Australian Government
Department of Defence
Defence Science and Technology Group

Setting the Scene – DIP Activator Project 3

Scalable distributed active sensing and sense-making systems

Dr Paul Gaertner

"Agile Command and Control" STaR Shot Leader

Dr Axel Bender

"Operating in CBRN* Environments (OCE)" STaR Shot Leader

*CBRN: Chemical, Biological, Radiological and Nuclear Threats

Scalable, distributed, active sense and sense-making

Ubiquitous need for innovative technologies, both in military and civilian settings

- **Military** – Two Defence innovation programs have co-developed (and are co-sponsoring) this DIP Activator challenge:
  - Agile Command and Control STaR Shot (Dr Paul Gaertner)
  - Operating in CBRN Environments STaR Shot (Dr Axel Bender)
- **Civilian**
  - e.g. Bushfire prevention;
  - Mining;
  - Agriculture… more on this later this morning.

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Operating in CBRN Environments

Current OCE STaR Shot Aim Points

Subsystem of

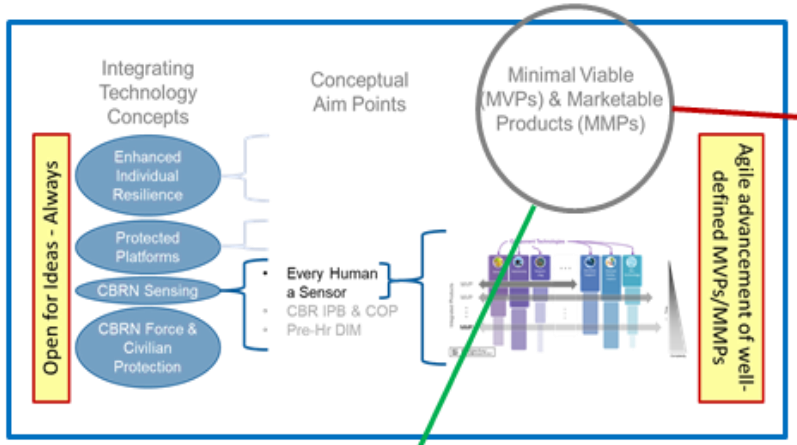
ACCESSS – Active Collaborative CBRN Environmental Sense and Sense-making System

- *Ambition*: 100's to 1000's of networked threat and environmental sensors that collaborate to generate accurate CBRN situational awareness and interoperate with extant and future military and civilian threat warning systems
- *Impact*: Reduce "no go" zones by 50% to 95%, leading to significantly enhanced freedom of manoeuvre

HISS – Human Integrated Sensor System

- *Ambition*: detect and interpret subtle variations in a human's biomarkers caused by exposure to chemical or biological threats and intervene when countermeasures can be employed with greatest effect
- *Impact*: (1 - military) neutralisation of effect of biological warfare agents targeting humans
  (2 - civilian) significant reduction of spread, morbidity and mortality of infectious diseases

Operating in CBRN Environments STaR Shot – Impactful Program



Active Collaborative CBRN Sense and Sense-making System

Ambition: multitude of networked threat and environmental sensors that collaborate to generate accurate CBRN situational awareness and threat warning

Impact: reduced *no go* zones and significantly enhanced freedom of manoeuvre

$3.4M Compact Aerosolised SARS Exposure Sentinel (CASES)

Toxic Air Sentinel commercialisation

$1.3M Hazardous Agents Challenge (HAC)

Human Integrated Sensor System

$3M HISS Challenge

$1M Defence AI Research Network project

$4.5M Human Performance Patch project

Ambition: detect and interpret subtle variations in a human's biomarkers caused by exposure to chemical or biological threats

Impact: neutralisation of the effect of biological warfare agents targeting humans (military); prevention of pandemics and reduction of mortality (civilian)

