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Multi-Domain Integrated Swarms (MDIS)

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Operational Analysis
TPG Services

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tpgroup provide consulting, digital solutions and engineering services across the full lifecycle of mission and safety critical programmes in **Aviation**, **Critical Infrastructure**, **Defence** and **Space** sectors

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Evidence Based Decision Analysis

- COEIA for procurements
- Modelling of 'what ifs'
- Expert analysis and assessment

Consulting & Solutions

- Workshops to generate consensus
- Stakeholder Engagement to secure buy in
- Requirements elicitation to shape projects

Customer Friend

- Independent, impartial and solution agnostic advice
- Aid procurement and support gate review
- Full Business Case Approvals Process

Holistic End to End Programme Delivery

- Full programme life cycle
- Partnering with SMEs and Primes where needed
- Delivery of projects, management of operations

- Approx. 160 Core staff, matrixed Account and Capability structure with significant Associate/SME partner base
- Broad client tasking portfolio including in Army HQ, Air Command, DE&S, Defence Digital and Dstl inc. wider S&T.

Capabilities – Operational Analysis

Case-Studies:

- **Future Beyond Line-of-Sight Communications** – analysis of use case scenarios to agree MOD needs for FBLOS in the 2040 timeframe.
- **CBR Modelling** – helping Dstl and DEFRA simulate different PPE supply strategies and hazard reduction efforts.
- **Human Augmentation** – identifying areas of future science and technology that could augment human capability in the military domain.

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4. MDIS Use Cases & RAS Concepts
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7. What's Next?

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What is MDIS?

MDIS aims: Change the Game

What is MDIS?

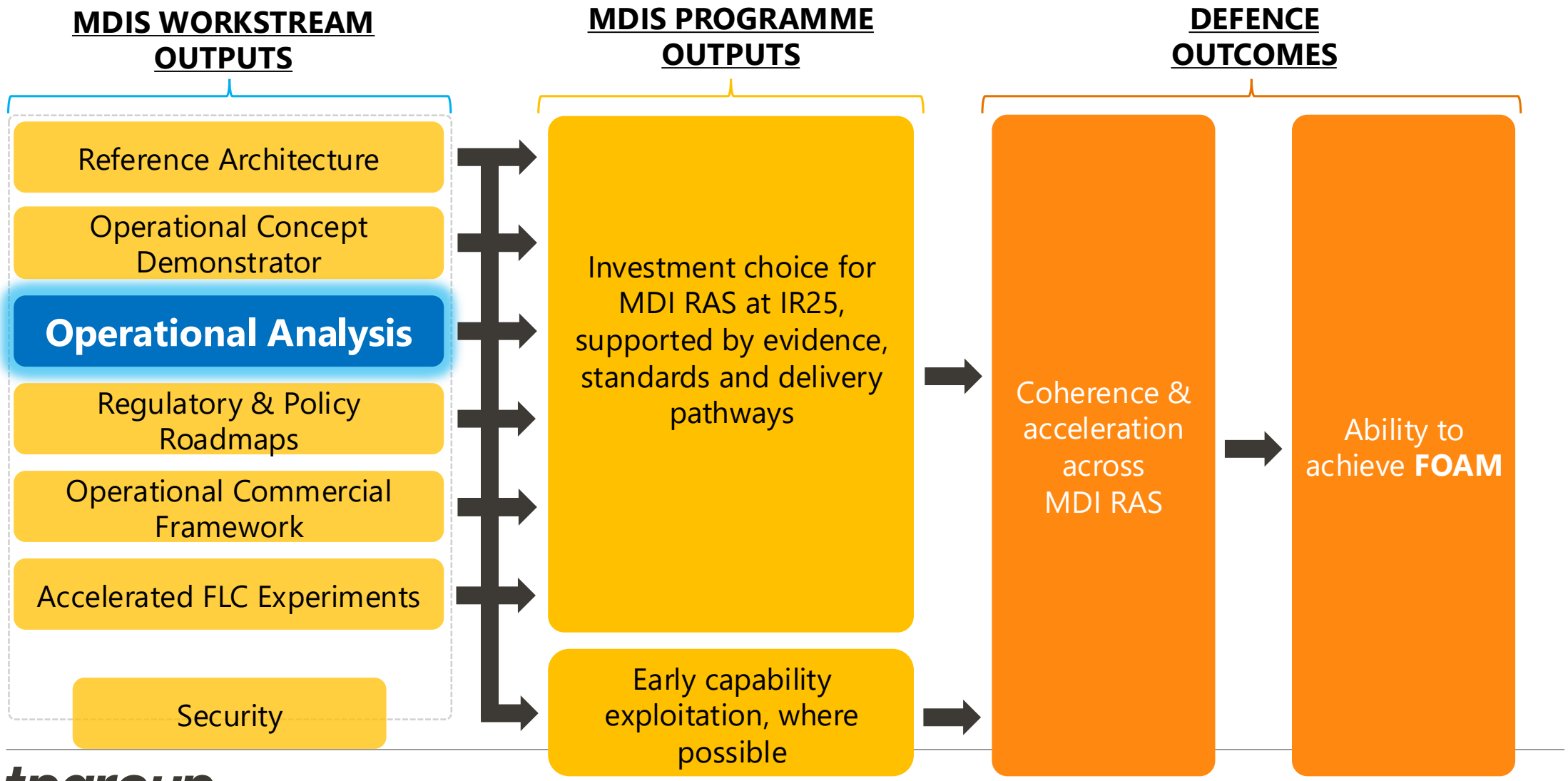
- A 4-year capability investigation
  - Demonstrate potential value to Defence of MDI RAS to inform investment decision at IR25.
  - Designed to produce high-quality decision-making evidence.
- A ‘Game Changer’ programme with a mandate to:
  - CHANGE **FIGHT**:
    - Change the way Defence fights, or
    - Render a current way of fighting, threat or process obsolete.
  - CHANGE **PROCURE**:
    - Deliver capability faster.
    - Use bespoke procurement and commercial models and a streamlined approach to approvals.

