Australian Government
Department of Defence
Science and Technology

Weapons and Combat Systems Division

Dr Shane Canney
Acting Chief Weapons and Combat Systems Division

Weapons and Combat Systems Division (WCSD)

Vision: To be at the forefront of the application of science and technology to tactical warfighting systems and operations.

Mission: Delivering a capability edge to the tactical war fighter.

Strategy:

- Focus on Integrated Tactical Systems
  - Leverages deep technology basis in weapons and combat/mission systems
  - Strengthen our understanding of threats
  - Understand ADF tactical capability against future threats in a complex environment.
- Shift towards future Weapons and Combat/Mission System Technologies

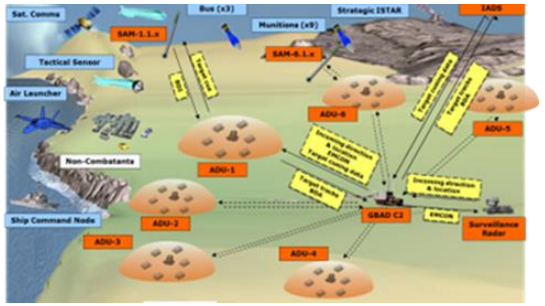
WCSD Capabilities

• Advanced Modelling and Simulation • Weapons Modelling and Analysis • Combat Systems Effectiveness and Analysis	• EO Sensors and Processing • RF Sensors and Processing • Guided System Technologies and Evaluation	• Electronic Systems Integration • Information Processing and Human Sciences • Information Architectures and Networking	• S&T Program coordination • Divisional Operations • Work Health Safety, Security, Facilities	• Land Weapons Technologies • Weapons Effects and Protection	• Explosives and Pyrotechnics • Weapons Propulsion	• Analysis of Threat Systems • Developing S&T capability to deliver on Intelligence requirements • Support ADF platforms and personnel

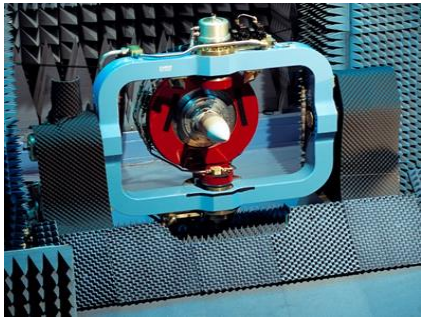
WCSD Major Science and Technology Capabilities

Combat and Mission Systems: Research into combat and mission systems for maritime and airborne platforms, and the tactical networking between air, sea and land platforms.

Weapons and Combat Systems Assessment: Assess individual weapon system performance and end-to-end tactical system effectiveness.



Weapons Guidance Technology: Undertakes research, development and analysis of advanced guidance technologies, electro-optic and radio frequency seekers, and integrated guidance systems of modern weapons.

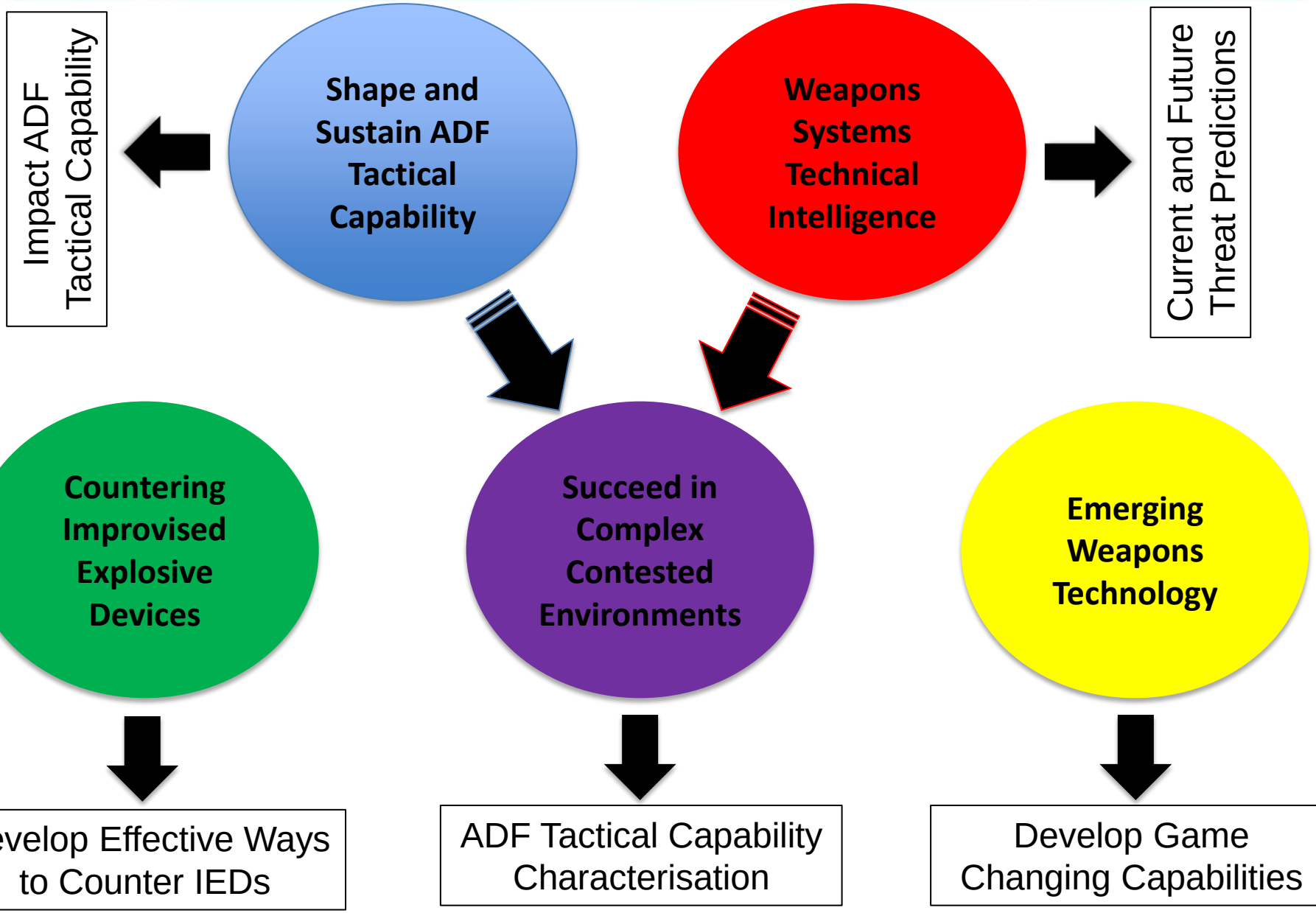


WCSD Major Science and Technology Capabilities

Energetic Materials and Systems: Research into energetic materials (propellants, explosives, & pyrotechnics) and energetic systems relevant to Defence & National Security.

Land Weapons Systems and Effects: Supports all aspects of ADF unguided weapons and the effects that weapons have on platforms and personnel.