Sense and sense-making: edge technologies

Exemplar Sensors

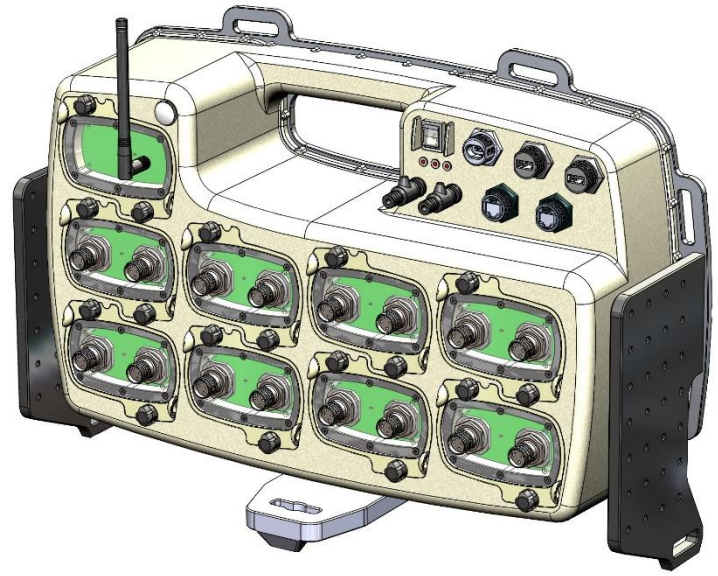
Toxic Air Sensor (TAS)
Multi-channel and modular early warning system.

Modular & miniature colorimetric chemical vapour sensor

CASES - Wearable airborne pathogen dosimeter

Miniaturised hand-held CRDS

Nodes



Unified Network Interface Technology (UNIT)

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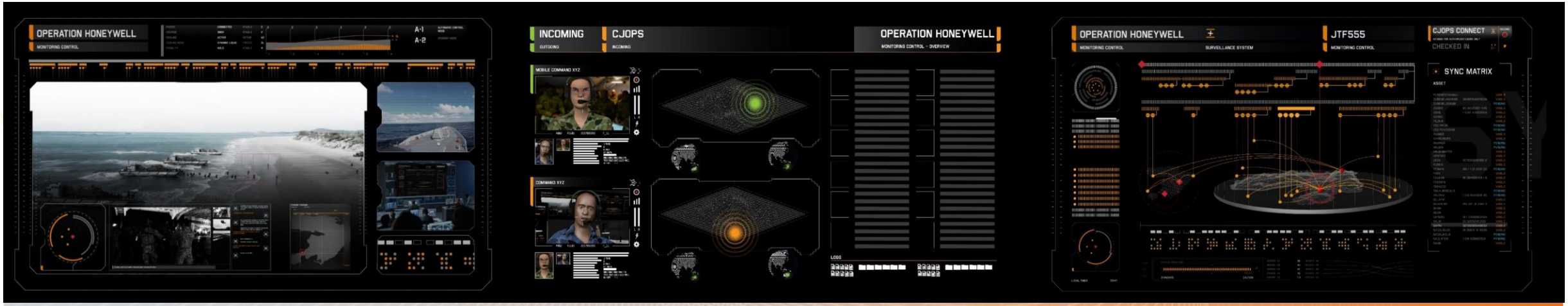
Agile Command and Control and Integrated C4

Australian Government
Department of Defence

Agile Command and Control and Integrated C4

"The ADF's operational success will depend on the ability of the Integrated Force to apply the following critical capabilities: … a theatre command and control framework that enables an enhanced Integrated Force, 2023

"Australia must have a fully integrated and more capable ADF operating across five domains which work seamlessly together on joint operations to deliver enhanced and joined-up combat power", 2023



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Delivering an effective, productive, adaptive, and supportable end-to-end Joint C2 capability able to meet the challenges of future contested and concurrent operations.

AGILE C2

Command and Control

STaR Shot

STaR Shot Purpose

- To transform how command and control is conducted across all operational levels, and how warfighting capabilities across Defence are synthesised into a more effective and resilient force, able to operate and prevail across all levels of command, all warfighting domains, and in all environments.

STaR Shot Vision

- Multi-Domain Visibility, Understanding and Decisions - adapting C2 to rapidly evolving battle spaces
- Synchronised Multi-Domain Manoeuvre - driving rapid evolution of multi-domain C2
- Prevailing in Distributed, Degraded & Disrupted Environments - delivering C2 at the speed of relevance

Sponsor Intent

To modernise command and control and warfighting decision-making capabilities across all domains and all operational levels.

Critical Research Challenges

- AI-enabled network and decision support capabilities that can in real-time provide increased agility, speed and quality of decision-making across all levels of command.
- Provision of C2 digital twins and advanced data analytic capabilities able to exploit and benefit from the vast quantities of increasingly diverse data and information.
- Implementation of Defence end-to-end C2 organisational change designed to achieve multi-domain operations, posturing the ADF to deliver synchronised effects.
- Optimised and resilient Defence C2 approaches to operating in contested, congested and denied environments.
- A paradigm shift in how C2 technologies are developed, acquired, tested, integrated and delivered to the warfighter.