MDIS Overview

What is MDIS?

- With FoAM as its key challenge MDIS will:
  - Assess whether MDI RAS, enabled by a common Reference Architecture, will have a noticeable and economical effect on Operational Advantage.
  - Identify and address security, regulatory and policy challenges and produce roadmaps to operationalisation of MDI RAS.
  - Seek, where possible, to exploit early capability delivery opportunities.
- MDIS has 4 primary desired outcomes:
  1. Develop a prototype, multi-domain digital architecture for MDI RAS.
  2. Accelerate RAS capabilities in all domains.
  3. Develop pan-Defence mechanisms for accreditation of RAS for operational use.
  4. Identify operational use cases for MDI RAS, including cost effectiveness analysis.

MDIS Outputs and Defence Outcomes



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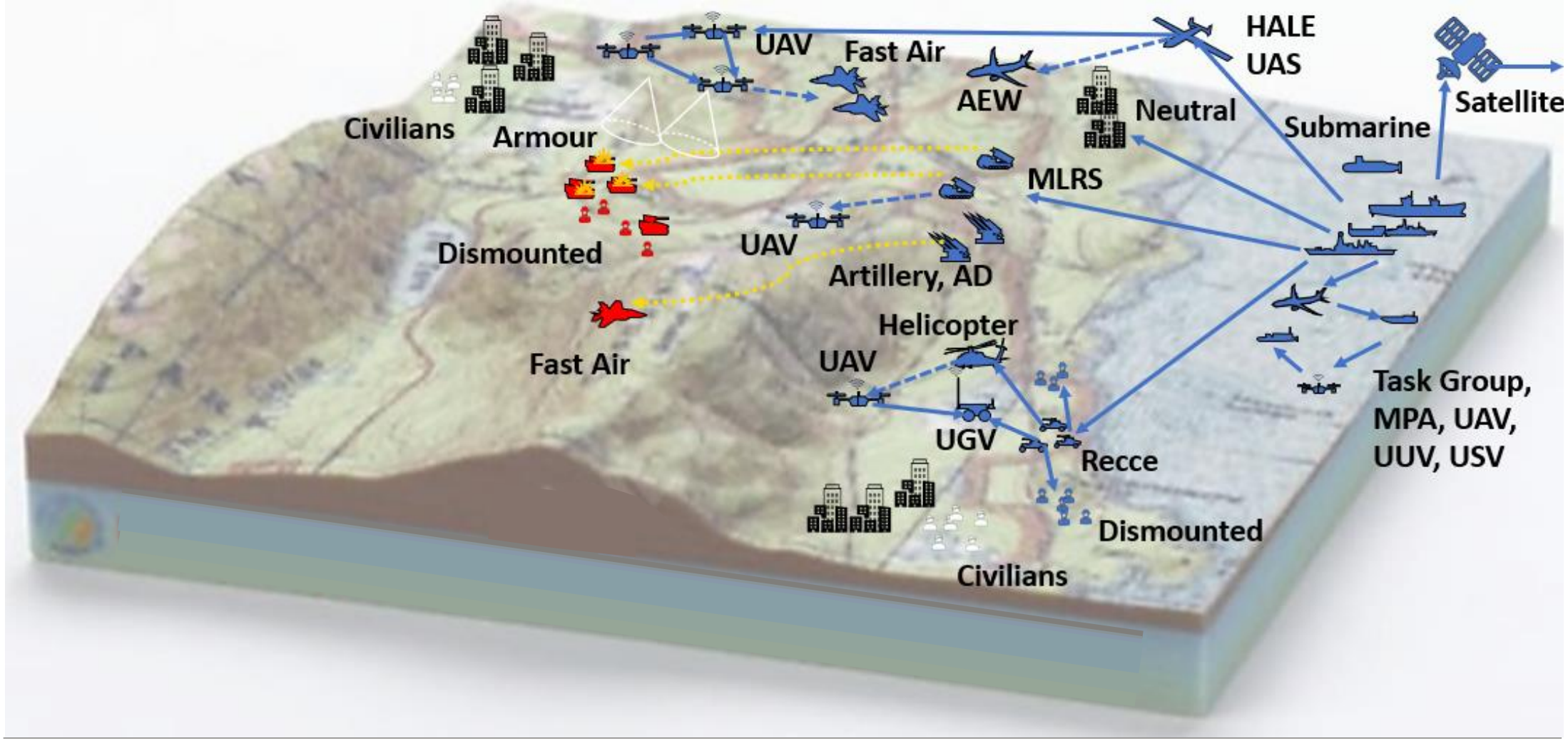
Freedom of Access and Manoeuvre (**FOAM**)



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What is RAS?

