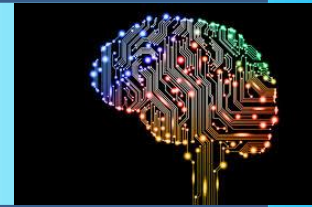
Autonomy Resilience

Philosophical and mathematical bases for dealing with uncertainty;
Significantly reduce exposure to harmful consequences;
Guaranteed to not exceed boundary conditions; new means to
certify for ADF use.



Cognitive Machines

Fast reactive and simultaneous slow logical “thinking”;
Machine high-level fusion, planning and intent subject to uncertainty;
Large scale control of machines; Machine-machine interaction
and tasking.



Trustworthy Partners

Interacting hybrid teams more effective than human-only teams;
Understand organisation changes required to acquire and operate;
Trust of machines; Mission Command of machines.



Embodied Intelligence

Evolutionary robotic design;
Multi-modal perception and control;
Lifetime learning and evolution of systems;



TTCP Autonomy Strategic Challenge

Littoral: Base protection, Critical infrastructure protection, Counter-smuggling

- 2016 C2 Systems Trials (US,UK,AS)
- 2017 Platform Autonomy Trials (US,UK,CA,NZ)
- 2018 “Autonomous Warrior” Trial (AS Nov)

Australian Defence Vessel (ADV) Ocean Shield for UxV launch, command and control, recovery



Objectives

- Human “on the loop” control of multiple simultaneous UxV missions
- Machine-learned plans
- Minimal operator interaction
- Autonomous systems that assess intent by probing / interaction
- Littoral threats and unknowns (manned & unmanned)



SAAB

AOS™



TTCP



The Technical Cooperation Program



DST GROUP

Science and Technology for Safeguarding Australia

Academic Impact

New mathematical foundations

Non-ergodic strategies

New machine cognition

Machine learning

**New human-autonomous systems
interaction**

Novel autonomous systems

UUV glider, Novel sensors & control

Defence-Industry Impact

3rd Offset Strategy capabilities

Theatre Anti-Submarine Warfare

**Autonomous Ops in Urban
Environments**

**5th Generation Command &
Intelligence Systems**

**Autonomous distribution: warehouse
to foxhole**

Summary

- TAS program seeks game changers for warfare
- Scoping a Defence CRC in Trusted Autonomous Systems
- Comprehensive new program
- Get involved from the beginning
- Your opportunity to shape a “Defence CRC” model in this area





Joint and Operations Analysis Division Contacts

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Trusted Autonomous SRI – Lead
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- Dr. Richard Davis
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