Capability Outcomes – Lines of Effort

- **Agile Commander** provides integrated planning, threat insight and execution capabilities for headquarters of the future to achieve flexible deterrence.
- **Agile Defender** delivers control for defensive and offensive missions in degraded environments across all domains.
- **Agile Core Platform** centres on resilient and capable communications and compute to enable Agile Commander and Agile Defender, together.

AN OVERVIEW OF AGILE COMMAND AND CONTROL

AGILE COMMANDER

Agile Commander provides integrated planning, threat insight and execution capabilities for headquarters of the future to achieve flexible deterrence.

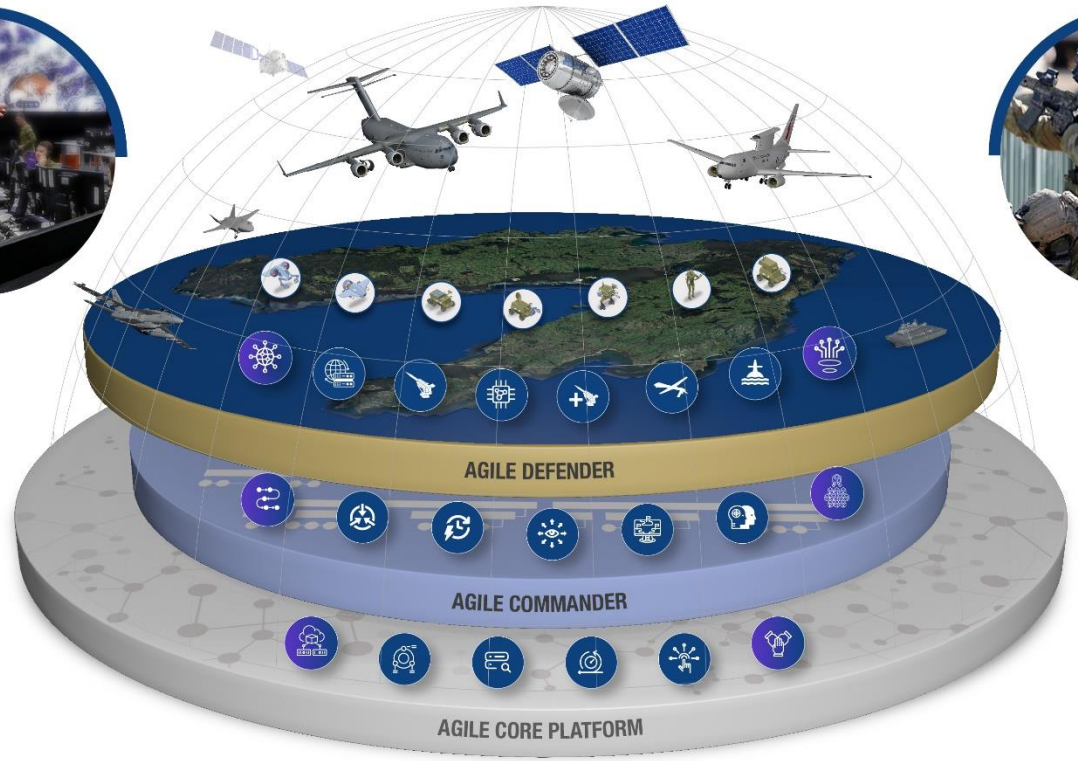
Research areas

1. Multi-domain picture compilation and analysis
2. AI-enabled Dynamic Planning
3. Decision Making under Uncertainty
4. Advanced Command Spaces, Processes and Functions
5. Agile Culture, Training and Selection

Major deliverables

Advanced Command Processes and Functions
- Integrated (joint) COP for situational assimilation at speed
- Rapid plan-to-execute cycles
- ISR Integration for priority collection and exploitation

Modular All-Domain Operations Centres (MADOCs)
- Resilient distributable Theatre Warfighting
- Human-machine teaming



AGILE DEFENDER

Agile Defender delivers control for defensive and offensive missions in degraded environments across all domains.

