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‘Skirmishing Mist’ Dismounted Infantry 2030 Concept

Nicholas Kempt

Joint and Operations Analysis Division
Defence Science and Technology Group

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Joint and Operations Analysis Division
Defence Science and Technology Group

DST Headquarters
Department of Defence F2-2-03
PO Box 7931
Canberra BC ACT 2610

www.dst.defence.gov.au
Telephone: 1300 333 362

EXECUTIVE SUMMARY

Defence Science and Technology (DST) Group's Land Capability Analysis (LCA) Future Technology Concept Exploration (FTCE) programme focusses on designing new and novel ways for Army to exploit and counter emerging technologies, and assessing the potential operational effectiveness of the conceptual and structural transformations. The results of these studies provide recommendations for Australian Army's consideration in order to inform research priorities, shape the future force, stimulate thought and debate, and address future warfighting challenges.

In conjunction with Army's Dismounted Combat Program, LCA conducted a FTCE study in support of future soldier development. The study aimed to develop post-2030 exploratory concepts that would support the long-term development of the soldier system and associated force structures and capabilities. The study was guided by the research question:

> *How will combinations of new and emerging technologies transform the battlefield engagement capability of dismounted infantry in close combat?*

The study applied a systemic design approach that combined several analytical research methods with a creative, participatory co-design exercise in order to generate novel initial concepts for the post 2030 close combat force. This report provides a complete description of the 'skirmishing mist' concept developed using the systemic design approach.

Skirmishing mist is a top-down paradigm driven concept based on the principle of small independent teams operating disconnected, disaggregated and decentralised below the detection threshold whilst delivering decisive multi-domain effects.

Key tenets of the concept are:

- Ability to move and fight dispersed, concentrating for specific actions to overwhelm a weaker enemy, and then dispersing again
- Ability to operate for long periods without orders (emphasising local decision making) or direct communications with other groups, reducing the communications and electronic signature of the team and improving its survivability
- Ability to deliver pervasive awareness and cueing — be intelligence driven through strong intelligence, surveillance and reconnaissance capabilities to 'find' and 'fix'

- Ability to 'infest' the terrain by blending with the physical, social, informational and electronic environments
- Ability to control and manage their signature by exploiting deception and concealment (deny all information) — hiding in plain sight
- Ability to conduct remote strike capabilities to engage adversary ('don't be there')
- Only rise above detection threshold and strike (multi-domain) for high value effect (the decisive blows)
- Skirmishing to set favourable conditions for decisive action by Brigade manoeuvre elements.

The Skirmishing Battalion (Bn) contains 25 teams under the command of an enlarged Bn headquarters reliant on artificial intelligence-enabled command and control systems to provide effective command and control of the teams. Each team comprises 20 soldiers contained in five functional cells (four soldiers per cell) – command, reconnaissance, pioneer, cyber-electromagnetic activities (CEMA) and strike. The team structure is adjustable in size and/or composition with supporting elements delivering psychological operations, air defence, human intelligence and medical capabilities depending on the operation and tactical situation.

The skirmishing force demonstrated strong find and fix capabilities but operating in a predominantly dispersed mode lacked combat mass and was vulnerable to being quickly overmatched if detected.

CONTENTS

GLOSSARY

2IC	Second in command
AD	Air defence
AO	Area of operations
ATGW	Anti-tank guided weapon
ATV	All-terrain vehicle
Bde	Brigade
Bn	Battalion
Bty	(Artillery) Battery
C2	Command and control
Cbt Eng	Combat Engineering
CEMA	Cyber-electromagnetic activities
CKEM	Compact kinetic energy missile
CSS	Combat Service Support
CYBINT	Cyber Intelligence
DARPA	Defense Advanced Research Projects Agency
DEW	Directed energy weapons
DMTD	Dismounted
DST Group	Defence Science and Technology Group
EA	Electronic attack
EO/IR	Electro-optical/Infrared
ES	Electronic sensing
FOE	Future operating environment
FTCE	Future Technology Concept Exploration
HATM	Hypervelocity anti-tank missile
HEL	High Energy Laser
HPM	High-Powered Microwave