RAS?

UAS?

UXVs?

UFOs?

MDIS

Multi Domain Integrated Swarms

Multi Domain Integrated Swarms

Official

What are Robotic Autonomous System & Uncrewed Vehicles?

UAV (Air, Fixed Wing)

Above: Proj. VERMEER platform:
https://www.gov.uk/government/news/rafs-first-synthetic-fuel-drone-flight

UAV (Air, Rotary Wing)
UUV (Underwater)

Above: Malloy t150 with a payload sensor
[https://mezha.media/en/2022/05/04/malloy-aeronautics-t150-uav-for-delivery-of-urgent-cargo-to-or-from-the-front-line]

UGV (Ground)

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USV (Surface)

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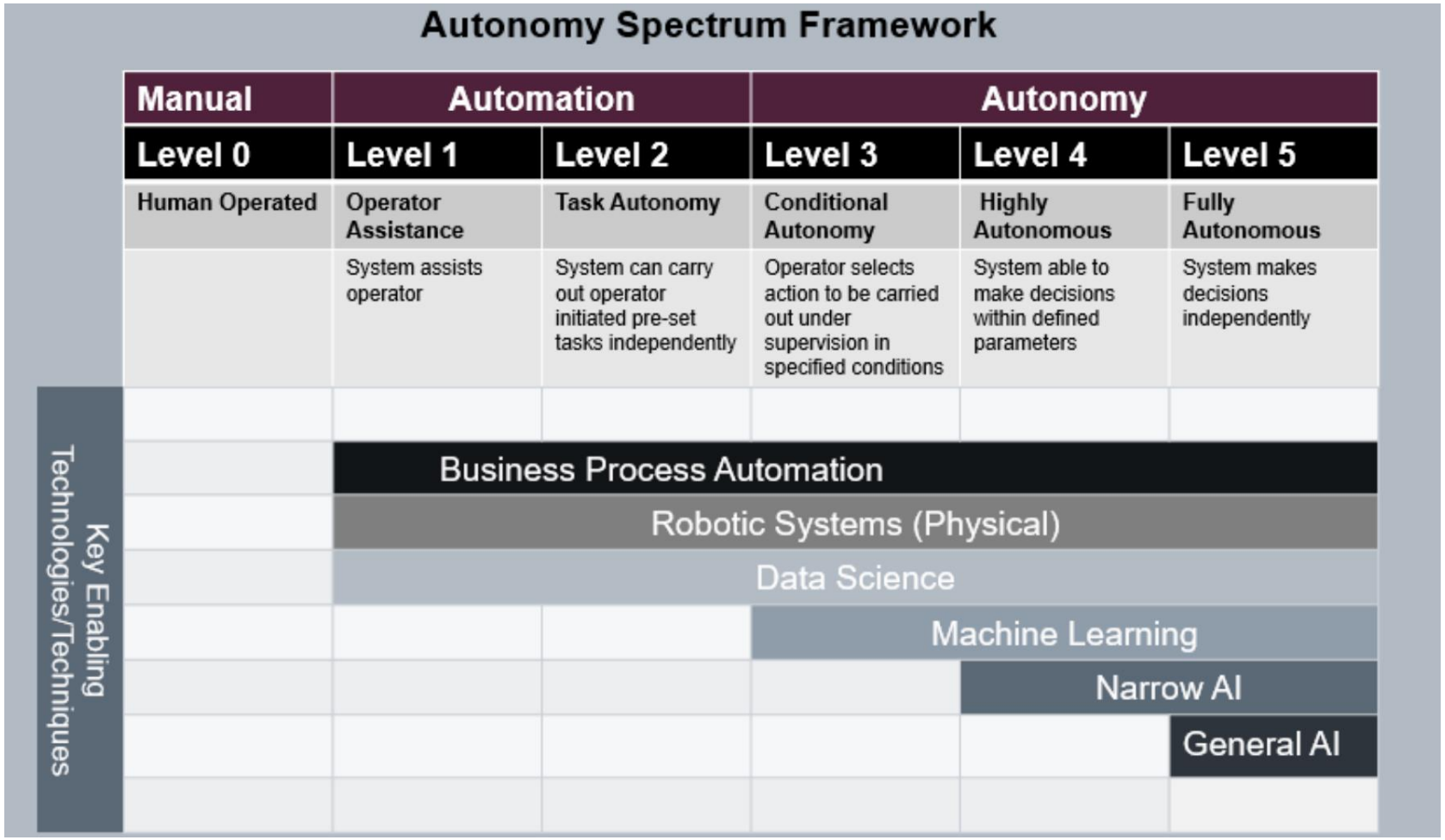
Definitions: RCO's (Current) Autonomy Framework