Research areas

6. Distributed Decision Making and Teaming
7. AI-enabled Multi-domain Effects Generation
8. Edge-to-Edge Sensing and Information Management
9. Digital Engineering and Digital Twins

Major deliverables

Digital Twin of the C2 Networked Force (Phoebe)
- High throughput MDS (Gen 1)
- Optimised IAMD configuration setting (Gen 2)
- Machine-aided Manoeuvre (Gen 4)

Distributed Combat Management System
- Optimised Force-level IAMD response
- C2 of Massed Autonomy
- Multi-statics capability for distributed ASW

AGILE CORE PLATFORM

Agile Core Platform centres on resilient and capable communications and compute to enable Agile Commander and Agile Defender, together.

Research areas

10. Cloud-native Survivable Architectures
11. Edge-to-Enterprise Network Integration
12. Collaborative, Continuous Capability Realisation at Speed

Major deliverables

Cloud-native Warfighting Architectures
- Fast, open, survivable edge-to-enterprise information flow
- Joint networks and application-hosting for multi-domain operations

Collaborative, Continuous Capability Realisation at speed
- Fast-tracking of technologies into the fight
- Rapid C2 system reconfiguration for changing circumstances

Strategic Context

2024
National Defence Strategy + Integrated Investment Program

THE NDS OUTLINES THE GOVERNMENT'S DIRECTION TO SHIFT THE ADF TO AN INTEGRATED FORCE

THE IIP DIRECTS INVESTMENT IN CAPABILITY PRIORITIES TO OPTMISE THE ADF TO DELIVER ON THE STRATEGY OF DENIAL

USING THE MINIMUM VIABLE CAPABILITIES REQUIRED ENSURES RESOURCES ARE MAXIMISED AND CAPABILITIES BROUGHT INTO SERVICE AS QUICKLY AS POSSIBLE

INTRODUCTION OF NEXT-GENERATION CAPABILITIES IS A PRIORITY

National Defence

- Whole-of government approach
  - One of the themes: national resilience – natural disasters (bushfire), pandemics etc.
  - Scalable, distributed, active sense and sense-making systems key technologies to enhance Australia's national resilience
- Theatre Logistics (supply chain resilience, deployed health, CBRN Defence etc.) and Theatre Command and Control are two of the eleven Defence capability priorities

"ADF commanders need to be able to quickly develop a comprehensive appreciation of key threats and opportunities on operations so they can make fast and effective decisions. […] The ability to exercise effective command and control is underpinned by […] systems that can rapidly collect, sift and integrate a diverse range of information from different sources." ***IIP 11.1, p.77***

Military Scenarios

ADF needs chemical threat sense and sense-making

"Protecting our joint force against CBRN threats remains a high priority for the ADF. Operating in these hazardous environments is both demanding on our personnel, and at times, may put their health and wellbeing at risk. Technologies that improve our ability to detect, identify and monitor CBRN threats quickly and accurately, are pivotal to reducing these risks. With this in mind, I am pleased to see CBRN innovation activities such as the Activator Three Project paving the path forward."

***COL Charles Slinger**, Director Land Combat Support Program, 31 May 2024*

Noncombatant Evacuation Operation (NEO)

Environmental Dimensions

- Civilian MASSCAS
- Densely Populated
- Degraded Infrastructure
- Tropical, littoral, Volcanic env.
- Ineffective/ overwhelmed Local Authorities
- Criminal Elements
- Protesters & IMGs

Operational Dimensions

- Host Nation Military
- Conduct SAR of Aus. nationals in urban area
- Req. to evac other foreign nationals
- Required to protect, decontaminate evacuate, treat casualties
- No Alert/ Intelligence Warning
- Single airfield capable of C-130J
- Composition of 1 ATG: constraints etc

Threat Dimensions

- Local TIC Manufacture
- Low Tech Delivery System
- Seeks to avoid Attribution
- Desired Effect: Low Fatality, High Casualty
- Tacit support from Political factions

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- Large fixed infrastructures
- Some infrastructures (e.g. air bases) provide critical operational and support functions
- Adversary's intent is to limit coalition freedom of action by deploying a chemical agent capable of sustaining a long-term effect

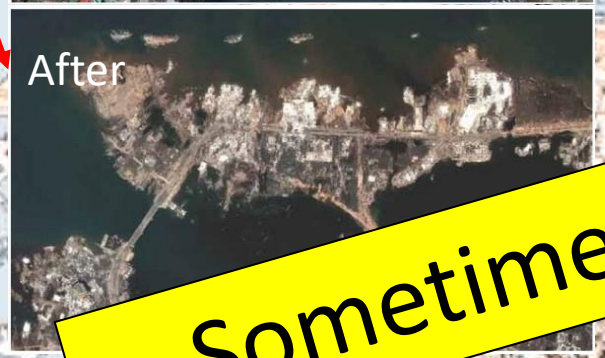
- Early intelligence, surveillance and reconnaissance warning is crucial to minimise impact of adversary's attack
- Rapid mapping of any contaminated areas and forecasting of threat propagation and expected changes to threat will provide important information to commanders and other decision-makers