HUMINT	Human intelligence
JTAC	Joint Terminal Attack Controller
JTF	Joint Task Force
LCA	Land Capability Analysis
LPD/LPI	low probability of detection/intercept
MANPADS	Manportable air defence systems
PSYOPS	Psychological operations
Regt	Regiment
RF	Radio frequency
RIAB	Radio-in-a-box
RSTS-V	Reconnaissance surveillance targeting strike vehicle
SNCO	Senior Non-Commissioned Officer
SPG	Self-propelled gun
SUO	Small unit operations
Tk	Tank
UAV	Unmanned air vehicle
UCAV	Unmanned combat air vehicle
UGS	Unattended ground sensors
UGV	Unmanned ground vehicle
UxS	Generic label describing all types of unmanned systems (Unmanned <class> System)
VTOL	Vertical take-off and landing

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1. INTRODUCTION

The Land Capability Analysis (LCA) Future Technology Concept Exploration (FTCE) programme explores the technologies, capabilities, concepts, and force structures future Australian Army combat teams require to deliver tactical overmatch and dominance in all foreseeable engagements under all conditions and future operational environments (FOE). The programme focusses on designing new and novel ways of operating (concept exploration) to exploit and counter emerging technologies, and assessing the potential operational effectiveness (the performance) of the conceptual and structural transformations. The results of these studies provide recommendations for Army consideration in order to shape the future force, stimulate thought and debate, and address future warfighting challenges.

Following discussions with the Army Dismounted Combat Program it was agreed that Defence Science and Technology (DST) Group's LCA would conduct a FTCE study in support of future soldier development. The study would develop post 2030 exploratory concepts that would support the long-term development of the soldier system and associated capabilities. This study is significant because Army needs to prepare for a future where 'advances in sensing, precision attack, and decision-making will fundamentally alter the character of future conflict engagement'[1].

1.1. Advanced Engagement Battlespace

The FTCE study was aimed at exploring future advanced engagement concepts guided by the research question:

- How will combinations of new and emerging technology transform the battlefield engagement capability of dismounted infantry in close combat?

Where:

- Technology are those capabilities assessed to be viable in 2030 timeframe
- Battlefield engagement is framed by the lower tactical functions of find, fix, strike and exploit[2]
- Infantry is light infantry[3] including unmanned enablers at the combat team level.

[1] https://smallwarsjournal.com/jrnl/art/advanced-engagement-battlespace-tactical-operational-and-strategic-implications-future

[2] Land Operations, Land Warfare Development Centre, UK Army Doctrine Publication AC 71940, 2017

[3] Future studies will explore the mounted infantry combat domain

The study assumed that close combat is enduring and involves a 'collision between two living forces', i.e. close combat still requires human interaction and that robot wars have not come into existence.

1.2. Methodology

The study adopted a systemic design[4] approach to answer the research question. This approach combined several analytical research methods with a creative, participatory co-design exercise in order to generate novel initial concepts for the post 2030 close combat force.

The systemic design method guides the analysts through:

- Foresight scenarios
- Concept/inspiration cards
- Historical analogue
- Divergent brainstorming
- Innovation ambition matrix
- Idealised design
- Wind tunnelling
- Concept sketch
- From-to shifts
- Riskiest assumption identification.

The options generated in this study are intended to be novel, plausible and transformational. They require further feedback, analysis and refinement before they should be used to inform conceptual aiming points for future dismounted combat teams.

A four-day systemic design workshop was held at DST Group Edinburgh (September 2019) with Army participants (Senior Non-Commissioned Officer and Officers) who had strong infantry knowledge base, and DST Group technology experts and operations analysis staff. Over the four days the participants were guided through the systemic

[4] The approach was previously used to study Australian Army in 2050.
Joint Studies Paper Series No. 3, *Design Thinking: Applications for the Australian Defence Force: 'Systemic Design of a Force for the Australian Army in 2050'* by Brandon Pincombe *et al.*

design process which enabled them to be immersed in future scenarios and post 2030 technological space[5], and gain an understanding of divergent conceptual evolution in the 1920/30s and its ramifications[6]. The participants were then separated in to two syndicates that mixed Army and DST Group participants to design and develop the future concepts. Two detailed concepts were generated during the workshop. The workshop concluded with an assessment of concept effectiveness against future scenarios and a risk identification assessment.

This report details the 'skirmishing mist' concept, its sub-concepts and the supporting force structures generated during the systemic design workshop. The report concludes with a performance assessment of the concept.