WCSD Programs



Opportunities to Connect, Partner, Collaborate and Innovate

- Foster support for open systems approaches to the development and acquisition of tactical systems
- Human Systems Integration
- Advanced Modelling and Simulation technologies
- Integrated advanced seeker technologies
- Transformative energetics
- Protection of people and structures against explosive events
- Sustainment of weapon systems (safety and life of type)
- Development and integration of advanced seeker components (SPAD, LADAR and hybrid IIR/LADAR)
- Future weapon system technologies and prediction of weapon performance

Australian Government
Department of Defence
Science and Technology

Combat and Mission Systems Partnering Opportunities

Combat and Mission Systems

Presented by: Mr Paul Heuer

Combat and Mission Systems Branch - Overview

The tactical systems integration S&T focal point for enhancing ADF warfighting capability

Current Force

8 FFHs (ANZAC)

6 AEW&C

Force-In-Acquisition

8 ASMD ANZACs

8 P-8As

6 AEW&C+

3 DDGs

72 JSF

Future Force

Future Frigates

P-8As

Future AEW&C

MUAS

72 JSF+

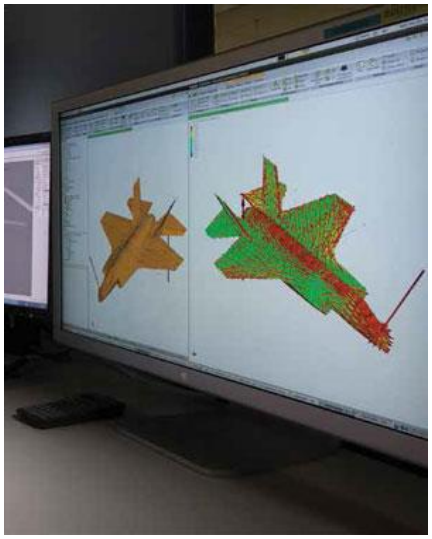
Upgraded DDGs

Combat and Mission Systems MSTC

- Electromagnetic Systems Survivability
- Information Processing and Human Systems
- Information Architectures and Networking

Partnership Opportunities – Electronic Systems Survivability

Electromagnetic Environmental Effects (E3) considers the compatibility of a military platform with its external electromagnetic environment. This includes lightning, telecommunications and radars, (inter-system compatibility) and between the electronic systems on-board the platform (intra-system compatibility).



Collaboration opportunities exist in E3 computational modelling/analysis and the development of novel test/measurement methodologies.

Partnership Opportunities – Information Processing and Human Systems

DSTO undertakes research **to underpin operator decision making** in tactical situation assessment, threat evaluation, effect and weapon assignment and resource management. User-centred design techniques are employed to improve warfighting through effective **design of interfaces and the physical environment.**

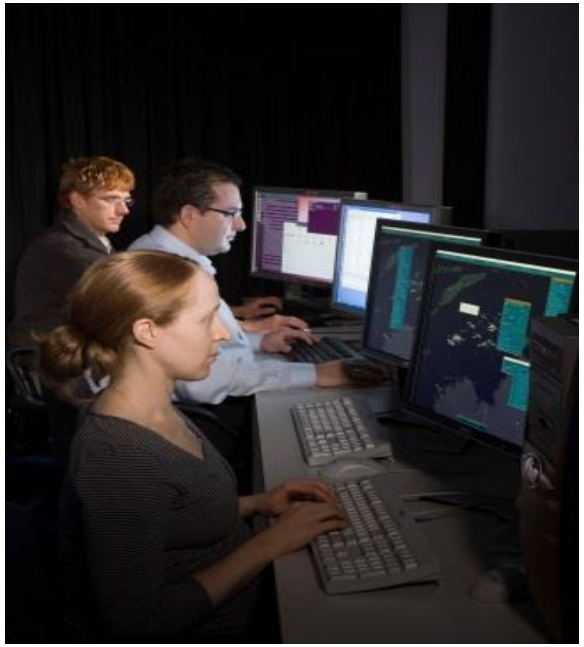
Collaboration opportunities exist in the development and implementation of concepts and tools to aid warfighter decision-making and in user-centred design, in particular cognitive processing and advanced display concepts.

Partnership Opportunities – Information Architectures and Networking

DSTO conducts world-leading research on **emerging information architectures, modular, open tactical system architectures and networking technologies** for next generation combat and mission systems.

LASAGNE©

Layered Approach to Service Architectures for a Global Networked Environment



Consider joining our team of international partners working towards the shared goal of seamless information exchange throughout the tactical battlespace and the wider Defence enterprise.

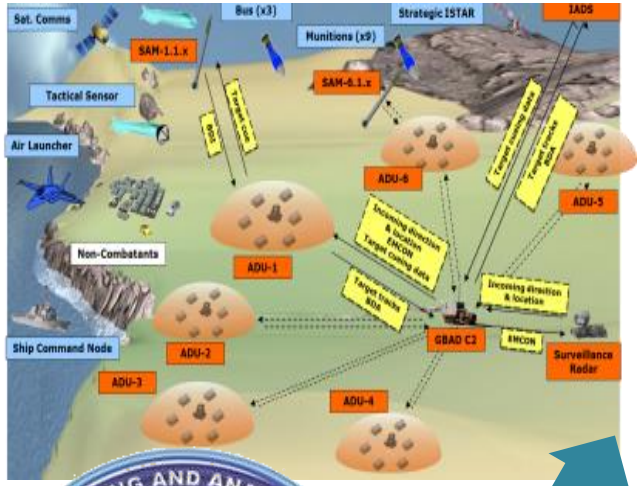
Australian Government
Department of Defence
Science and Technology