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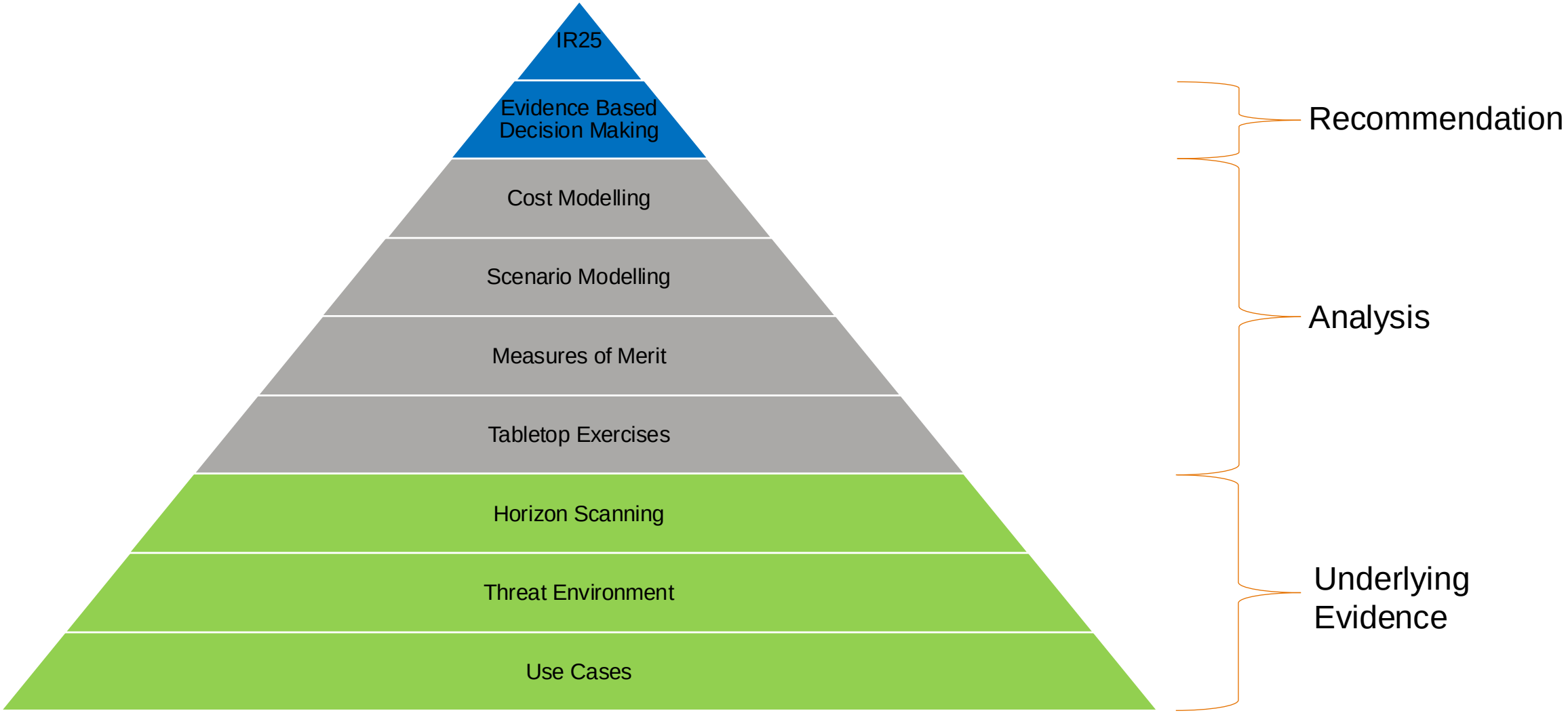
Operational Analysis on MDIS

MDIS OA Master Question List (MQL)

1. What are the representative scenarios for MDIS to be applied against?
2. What operational advantages could an MDIS-enabled force provide in 2025+?
3. What system elements and enablers does an effective MDIS capability require?
4. What are the cost implications of implementing MDIS?
5. What future (2030+) developments to elements in an MDIS system would create the greatest benefit?

Where we are


IR25
Evidence Based Decision Making
Cost Modelling
Scenario Modelling
Measures of Merit
Tabletop Exercises
Horizon Scanning
Threat Environment
Use Cases
Recommendation
Analysis
Underlying Evidence

Hypotheses for MDIS Enabled Operations

Accuracy, Precision & Timeliness	MDIS-enabled platforms perform FIND, IDENTIFY and STRIKE missions more effectively than the current 2030 baseline, by connecting multiple sources that enable the dynamic and timely collection of ISR data. This provides in-depth and multi-layered ISR pictures, to deliver greater accuracy and precision.
Lower Cost, Same Effect	MDIS nodes can be equipped with less expensive effectors than traditional platforms, and which require less technologically sophisticated systems to deliver precision effect.
Greater Redundancy	High volume of MDIS platforms in operation enables greater redundancy and coverage to improve mission survivability.
Lower Risk To Life (Blue)	The risk incumbent in having multiple MDIS platforms destroyed is still lower in cost (both financially and in human life) than losing manned platforms.
Greater Endurance	The endurance of MDIS platforms is great enough to support the duration of an operation without impacting allocation of resources away from other taskings.
Quality of Information Exchanges / Decision Making	The speed at which better information is exchanged between platforms is increased, enabling better decision making.