As noted above, future scenarios are used to enable an understanding of the contexts and challenges any future-orientated design must satisfy and secondly provide test environments to evaluate the performance of the designs. The scenarios and associated vignettes used in this study are summarised in Table 1. A set of vignettes derived from past experiments and historical battles have been classified by the four scenario themes representing different tactical situations and terrain; the threat forces being encountered, and the type of mission to be conducted – offence or defence overlay.

Table 1 Scenario space

	Scenario Themes			
Threat	**Tropical Battlefield**	**Urban Battlefield**	**Subterranean Battlefield**	**Airmobile Operations/ Isolated Position**
State-Sponsored Hybrid	1.B Long Tan	2.A Marawi	3.A Cu Chi	4.B Secure Airfield 4.C COP Keating
State Force	1.A Borneo	-	3.B Toronto	4.A Coy Block

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[5] A total of 108 emerging technologies and concepts were presented

[6] Reflection on the different concept development by France and Germany in response to post-WW1 analysis during the inter-war period.

2. SKIRMISHING MIST CONCEPT

Following the contextualisation and technology immersion phase of the design process the syndicate reflected on the challenge of designing novel and transformative concepts against the research question – future battlefield engagement capability. Through a process of discussion and reflection the syndicate embraced the idea of operating and fighting below the detection threshold as a potential transformative vision. The idea framed by the notion of a professional guerrilla style army operating as small dispersed loosely connected teams.

Through the systemic design process this initial idea was matured under the label 'Skirmishing mist'. The label represents the ability of the land force to disperse and envelop the terrain, concentrate for action and then evaporate. It echoes the words of T.E. Lawrence who said:[7]

> 'Suppose we were (as we might be) an influence, an idea, a thing intangible, invulnerable, without front or back, drifting about like a gas? Armies were like plants, immobile, firm-rooted, nourished through long stems to the head. We might be a vapour, blowing where we listed. Our kingdoms lay in each man's mind; and as we wanted nothing material to live on, so we might offer nothing material to the killing. It seemed a regular soldier might be helpless without a target, owning only what he sat on, and subjugating only what, by order, he could poke his rifle at.'

The underpinning operating paradigms[8] developed for this concept were:

- Skirmish to set favourable conditions for decisive action by manoeuvre elements
    - The concept is not the grand sole solution to everything; it is a key element of a Brigade (Bde) Joint Task Force (JTF) capability.
- Operate disconnected, disaggregated and decentralised
    - Ability to operate in small modular teams that can survive the destruction of other groups.
    - Ability to move and fight dispersed (the invisible water droplet), concentrating for specific operations (cloud formation) to overwhelm a weaker enemy, and then dispersing again (to evaporate).

[7] *Seven Pillars of Wisdom*, By Thomas Edward Lawrence, Wordworth Editions Limited, 1935 & 1997

[8] The authors acknowledge the basis to some of these ideas and language use is adapted from a presentation by David Kilcullen at RUSI Land Conference 2018

    - Ability to operate for long periods without orders (local decision making) or direct communications with other groups, reducing the communications and electronic signature of the team and improving its survivability.

- Operate below the detection threshold (embrace stealth)
    - Ability to deliver pervasive awareness and cueing – be intelligence driven through strong intelligence, surveillance and reconnaissance capabilities to find and fix.
    - Ability to 'infest' the terrain by blending with the physical, social, informational and electronic environments (the enveloping mist).
    - Ability to control and manage signature by exploiting deception and concealment (deny all information) – hiding in plain sight.
    - Ability to conduct remote strike capabilities to engage adversary (don't be there).
- Do not hold terrain but destroy, disrupt, degrade, deny and deceive the adversary
    - Only rise above detection threshold and strike (multi-domain) for high value effect (the decisive blows)
        - Ability to coordinate with adjacent teams and reachback for collaborative/synchronised effect (cloud formation)
        - Achieve time sensitive attack through rapid effects generation
    - Systematically targeting the linkages and nodes that hold the force together (fragmenting the force)
        - Attack the adversary across all domains and locales (strike in depth) with emphasis on 'info-kinetic manoeuvre'
        - Enduring attacks and harassment to dislocate, weaken and exhaust the mind of the enemy
    - Avoid major combat – do not become decisively engaged in combat.