Partnering Opportunities in Weapons and Combat Systems Assessment

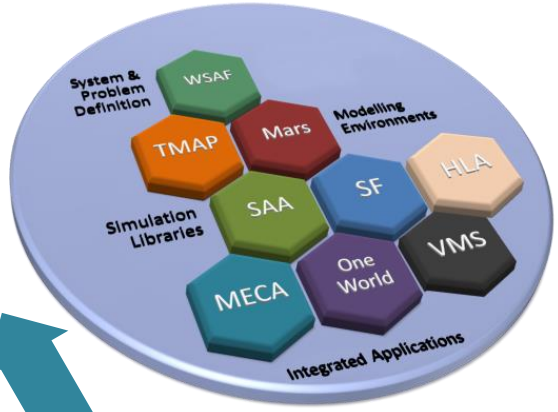
Weapons and Combat Systems Assessment

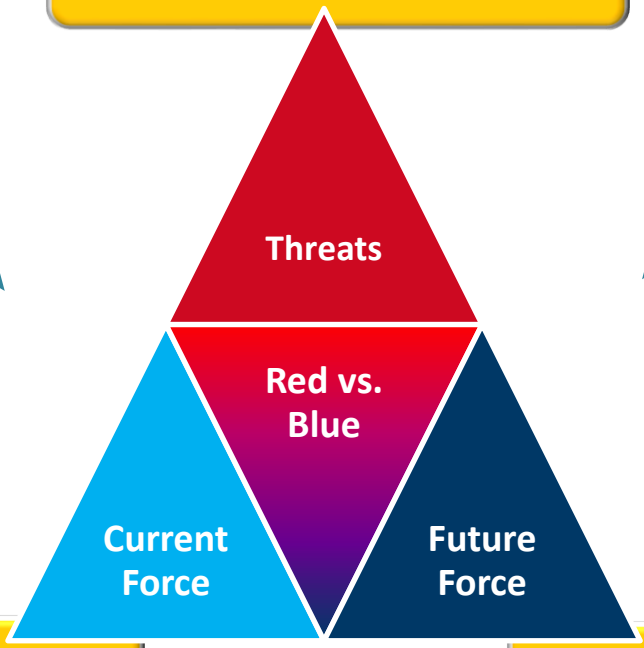
Presented by: Ms Janet Hocking

Weapons and Combat Systems Assessment MSTC



Combat Systems Effectiveness Analysis

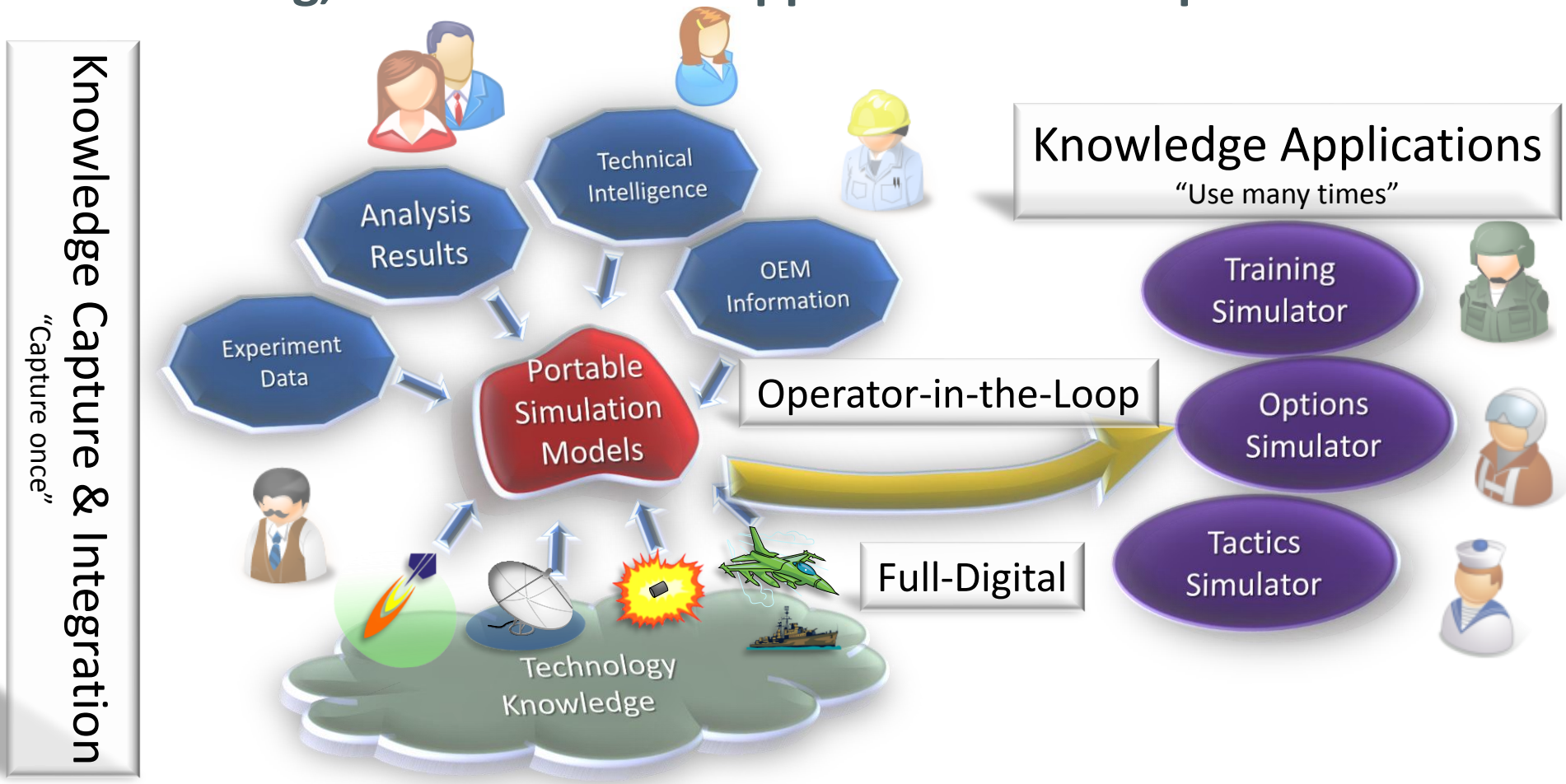




Weapons Modelling and Analysis

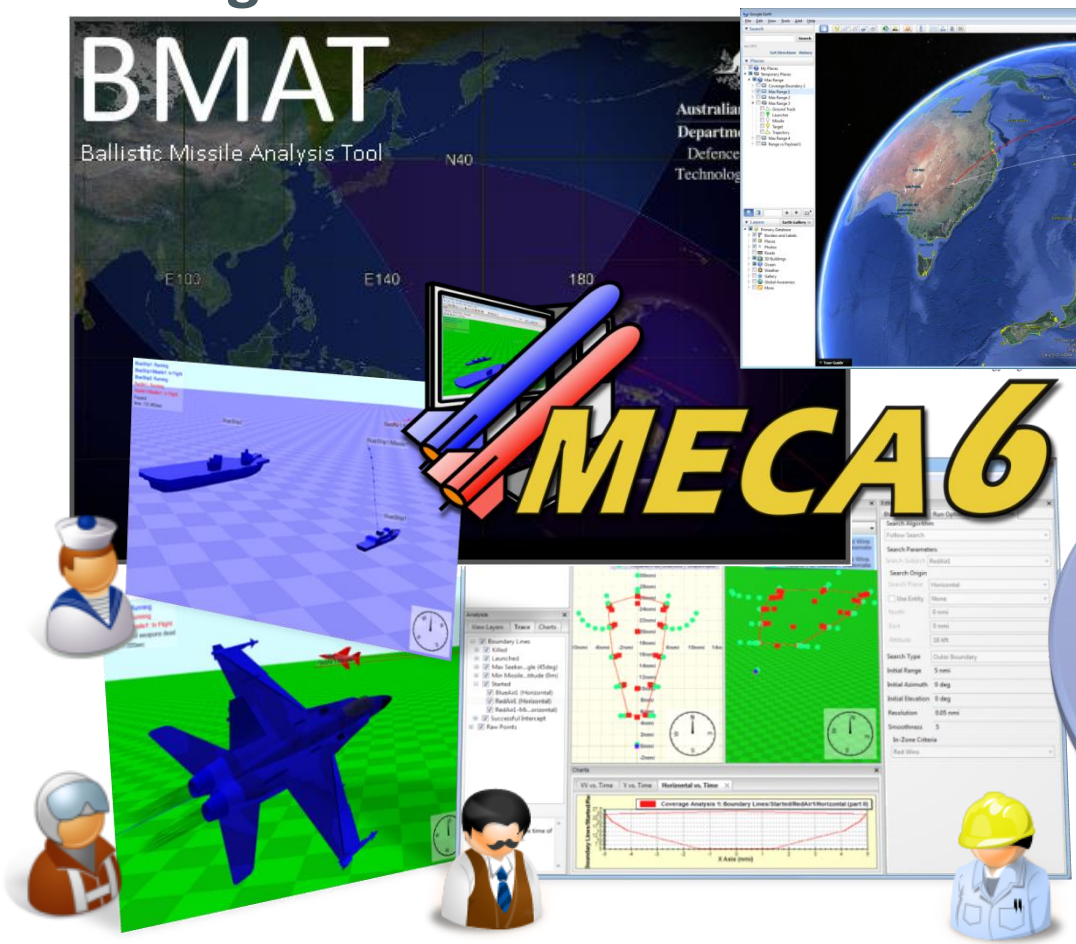
Advanced Modelling and Simulation

Modelling, Simulation and Application Philosophies

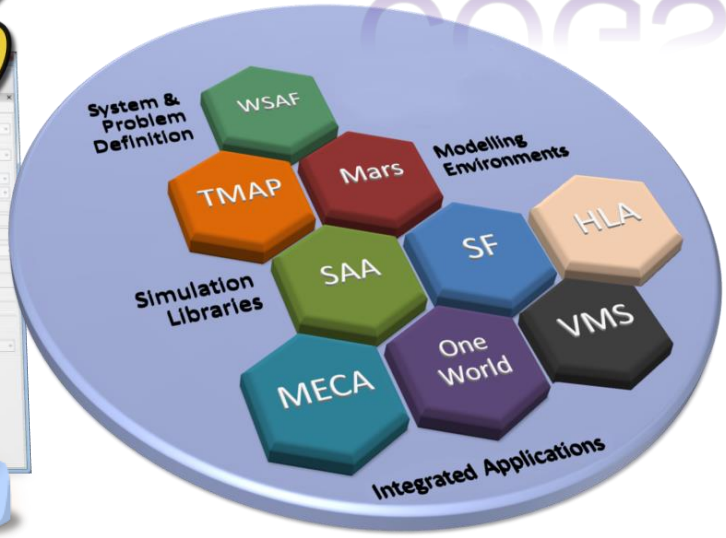


Opportunities exist to partner to ensure knowledge portability through the definition of interfaces and standards

Full-Digital Simulations



COGS