Possible MDIS Options

Baseline (No MDIS)	- Current RAS Programme - **Without** Common Architecture - No SWARM capability (Except through remote pilot / HITL)
MDIS +	- Current RAS Programme - **With** Common Architecture - No SWARM capability
MDIS + +	- Current RAS Programme + Additional RAS platforms - Common Architecture - AI/Autonomy (Optimised SWARM using extra RAS platforms)

* This is not meant to be a complete set and other alternative solutions may need to be considered

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MDIS Use Cases & RAS Concepts

MDIS Use Cases Developed (to date)

Use Case 1 - SEAD

Use Case 2(a) – ASW Barrier, North Atlantic

Use Case 2(b) – ASW Barrier, Carrier Strike Group

Use Case 3(a) – ISR, Deep Recce FIND

Use Case 3(b) – Engineering Gap Recce

Use Case 4 – Littoral STRIKE

Use Case 5 – Operating in a Denied Environment

Use Case 6(a) – Theatre Entry, NEO

Use Case 6(b) – Theatre Entry, Opening A New Flank

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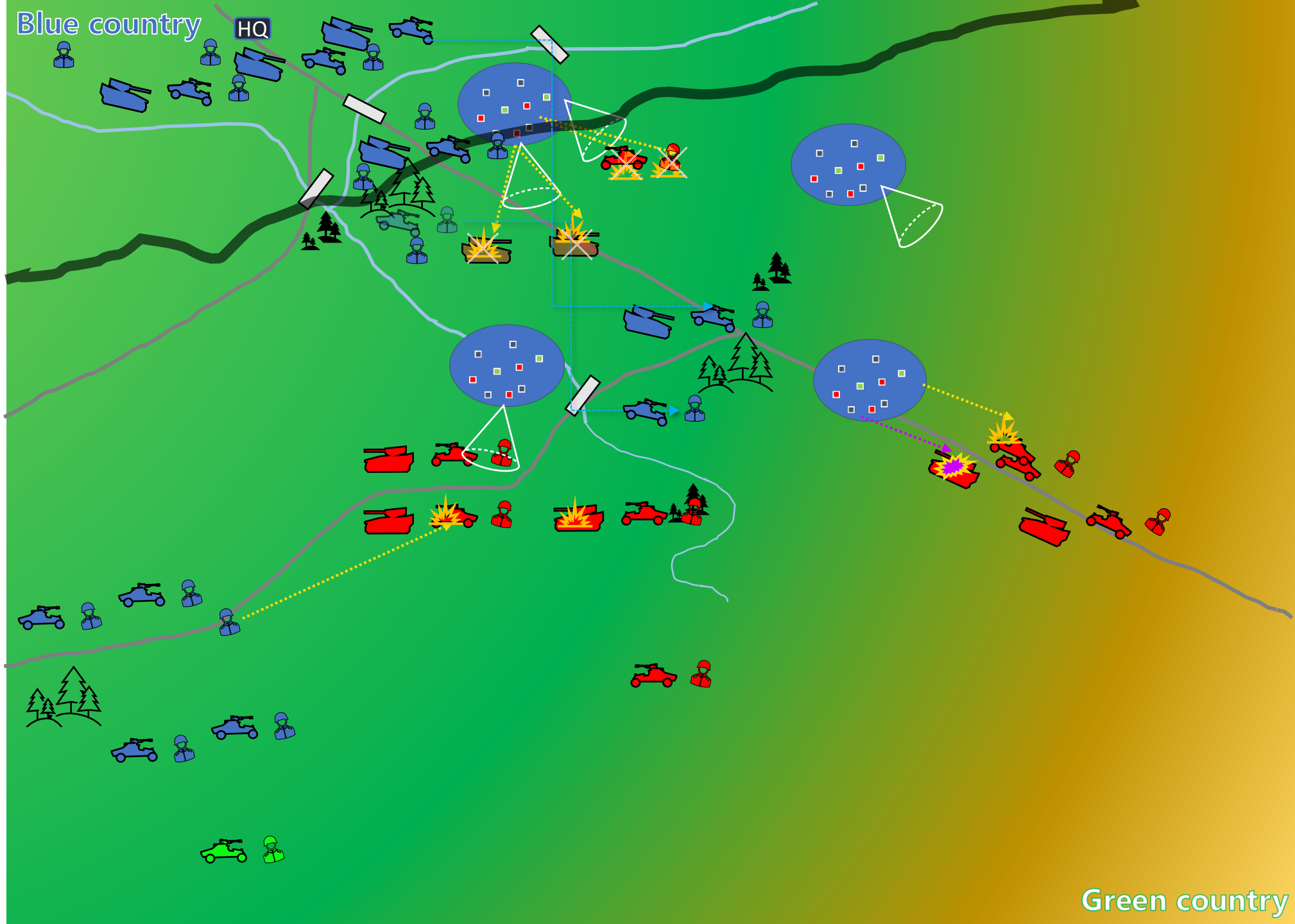
Use Case 6(b)

Theatre Entry: Opening a New Flank

Situation: Conduct a deliberate operation for theatre access and entry, enabling a Divisional size force to enter the battle space and open up a new flank. Then provide support to Green military forces to DEFEAT Red Forces from Green Territory, under NATO Article V agreement.

Intent: Through the use of MDIS-enabled Forces, a theatre access and entry operation will be conducted to provide re-enforcements through a new flank in order to defeat Red forces operating in the area of operations (AO), whilst maintaining FOAM in the vector of ingress and preventing a Red counter-flanking manoeuvre .

Main Effort (ME): Opening up a new flank to provide a secure theatre entry point for s divisional size force re-enforcing the AO.