A conceptual metaphor for this idea is submarine warfare - independent submarine actions (the team) and the opportunity for collective attack by several submarines (i.e. coordinated/synchronised 'wolfpack' teams) operating under broad direction and limited control. Submarine tactics are 'dispersion, surprise, strikes where the enemy is weak and unprepared, disappearance into the vastness of the ocean, and a continuing erosion of enemy morale and dilution of his resources.' The concept also echoes, for

example, the US Navy distributed lethality sea control concept[9], the MITRE Corporation's Small Unit Operations (SUO) concept[10] and DARPA's Mosaic Warfare[11].

2.1. High-level Concept

Figure 1 illustrates the overarching concept based on the design paradigms. Small low signature teams will provide a persistent force across the battlespace in the support, close and deep areas. Each team is assigned an area of operation (AO) where they would seek to destroy, disrupt, degrade, deny and deceive the adversary under broad guidance and direction. Decision authority and initiative is held by the team leader. Entry into the AO would be achieved using airmobile, amphibious and riverine support capabilities and land infiltration. This mode of entry and operating paradigm demands capabilities that are stealthy, light, agile and austere. In support of the teams are a higher command and communications element, a range of strike fires services delivering persistent and timely area and precision effects, and logistic and medical services.

[9] https://www.public.navy.mil/surfor/Documents/Surface_Forces_Strategy.pdf
[10] https://apps.dtic.mil/dtic/tr/fulltext/u2/a350176.pdf
[11] https://www.darpa.mil/work-with-us/darpa-tiles-together-a-vision-of-mosiac-warfare

