Partnering with
Joint and Operations Analysis Division
Joint and Operations Analysis Division undertakes rigorous scientifically-based analysis of Defence operations and capability.
Major Science & Technology Capabilities

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

**Joint 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

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

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

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

**Decision Sciences**
- Planning and Logistics
- Situation Assessment
- Command Intent
- Behaviour and Control

**Trusted Autonomy, Behavior, Complexity and Control**

**Principal Scientist**
Opportunities for Collaboration: Technology Forecasting and Force Design

Strategic Analysis

Development of methods for robust future technology forecasting.

Force Design

Complex Systems Evaluation.

Advanced visualisation.
Opportunities for Collaboration: Acquisition Support

Land Combat Vehicle System

War-gaming & Experimentation

Simulation

Development of operations research techniques for comparison of Army mounted combat system options
Opportunities for Collaboration: Autonomy & Situational Awareness

Trusted Autonomous Systems

Operations analysis to capture need and uncertainty.

New approaches to machine cognition.

Human/Machine interaction.

Technology development and transition.

Enhanced Situational Awareness

Advanced capabilities that can capture the story behind the data.
Summary

Joint and Operations Analysis Division is engaged across the capability spectrum
Future Technology Forecasting
**Technology Forecasting & Futures**

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

**Technology Forecasting & Futures**

- Provide input to and guidance on:
  - Avoiding strategic surprise
  - Future Operating Environments
  - Inform Investment decisions

**Strategic Capability Analysis**

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-CENTRIC FORECASTING AND FUTURES PROCESS

- Identification & Capture
  - Leverage TW/HS tools & approaches (EMR)
  - Emerging Trends

- Scientific Assessment
  - Leverage SMEs across disciplines (burden-sharing)
  - Emerging Trends

- Contextualisation & Prioritisation
  - Leverage Impact Assessments to cover additional topic
  - Emerging & Disruptive Trends

- Reporting & Intervention
  - Leverage common formats to produce sharable results

- TW/HS products
  - (EDT Toolkit and List)

- Input to research & planning
- Input to operational programs

- General Australian Perspective
- Other Countries Defence and Intelligence Perspectives
- Academic Literature and patent data
- Industry Perspectives and Popular Literature
- Global Institutions (UN, OECD, ILO)
PARTNERSHIPS

• Impact across Defence: DSTO, Strategy group, VCDF, Services.

• External:
  – Universities
    • Emerging and Disruptive Technology Assessment Symposium (EDTAS)
    • Technology Assessments
  – Academy of Science
    • Joint Foresight Assessments
  – National Security
  – CSIRO
    • Mega-trend analysis
  – TTCP JSA TP9
    • International collaborations
CONTRIBUTING PATHWAYS

CAPABILITIES

• Depth of knowledge with ‘reach-back’ into wider DSTO experts
• Ability to leverage from academic partnerships and international communities
• Ability to contextualise technologies in a future environment
• Modelling & simulation test-bed and development environment
• Emerging and Disruptive Technology Assessment Symposium (EDTAS) – Trusted Autonomy
• Red teaming capabilities including workshop and war-gaming support

EXPLOITATION of PRODUCT

• Collaborative ‘blue-red’ briefs (Joint assessments)
• Emerging technology watch, issues papers and reports
• Capability ‘concept’ cards
• Biannual Strategic S&T Estimates
• Support to developing future operating concepts and scenarios
• Independent credible assessment of capabilities within defined scenarios
• Input to FSR and Defence Whitepaper
• Contribute to export control considerations
Strategic Force Design
Strategic Force Design

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

Our centre of gravity
Acquisition Support
Simulation-based acquisition

- Capability analysis
- Data representation and visualisation
- Combat simulation
- Cost and capability trade off analysis
- Multi criteria decision analysis
Army’s Mounted Combat System Transformation

**LAND 400**
Land Combat Vehicle System
- Reconnaissance, Fire Support & Lift
- Enhanced Firepower & Survivability
- Enable Future Combined Arms Teams
- Acquisition Cost >$10b

**LAND 907**
Tank Upgrade
- Enhanced capability

**Mounted Combat Reconnaissance Capability**
- ASLAV Replacement
- Request for Tender 2015
- ~225 vehicles

**Mounted Close Combat Capability**
- M113 Replacement
- Subject to White Paper

**Heavy Assault Capability**

*DSTO explores the operational effectiveness of L400 candidate options*
Combat Simulation

- **Objective** - Improve combat effectiveness of the combat brigade.
- **Method** - Competing systems are run through a set of battlefield evaluations using a high-resolution simulations of the combat environment to evaluate the trade-offs.
- **Example** - What is the “battlefield impact” of changing the calibre of the cavalry vehicle cannon from 25mm to 40mm?