UAS SWARM to Overload En. AD Targeting

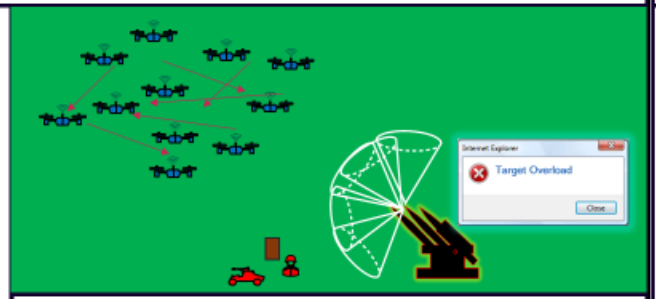
Aim: *Use of UAS Swarming in a dense array that forces En AD to attempt multiple targeting, rendering the system unable to select targets too overload.*

Description

BLUE possesses high volume of attritable RAS air-platforms that are able to cohesively swarm in a rapidly changing and randomised way (mimicking natural swarming of birds/fish/insects) that can cover a large area near AD installations.

Once the AD system is beginning to overload, BLUE Fast Air can be deployed to STRIKE the target locations in the window opened by AD impairment caused by the aerial swarm.

Acting autonomously, the swarm can either:
a) Be programmed with an ability to confidently assess an AD systems' impairment,
b) Be able to communicate to BLUE JF that the mission to overload En. AD is begun,
c) Behave autonomously, without comms link, and BLUE Air have another method of gauging AD's impairment.



Example Platform(s):

Domain(s)	
Air, Ground	

Autonomy Level	CMF	Status	Updated
XX	Not Completed (Link)	*Concept*	*24/01/2023*

Engineering Recce – Specialist UAV + USV Team (Wet Gaps)

Aim: *Supplementing an Engineering Recce Sergeant's team, the RAS team is able to provide gap reconnaissance and measurements, as well as delivering an aquatic asset to recce any body of water, including subsurface scanning.*

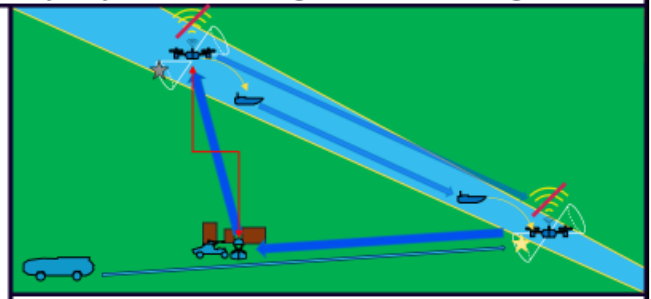
Description

UAS asset (i.e. Malloy 150) is deployed from Engineering RV and advances ahead of the Recce team with the USV (i.e. Sonobot 5) attached as a deployable payload.

UAS flies along the obstacle (i.e. river line), scanning and measuring with optical payloads. The USV is deployed and travels along the water taking river speeds, bank profiles, and subsurface scans. Data is reported back to the Recce Sergeant.

Recce team (Sergeant) relay information on the obstacle back to the Battle Group Engineer (BGE). BGE selects a crossing site / route clearance method.

Engineering RV moves in to position and deploys crossing assets.



Example Platform(s):

Example	Ops Range (Km)	Comms Range (Km)	Mission Life (hrs)	Max. Speed (Kph)	Cruise Speed (Kph)	Transport Req.s	Max. Payload (Kg)	Size (m, L x W x H)	Weather Conditions
Evologics Sonobot (Military)	30	2.5	9	18	4	2 Persons (50kg case)	10	1.3 x 0.9 x 0.8	River Speed Max. 15kph

Domain(s)	
Sea, Land, Air	

Autonomy Level	CMF	Status	Updated
XX	Not Completed (Link)	*Concept*	*24/01/2023*

High Altitude Balloon-launched Kamikaze Drones

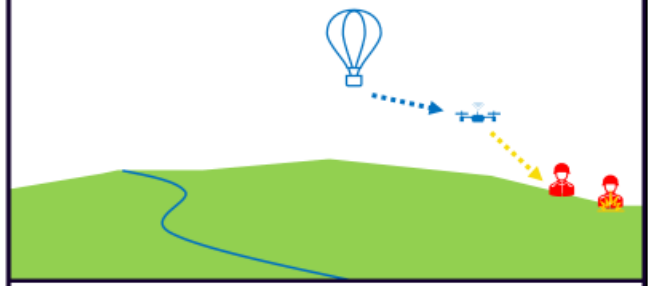
Aim: *Delivery of kinetic effects deep into enemy territory using a balloon as a launch platform for a drone.*

Description

Balloons operating at high altitude, deep within enemy territory, carry UAVs designed to crash into and destroy enemy targets.

The wings of the drones are retracted during transport but fold out upon release from the balloons.

The use of a balloon allows a UAS to be delivered at depth, which would not be possible based on the UAV's own battery.