- Manufacture
- Low Tech Delivery System
- Seeks to avoid Attribution
- Desired Effect: Low Fatality, High Casualty
- Tacit support from Political factions

Humanitarian Assistance and Disaster Relief

Environmental Dimensions

- Degraded Infrastructure
- Tropical, littoral env.
- Civilian MASSCAS
- Ineffective/ overwhelmed Local Authorities
- Monsoons, Tropical Weather
- >2,000,000 Human and Animal Remains



Sometimes the "adversary" is nature.

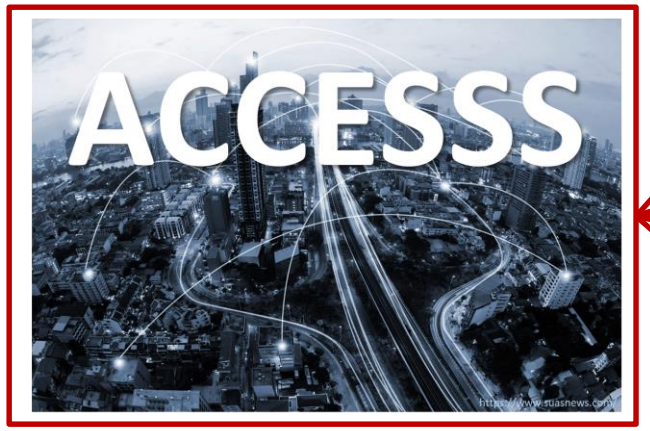
Operational Dimensions

- Req. to evac other foreign nationals
- Required to protect, decontaminate evacuate, treat casualties
- Required to protect, evacuate, treat casualties
- Composition of ADF Deployment: constraints etc
- Conduct SAR of Aus. nationals in DUA

Threat Dimensions

- **Transmission:** Vector Borne, Airborne, Fluids
- Contaminated Food & Water Supply
- Highly Pathogenic Virus
- Tropical Diseases
- No prophylaxis for RNA virus
- Delayed onset of symptoms & Asymptomatic

Dual Use



Agriculture

Mining

Biosecurity

Bushfire Prevention

National Security

Activator Project 3 - Specifications

Scalable distributed active sensing and sense-making

- Development and prototyping of an open architecture for a distributed active sensing and control system that can be expanded to eventually include thousands of nodes
  - Affordably scalable – increasing the number and type of sensors (including humans as sensors) without need for redesign
  - Secure – including rapid inclusion of untrusted sensors
  - Leveraging collectively generated understanding of situation/threat while minimising requirement for network communications
  - Near real-time updates of situational understanding
  - Minimisation of human intervention when scaling up, introducing new sensors etc.
  - Utility as decision support tool – Optimal sensor placement? Optimal sensor mix?
- Focus
  - Improvements to information architectures, edge computing, data fusion, modelling & simulation, as well as integration, while employing currently available sensors (both off-the-shelf and developmental), platforms and network capabilities
  - Focus is **not** on new sensor or new autonomous platform development

Scalable distributed active sensing and sense-making

Desired Outcomes:

1. Consolidated picture of threat dispersion over time, over large areas (10s to 100s of sqkm), leading to decreased response times and increased situational awareness.
2. Network and information architecture backbone that can support hundreds to thousands of different sensors, and is expandable.
3. Information architecture that can span security levels enabling inclusion of new and third party sensor data; e.g. planning and task monitoring at high security levels but able to receive information from sources at lower security levels including from untrusted sensors.
4. Reduce or remove specialist input required to provide a CBRN common operating picture and reduce network loads. Minimal (human) intervention to integrate new sensors.
5. No new sensor development: employ currently available (or developmental (TRL5+)) low SWaP-C sensors; aim is to avoid a bespoke CBRN sensing capability and rather for CBRN to form part of broader C4ISR capability.
6. This challenge is focussed on a CBRN event but the outcomes of the project should be relevant for other threat events. More about this from Paul G and later this morning.
7. Where feasible, include live trial and demonstration of capabilities.

Questions?