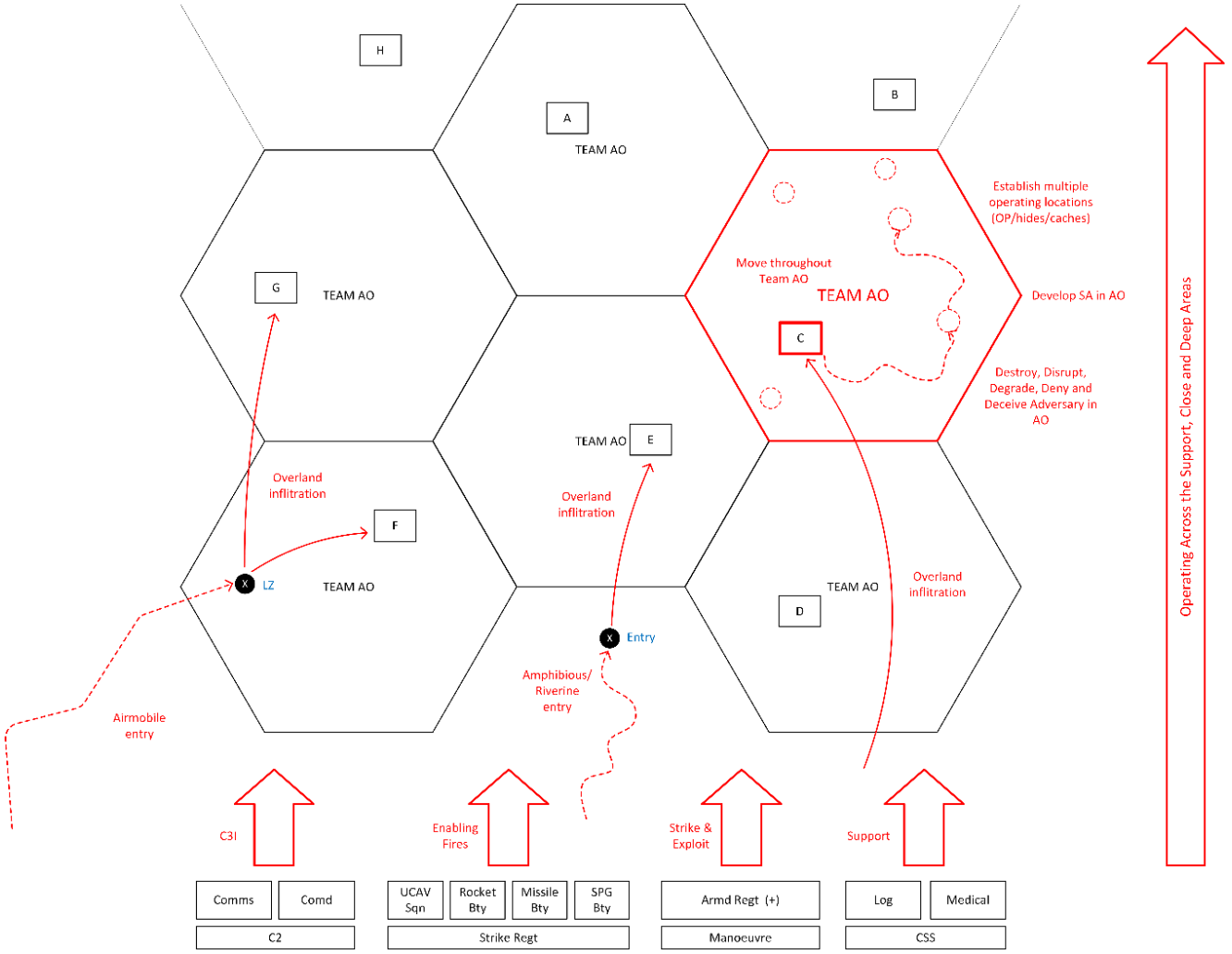

Figure 1. Skirmishing mist high-level concept framework

A heavy mounted manoeuvre element is primed to deliver a decisive strike exploiting the situation and window of opportunity created by the skirmishing actions (Figure 2). The manoeuvre force has the capability to own and control terrain – a capability not resident in the skirmishing force concept.