Method delivers statistically supported findings ... such as: *In this test the weapon change made no significant difference.*
There is an opportunity for industry to partner with DSTO in the delivery of operations research support to Land 400, particularly around combat simulation.
Trusted Autonomous Systems
Strategic Research Initiative
Summary

- Aim for World’s Top 5 in *autonomous* systems R&D in 7 yrs
- Coordinated focus on a single unified research question
- Develop new DSTO and academic research capabilities
- Smooth a path for industry and transition to Defence
- Significant outcomes planned in science and technology
- Intention to partner with the best
Automation vs Autonomy

Autonomy has been “just around the corner” for 20+ years but never arrives?

- Hyundai autonomous car competition called off after rain - Oct 2014
- DARPA Robotic Challenge winner SCHAFT opens a door but gets a surprise - Dec 2014
- Deutsche Euro Hawk cancelled deemed unverifiable without massive expense - 2013

• The autonomy we dream about and the automation we currently posses

• “Four elements make up the climate of war: danger, exertion, uncertainty and chance” Clausewitz (1834/1984)

• The research question centres on systems that deal with uncertainty / unpredicted events.
Research Themes

Foundations of Autonomy
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.

Platforms, Sensors & Effectors
Exploit existing and develop new: sensors, platforms, materials & propulsion;
Sound validation and test with increasing accuracy of uncertainty (simulation to field);
Innovations with high technical risk, but low strategic program risk.
Academic Impact

New mathematical foundations
- Viability of actions subject to hard constraints
- Resource allocation under uncertainty
- Online verification

New machine cognition
- Extreme event cognition
- Integrating fast and slow “thinking”
- Metacognitive strategies
- Context-based fusion
- Planning under uncertainty
- Intent creation & policy management
- Information processing role of glial cells

New machine interaction
- Human trust and acceptance
- Social agreement protocols & teaming
- Mixed initiative decisions
- Organisational plasticity

Novel autonomous systems
- Legal and ethical decision support
- New forms of OA based on uncertainty

Defence-Industry Impact

Autonomous Ops in Urban Environments
- New smart algorithms retrofit OTS platforms
- Situation awareness inside cities
- Communicate awareness to C2 centres and traversing forces

5th Generation Command & Intelligence Systems
- Autonomous agent partners that recognise context, role, intentions, respond to dialogue and generate narratives
- Integrate sensors with dynamic context information
- Identify emerging conflict hot spots, objects and relations of interest

Autonomous Distribution: warehouse to foxhole
- Reduce signature with smaller payloads, diversify lines of communication.
- Autonomous transport, material handling, drop-and-swap, ordering, routing.

Anti-Submarine Warfare
- UUV’s for persistent surveillance at greater depth
- Long range and endurance, complement future submarine fleet
Summary

• This autonomy R&D program may be a game changer for warfare

• Autonomy for uncertainty is the main research focus, but does allow for automation research in niches
  o Sometime efficiency has effectiveness alone!

• A “Defence CRC in Trusted Autonomous Systems” likely

• Potential for significant value for allies due to focus & scale

• Comprehensive new program starts 1 July 2015
  o Provisional & changing program as new knowledge is uncovered & shared

• Opportunity to get involved from the beginning
Enhanced Situational Awareness
Telling The Story Behind The Data...

- Information fusion technologies automatically identify the nature of an evolving situation (the scenario) from ‘the data’

- Automated systems convey this to an audience as tailored multimedia narrative:
  - Intelligent Virtual Agents engage the audience’s attention and convey non-verbal cues.
  - Coordinated multimedia content provides aural and visual aids to storytelling.

- Challenges include:
  - Factors affecting audience engagement
  - Modelling audience requirements
  - Dialog and other feedback
  - Content selection
  - Automated narrative generation
  - Media assignment and orchestration
  - Automatic behaviour generation for intelligent virtual agents.
Questions
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