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HAB Concept	150	50	~	Wind	Wind	Team Crew (RV)	2:28 Load:He	2-10x10x10	High Endurance

Domain(s)	
Air	

Autonomy Level	CMF	Status	Updated
XX	Not Completed (Link)	*Concept*	*24/01/2023*

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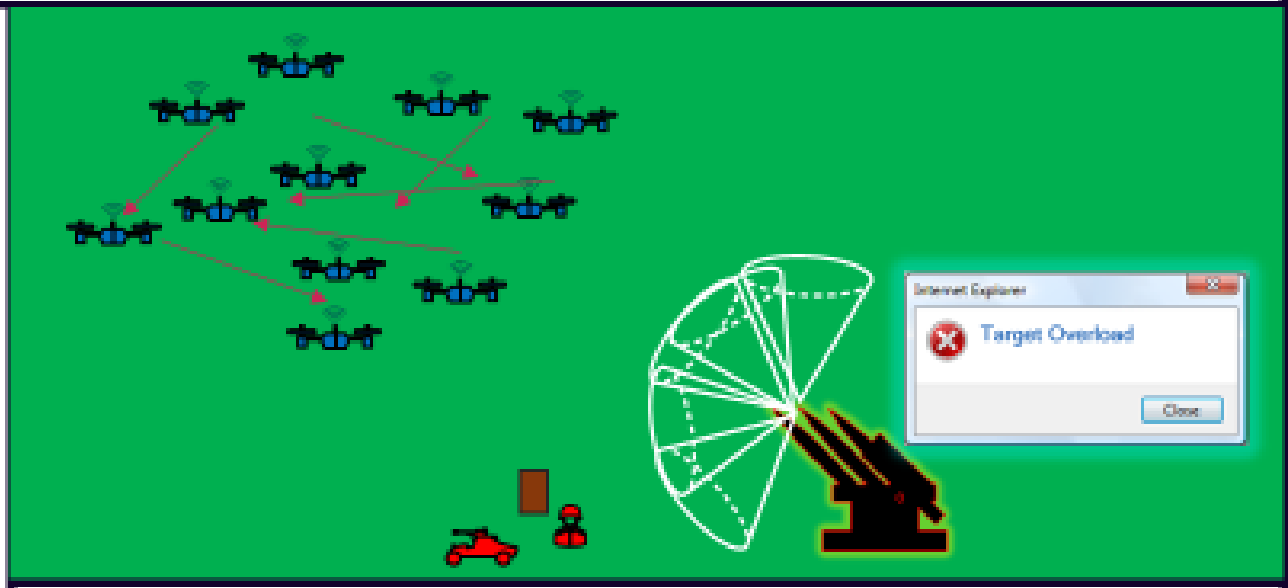

Example Platform(s):

Domain(s)

Air, Ground

Autonomy Level	CMF	Status	Updated
XX	Not Completed (Link)	*Concept*	*24/01/2023*

Measures of Merit

Examples:

- Probability of Mission Success
- Number of Blue System Losses
- % Red targets engaged
- Endurance time on task for an MDIS – enabled system
- Proportion of tasks executed without conflicts in resource allocation
- System failure / breakdown rate