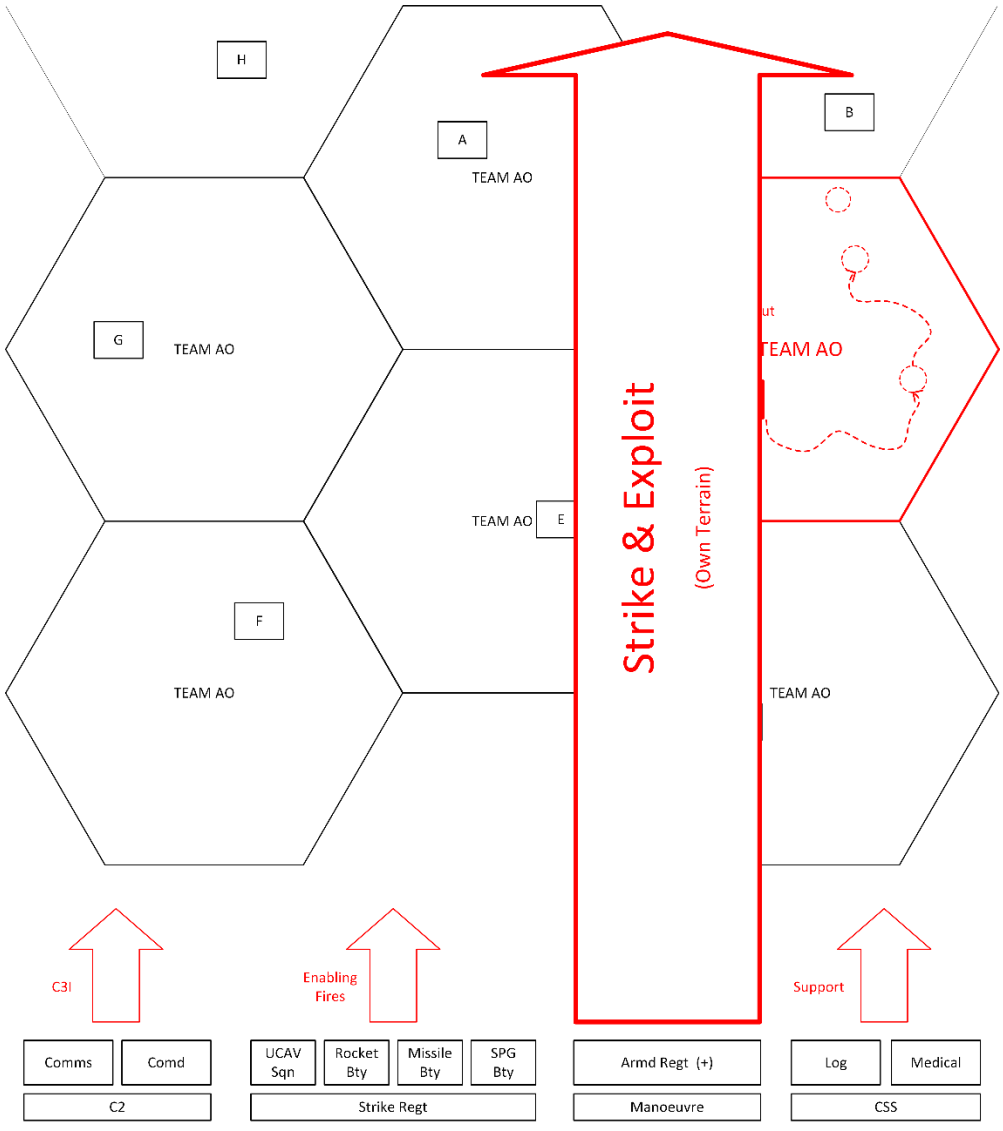

Figure 2 Skirmishing mist mounted manoeuvre

The following sections describe how the concept is realised.

2.2. Strike Sub-Concept

Five modes of strike were developed as part of the concept (Figure 3):

- Mode A – the primary mode of operation, involving the team detecting and acquiring targets and then 'tagging' for prosecution by loitering unmanned combat air vehicles (UCAVs) and/or munitions. The tag can be an electronic tag[12] emplaced via for example a nano-class UAV, smart dust, or chemical marker; or the tag can be a biometric profile that is passed to higher HQ for coding. As well as destroy tags the team can tag targets for preservation – do not strike, representing significant locations, assets or people. Remote strike is also achieved using smart mines and remote robotic weapon stations against tagged targets and targets of opportunity that match a given hostile profile/signature with authorisation to engage enabled by an 'AI judge' within the weapon fire control system.
- Mode B involves the team executing a remote strike by calling in fire on confirmed targets using the Strike Regiment (Regt)(a recon-strike JTAC mode). This mode requires the team to raise its signature by transmission of request for fire and any coordination.
- Mode C has the team conducting local direct action with organic to team weapon systems when the situation presents an opportunity to strike under favourable conditions. This mode can be supported by remote fires to deliver the decisive effect.
- Mode D involves a coordinated local strike by the teams using organic to team weapon systems (the 'wolfpack' vision). The mechanism to coordinate the strike discussed in Section 2.3. The target has to be of significant value and size to warrant the coordinated use of the teams. This mode can be supported by remote fires to deliver the decisive effect.
- Mode E represents the ability of loitering UCAV and missile systems to conduct independent sense and strike missions. This mode embraces the technology concept of independent collaborative UCAV/weapons. This mode requires identification friend or foe capabilities to avoid fratricide.

The teams contain the ability to deliver scalable lethal, non-lethal, informational and cyber effects.

[12] A brief description of 'tagging tracking and locating' (TTL) technology is described in https://www.wired.com/2009/06/inside-the-militarys-secret-terror-tagging-tech/