Opportunities exist to partner in MBSE techniques, the creation of models, architectures, tools, applications and complex analysis methods

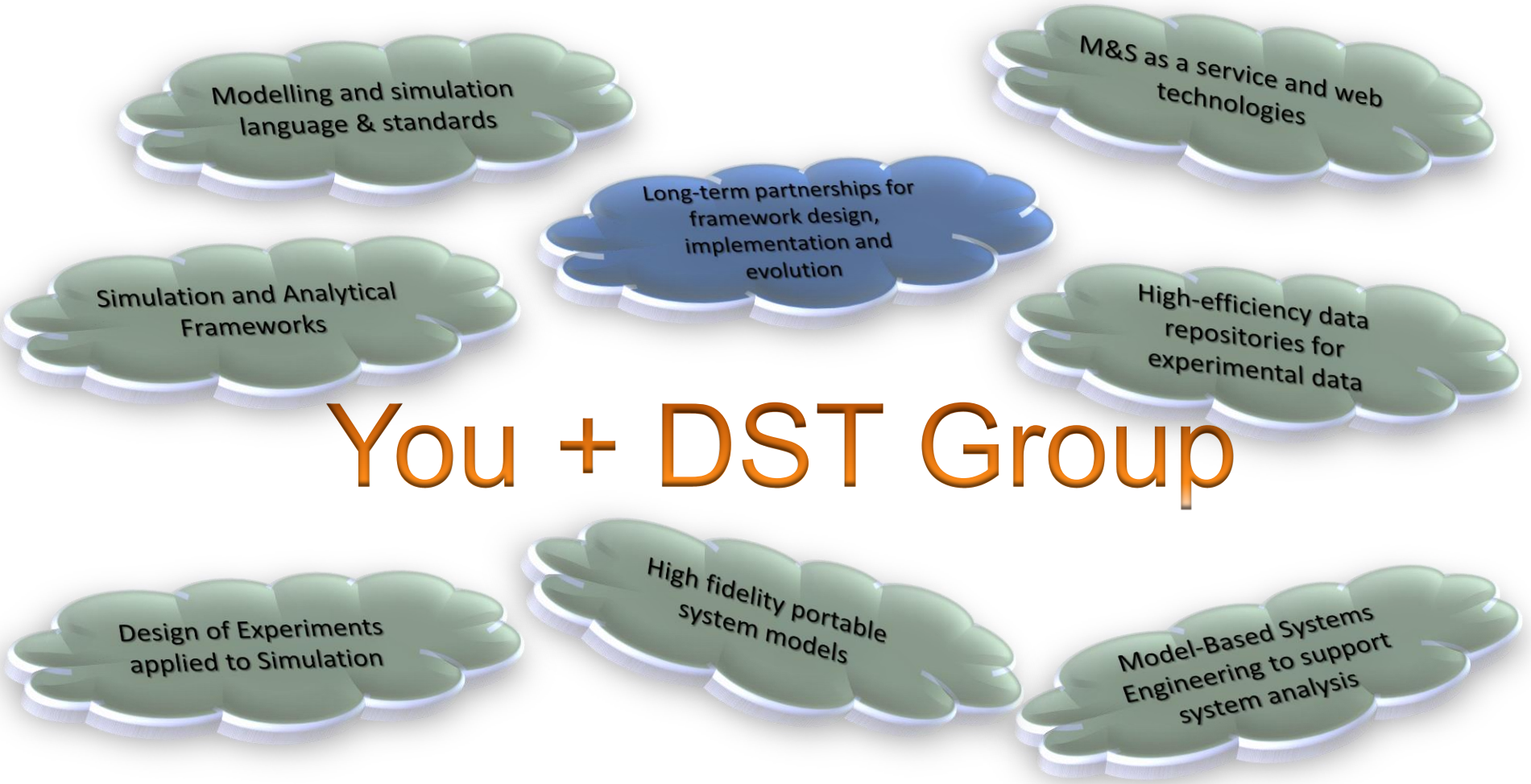
Operator-In-The-Loop Simulations

- High fidelity hardware, simulated environments and customisable scenarios
- Integrate and test new algorithms, equipment or services
- Optimise Operator-Machine effectiveness
- Ability to integrate into any stage of the engagement chain

Threat Environment → Sensors → Combat System → Decision Agent → Effector(s) → BDA

Opportunities exist to partner together on researching agile, reconfigurable, upgradable human-in-the-loop facilities

Come Partner With WCSA Branch!



Our Partnering can develop the best outcome for You and Defence!