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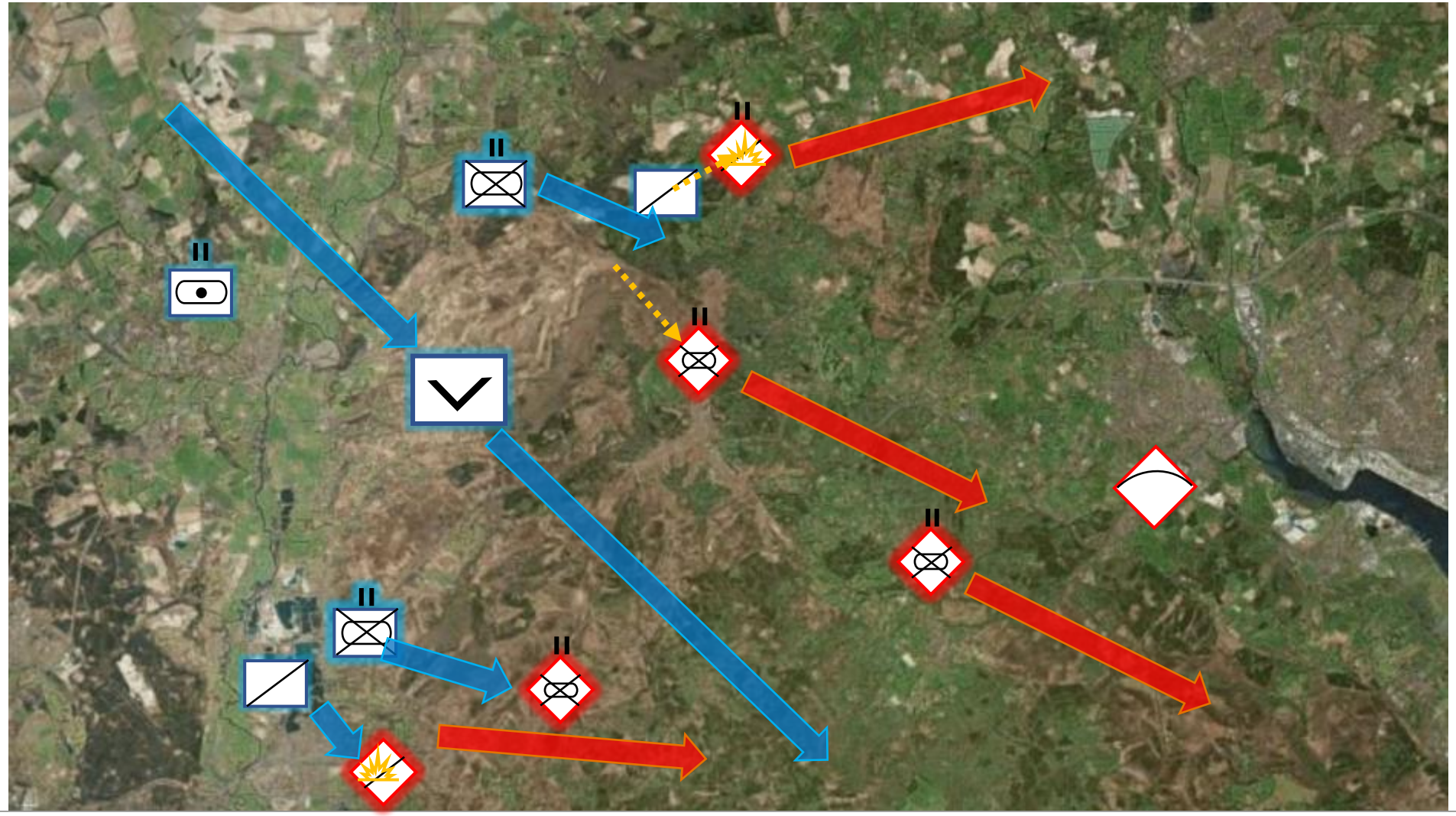
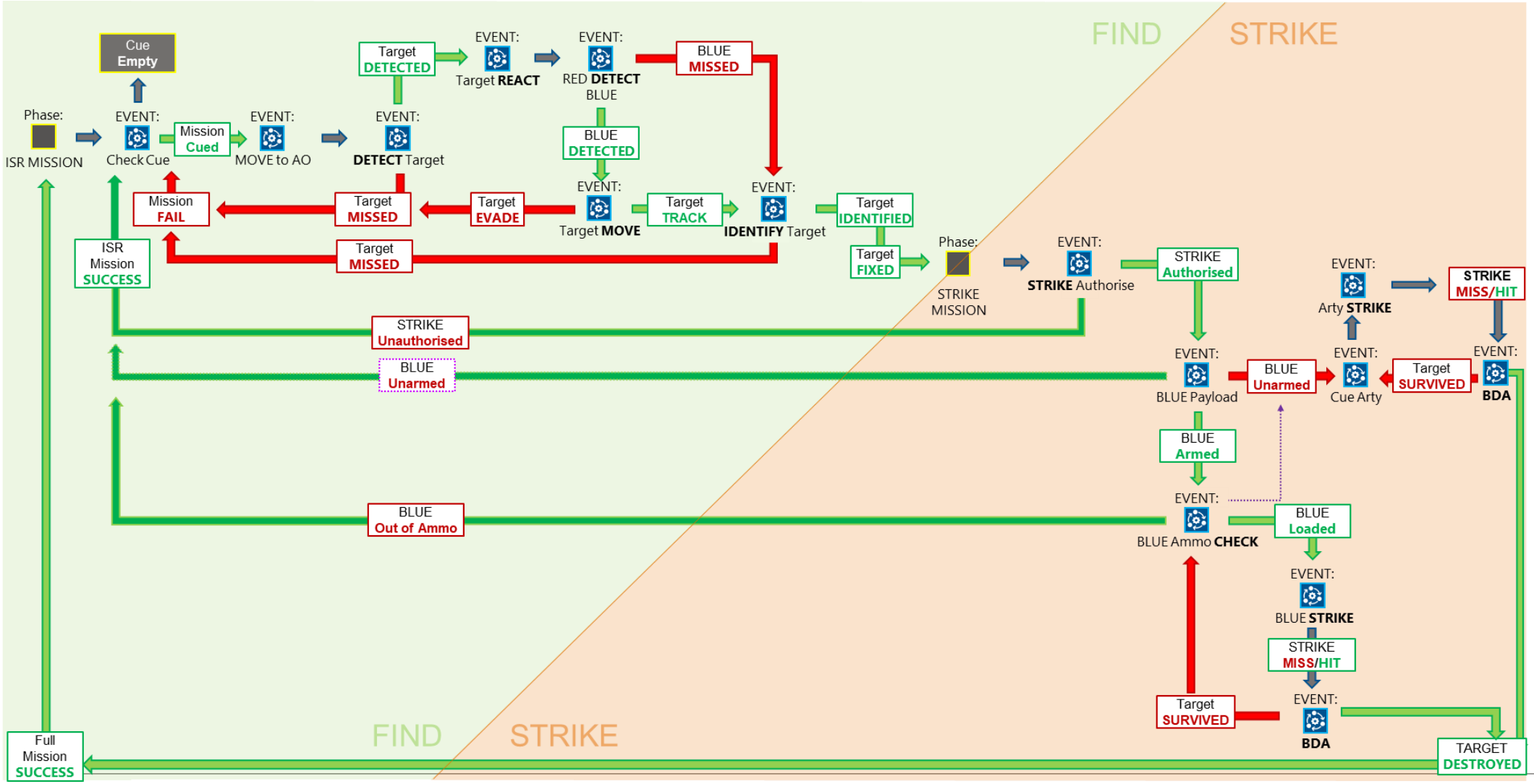
Testing & Modelling

Tabletop Exercises (TTX)



Modelling Example: Use Case 6(b)



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What Next?

- Gap Analysis
- Cost Analysis
- MOD RAS programme and platform investigations
- Attending RAS experimentation events
- Modelling
  - Theatre Entry Use Case modelled in SIMUL8.
  - SEAD Use Case modelled in Python.
  - ASW Use Case to be modelled soon.

- **Full OA report for the MDIS programme (March 2024)**

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Questions