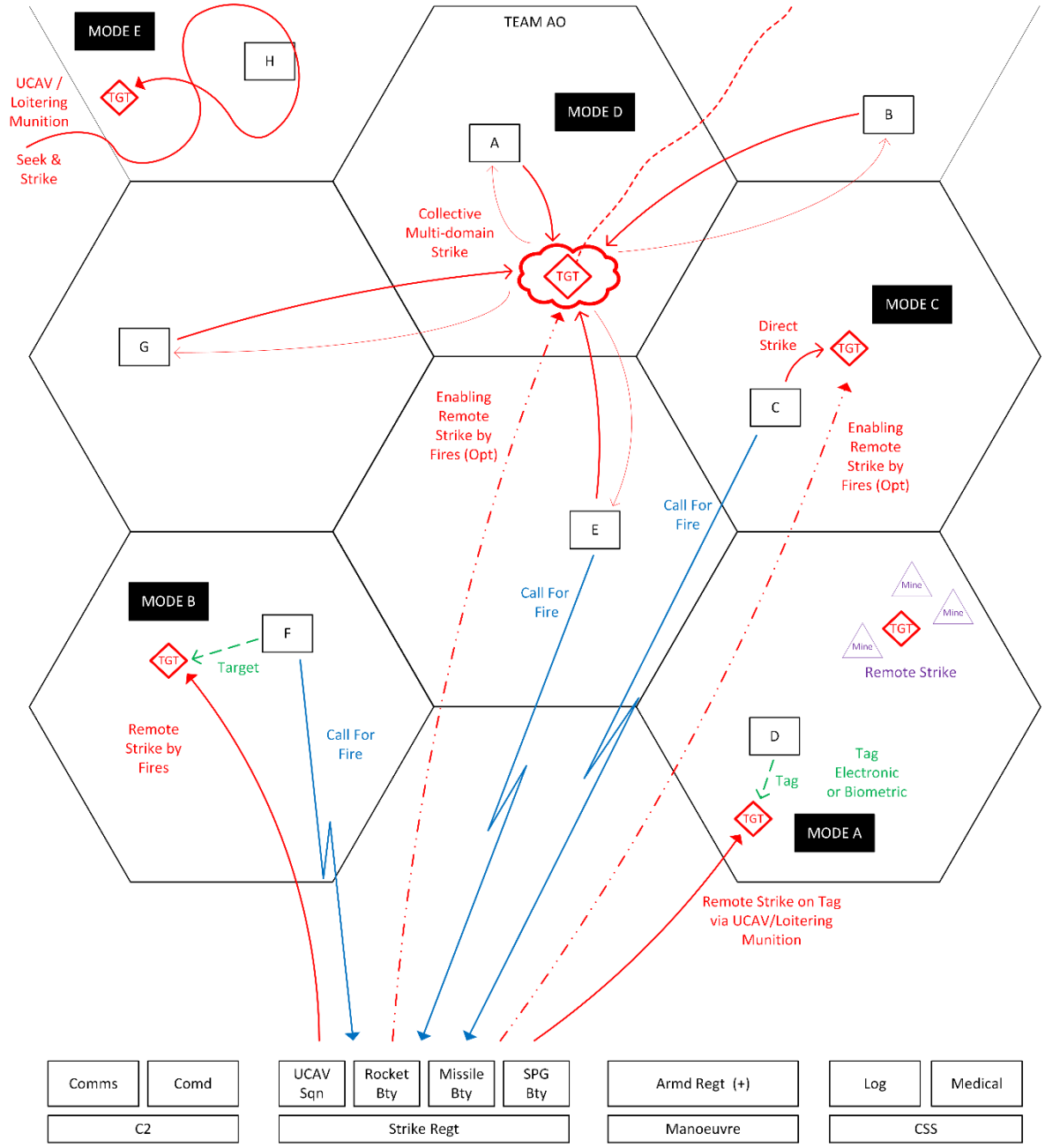

Figure 3 Skirmishing mist strike sub-concept

2.3. Communications Sub-Concept

The ability to remain below the detection threshold whilst effectively communicating within and between teams and to higher HQ presented a major challenge. The syndicate adopted a range of communication means to maintain a minimal signature:

- Following the submarine operations philosophy, the primary means for the higher HQ to communicate with the teams is through a one-way broadcast messaging system using coded transmissions. This form of communication would be for short control messaging given the bandwidth and security constraints.
- For high information density transmission between the teams and with the higher HQ a UAV courier method is to be used. High volumes of data can be uploaded on to the UAV and dispatched. The recipient then retrieves the UAV and conducts a data upload. With small UAVs having the ability to transit in excess of 200 kph this provides a short delay (a few hours) in information exchange, however it provides a very high bandwidth. Extending this mode of operation is the ability for two UAV couriers to meet a predesignated data exchange points and conduct short range aerial data transfer.
- Inter-team communication can be achieved by face-to-face conversations with adjacent teams at designated coordination points on AO boundaries or through the use of optical communications (when present) either by direct line-of-sight or UAV repeaters. Optical communications[13] can also be used as an intra-team mode of communications when team cells are widely dispersed.
- When possible the teams can exploit civilian communication and transmission systems by 'hiding in plain sight' through the use, for example, steganography or within an inconspicuous carrier protocol[14].
- The final mode of communication within and between the force elements is the use of low probability of detection/intercept. (LPD/LPI) communication over radio-frequency (RF) channels but this is considered for use by exception to reduce team susceptibility of compromise.