Australian Government
Department of Defence
Science and Technology

Weapons Guidance Technologies Partnership Opportunities

Weapons Guidance Technology

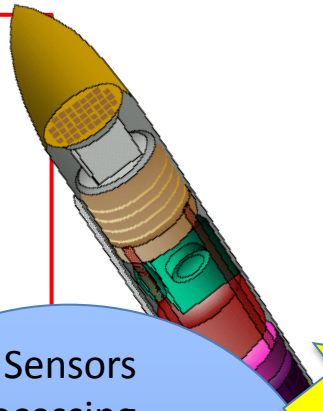
Presented by: Dr Mark Petrusma

Weapons Guidance Technology Branch

To provide clear and identifiable support to the ADF capability advantage through detailed knowledge of the development and application of weapons guidance.

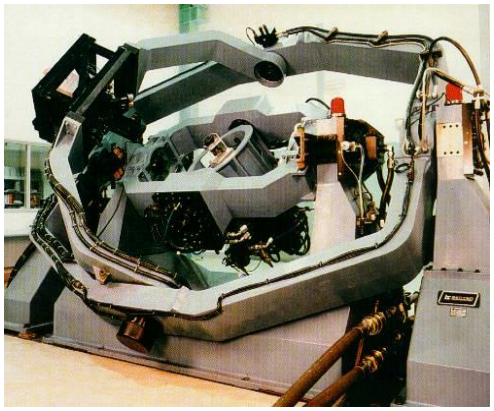
Weapons Analysis

- Seeker and autopilot characterisation
- Guidance performance evaluation
- Target and countermeasure response
- HWIL, captive-carry and live trials



Advanced Capabilities

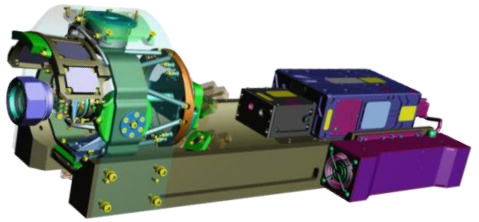
- Millimetre wave
- Ladar Seeker
- Autonomous navigation in GPS denied environments
- Adaptive control
- Seeker augmentation through hardware and software development



EO Sensors and Processing

Guided Systems Technologies and Evaluation

RF Sensors and Processing

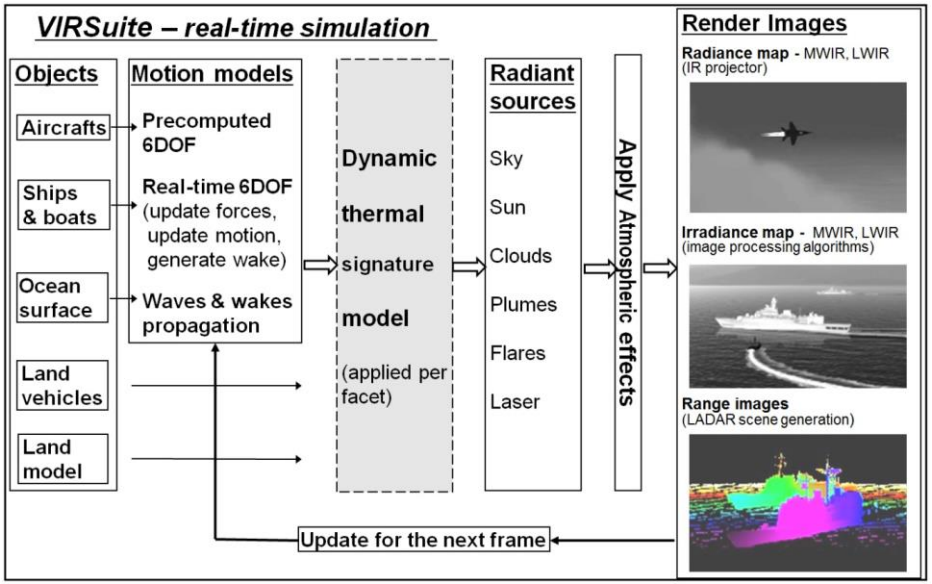


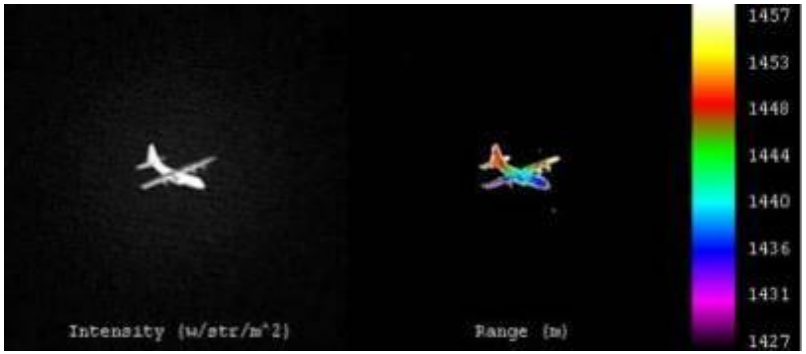
Performance Prediction

- Digital models based on system/subsystem analysis
- Real-time hardware-acceleration
- Accurate signal processing implementation

VIRSuite Simulation Capability

- Real-time physics-based
- Infra-red and visible imagery
  - aircraft, ships, land vehicles
  - terrain model
  - sky, sun clouds
  - plumes, flares
  - active radiant sources
  - atmospheric effects
  - sea properties
  - dynamic models





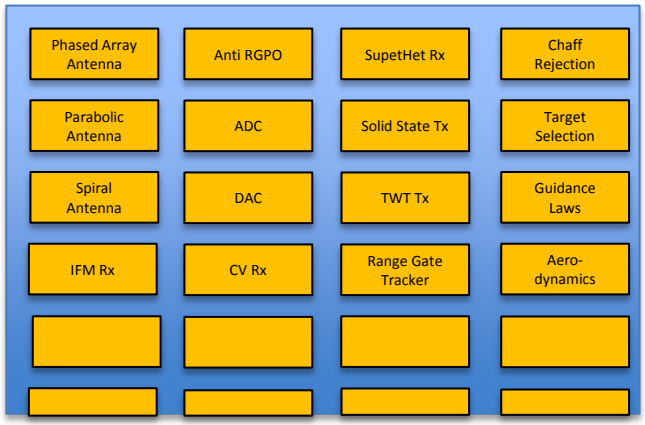
Applications

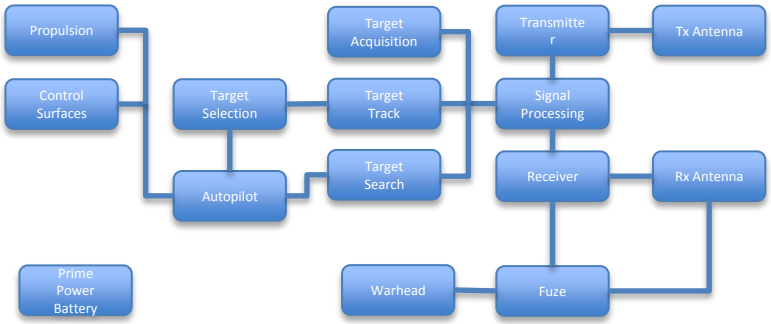
- Hardware in the loop systems
- Training simulators
- Trials reconstruction
- Tactical development

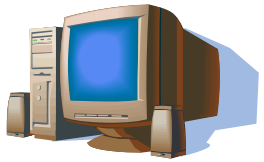
Partnership opportunities exist in further developing and exploiting the VIRSuite capability and implementation in applications for ADF and Allies' use.

CHIMERA Weapons Emulation

- **Requirement – hi fidelity, physics based prediction of weapon performance**
  - Targets - multiple with accurate dynamic signatures
  - Electronic Warfare – advanced jamming techniques
  - Clutter – dynamic in any environment
- Simulink Auto-code FPGA hardware accelerated real-time models
- Collaborative activity with US and UK government agencies and contractors





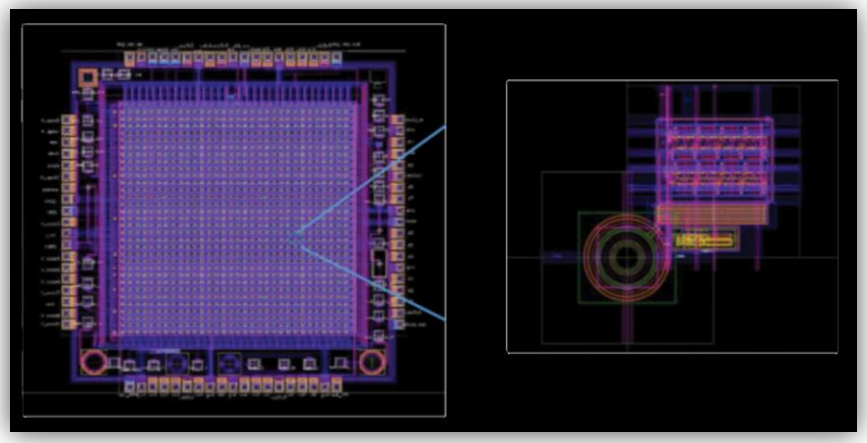


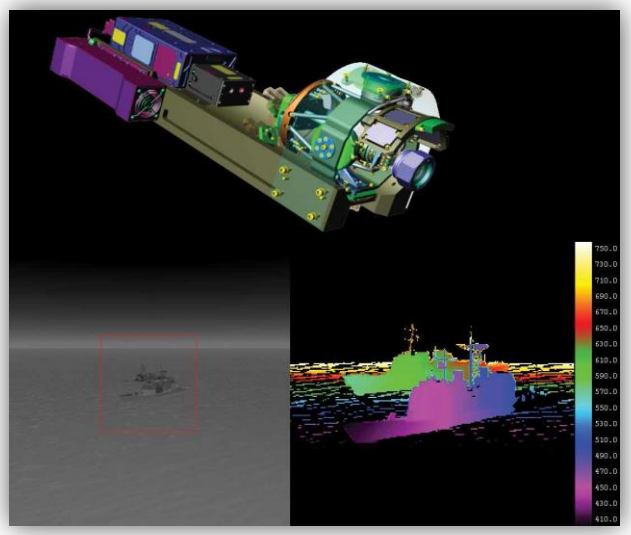
Re-usable Blocks → **System/Subsystem Model** → **Hardware Integration**

Partnership opportunities will exist in sub-system model development and implementation in hardware-in-the-loop digital models.

Advanced Electro-Optical Sensors

- 3D imaging sensors for the next generation of electro-optical seeker
  - Development of highly sensitive Single-Photon Avalanche Diode (SPAD) arrays
  - Compact system comprising co-axial LADAR and Infrared imagers
  - Exploitation of leading-edge range-imaging processing
- Sub-metre range resolution up to 30 km for accurate target identification
- Wide collaborative activity including UWS, Milan Polytechnic & BAE Systems





Partnership opportunities exist to develop and integrate advanced seeker components (SPAD, LADAR and hybrid IIR/LADAR).

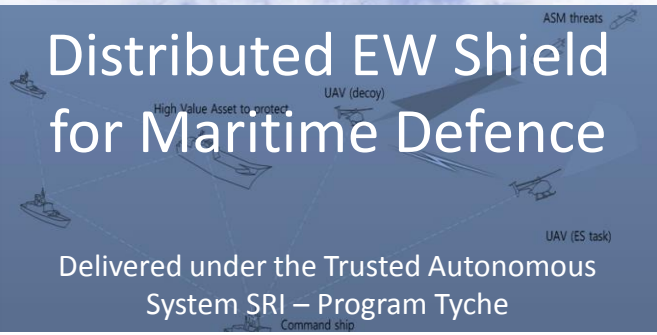
Cognitive Weapons and Combat Systems

Distributed - Cooperative - Coordinated

Cooperative and Coordinated Strike

Delivered under the Trusted Autonomous System SRI – Program Tyche

Distributed EW Shield for Maritime Defence



Delivered under the Trusted Autonomous System SRI – Program Tyche

AI for Combat Systems

- Cooperative, decentralised perception and decision making
- Sensors/effector coordination for complex, contested and uncertain environments
- Thinking Fast and Slow – Machine learning and Optimisation approaches
- Respond dynamically to new information
- Cooperative manoeuvres and effects for deception and defeat
- Dynamic path planning to balance requirements for survivability, lethality, observability
- Graceful degradation in response to attrition

Current Partners: CISR AFRL ARL DRDC RDDC

Partnership opportunities exist in algorithm development for decentralised multi-agent perception and decision making and automated tactics development

Australian Government
Department of Defence
Science and Technology

Innovation in Energetic Materials & Systems

Energetic Materials and Systems

Presented by: Dr Kym Thalassoudis

Weapons Propulsion S&T Capability

Gun & Rocket Propellants

- Formulation, analysis & characterisation
- Thermo-chemical modelling & performance prediction
- Chemical & mechanical degradation and interactions

Missile & Gun Propulsion Systems

- Rocket, ramjet & gun propulsion systems & technologies
- Performance prediction, analysis & assessment
- Interior ballistics and FSI/CFD multi-phase modelling

Propulsion Systems Safety & Sustainment

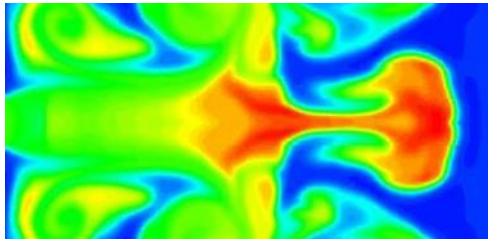
- Specialist S&T advice informs safety & service life assessments
- Impact of operational environments and ageing of systems
- In-Service Surveillance of ADF gun propellants

Unique National EO Facilities

- Research-scale propellant mixing & casting labs
- Chemical analysis, mechanical & ballistic characterisation labs
- Static firing stands, instrumentation & acquisition systems

Linkages, Collaboration & Clients

- Multiple Domestic & International S&T Partners
- Multiple Defence Clients



Explosives and Pyrotechnics S&T Capability

Military Explosives, HME and Pyrotechnics

- Ingredient and formulation development and charge manufacture
- Safety, physico-chemical and performance characterisation
- Computational and experimental detonation physics
- Development and evaluation of explosives detection technologies

Warheads, IEDs and Countermeasures

- Development, manufacture, characterisation and exploitation
- Initiation and performance modelling

Sustain and Enhance Capability

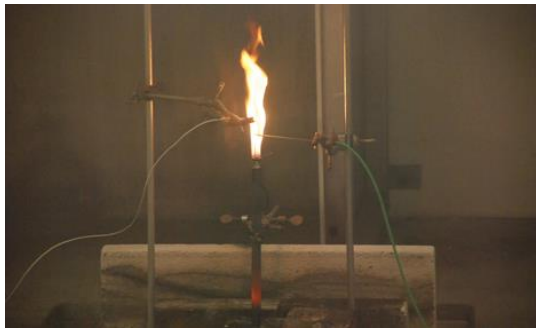
- Safety and service life including Insensitive Munitions
- Counter-Measure Development and Validation inc. technology transfer
- HME/CIED training and threat assessment

Unique National EO Facilities

- Energetic materials synthesis, characterisation and detection laboratories
- Explosives and pyrotechnics processing and EO manufacturing facilities
- Safety and performance evaluation facilities

Linkages, Collaboration & Clients

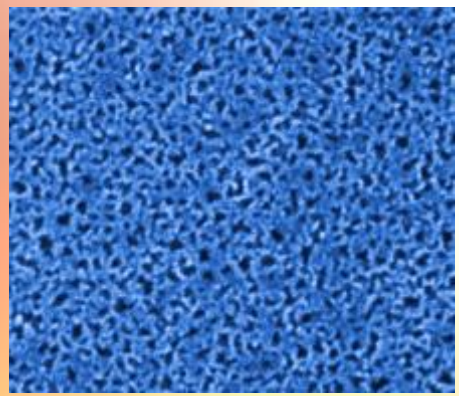
- Multiple Domestic & International S&T Partners
- Multiple Defence & National Security Clients



Transformative Energetics

Nano-Energetics

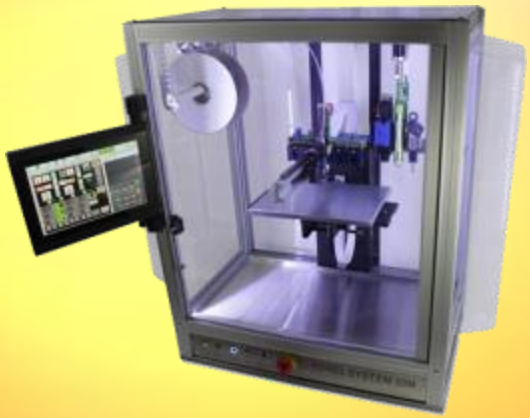
- Recent developments in energetics have found that nano-scale materials provide several advantages over conventional energetic materials including decreased sensitivity, higher stability and improved energy release.



Porous Silicon (Source: CEEM, Flinders University)

3D Printed Energetics

- DST and international partners are researching additive manufacturing of gun propellant grain, with the aim of building new and complex propellants which offer leap-ahead ballistic performance.



Test bed 3D printer (Source: Hyrel)

Partnership Opportunities:

- Collaborative research with academia & industry

Resonant Acoustic Mixing (RAM)

New Energetic Materials

- RAM is an innovative mixing and processing technology that utilises acoustic energy
- DST Group is using RAM to create higher performance energetics and to improve the production of existing energetic materials

LabRAM installed at DST Group

Applications:

- High-Performance Energetic Systems
- High Efficiency, Greener Processing

Partnership Opportunities:

- Research into new energetic materials
- New manufacturing capabilities

RAM energetic in process at DST Group

Development of PyroFilm Technology

Pyrotechnic Sheet:

- Innovative multi-layer pyrotechnic material
- Expands the gamut of pyrotechnic applications, including thin flakes for electro-optic countermeasures
- Developed by DST Group (Prov. Patent, 2016)

Coloured emission

Prototype testing

Glowing emission

Applications:

- New IR Countermeasures
- Pyrotechnic Special Effects

Partnership Opportunities:

- Co-develop and transition PyroFilm technology into new applications

Advanced Tactical Booster Technologies

DST-AFRL S&T Collaboration Progressing Booster Technology to Enable Future Applications

DST & AUS Industry Innovations

ATBT High-Speed Weapon Concept

Applications:

- Flight Test Capability
- Next Generation Tactical Missiles
- High-Speed and/or Long Range Weapons
- Responsive Access to Space

Partnership Opportunities:

- Reduced cost design & manufacture (industry)
- Demonstrate indigenous manufacture (industry)
- Propulsion materials technology (academia)

ATBT static firing at DST Group

Integrity of ADF Rocket Motors

DST Group is researching new methods to understand how environmental factors and Australian usage interact to affect the safety and performance of rocket motors. This allows the ADF to use its missiles longer, enhances safety, increases logistical flexibility in theatre, and also saves many millions of dollars.

Partnership Opportunities:

- Computed tomography image processing

"There are 1000 things that can happen when you light a rocket motor, but only one of them is good"

– Elon Musk

Rocket motor failure at launch (July 2015)

Energetic Materials & Systems MSTC

Partnering Opportunities:

- **Transformative Energetics**
  - Nano-Energetics
  - Printed Energetics
  - Resonant Acoustic Mixing
- **PyroFilm**
- **Advanced Tactical Booster Technologies**
- **Integrity of ADF Rocket Motors**

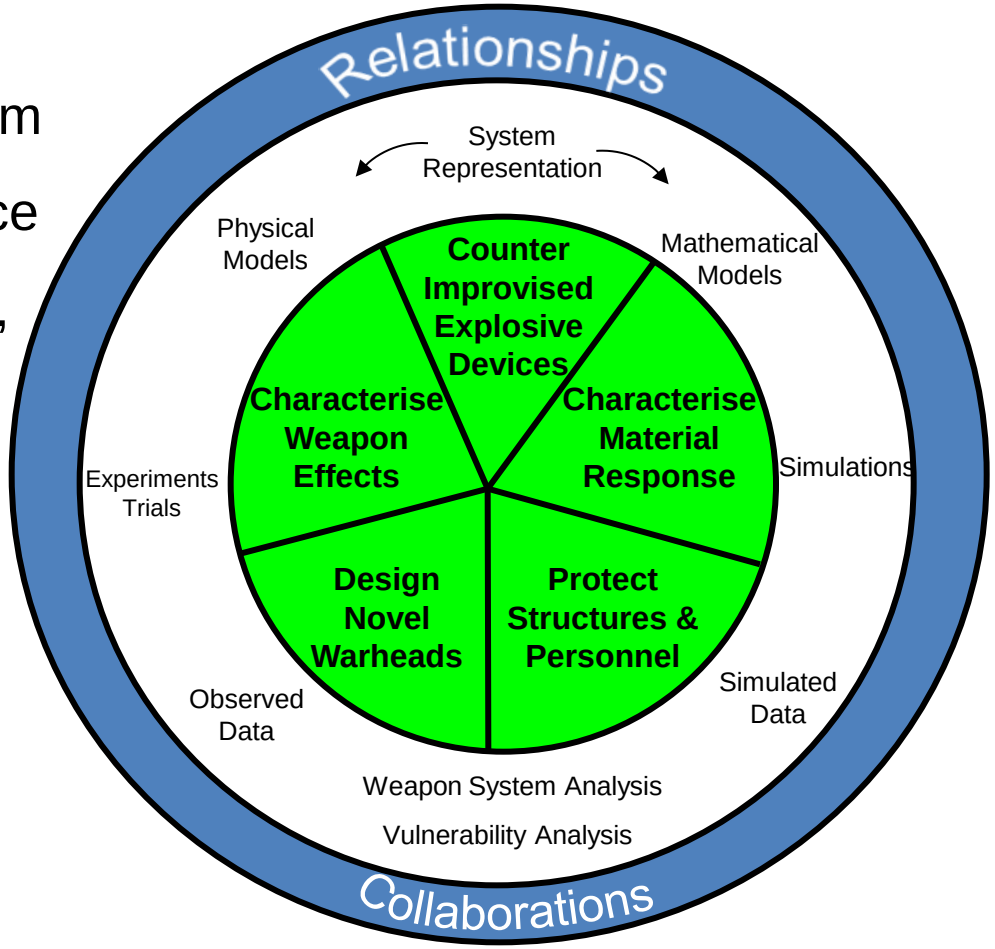
Further information:

- Research Leader: WCSDRLEMS@dsto.defence.gov.au

Land Weapon Systems & Effects Capability

Mission:

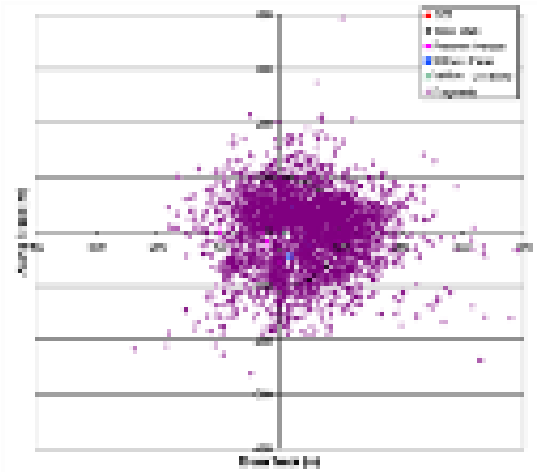
To enable superior weapon system employment, and to enhance force protection by harnessing science, technology and innovation

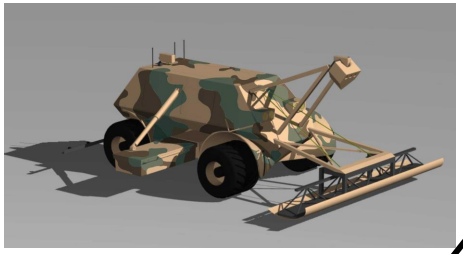


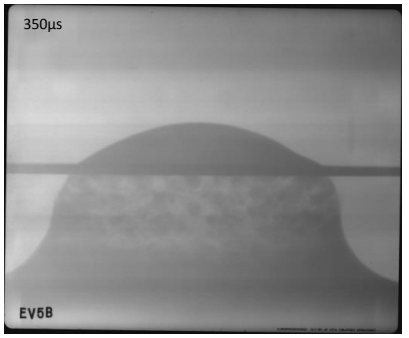
Further information:

•Research Leader: WCSDRLLWSE@dsto.defence.gov.au

Land Weapon Systems & Effects Capability







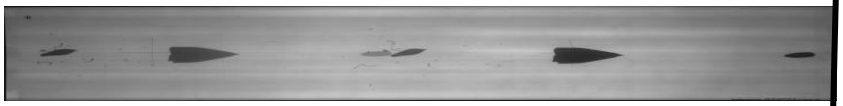
Counter Improvised Explosive Devices

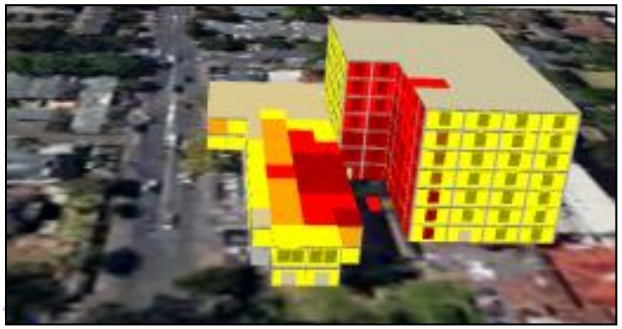
Characterise Weapon Effects

Characterise Material Response to Explosives

Design Novel Warheads

Protect Structures & Personnel

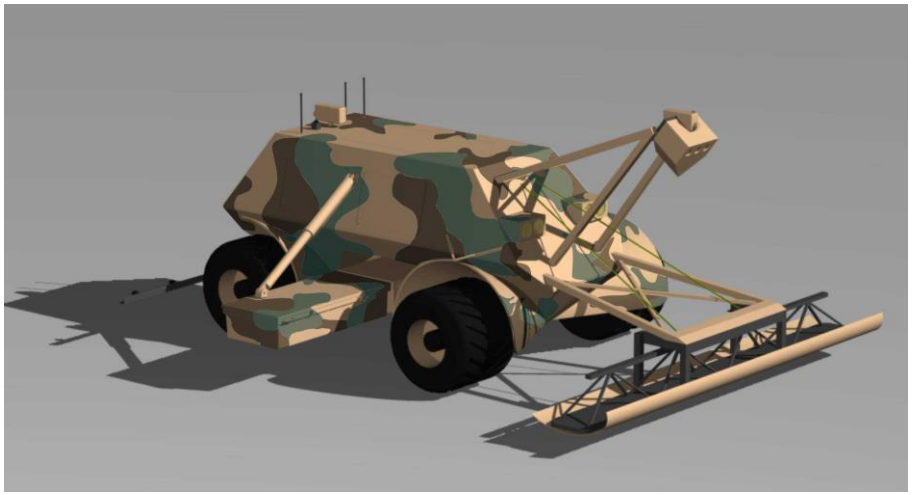




Partnership Opportunities – Land Weapon Systems & Effects

The CIED Grand Challenge seeks to harness science, technology and innovation to

Defeat Improvised Explosive Devices without Casualties



A suite of detection sensors/systems will be integrated onto an UGV as part of a stand-off detection concept technology demonstrator.

Australian Government
Department of Defence
Science and Technology

Weapons and Combat Systems Division is looking to COLLABORATE…

We would welcome opportunities to partner with you!

Please visit our booth or contact

Craig Eales– WCSD External Engagement Manager

(08) 7389 6466

craig.eales@dsto.defence.gov.au