[13] For example the US Navy Postgraduate School exploring digital semaphores using QR codes. (https://calhoun.nps.edu/handle/10945/34727?show=full)

[14] https://www.blackhat.com/docs/eu-15/materials/eu-15-Bureau-Hiding-In-Plain-Sight-Advances-In-Malware-Covert-Communication-Channels-wp.pdf

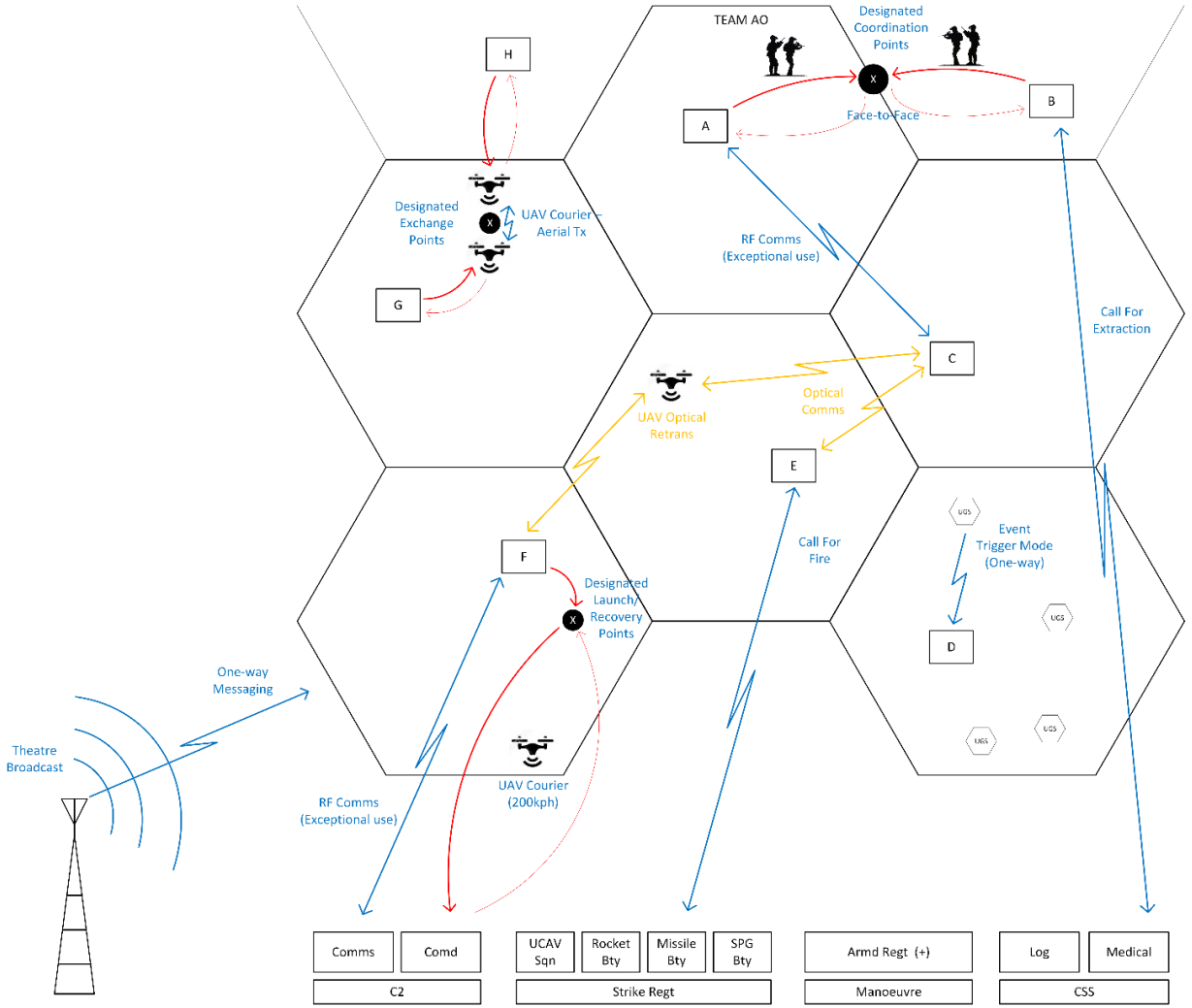

Figure 4 Skirmishing mist communications sub-concept

2.4. Sensing Sub-Concept

The concept is strongly based around the use of passive and remote sensing technologies to acquire data and information on the battlespace. Passive sensing includes electronic warfare (EW), acoustic, seismic, magnetic, chemical, and electro-optical / infrared (EO/IR); however the EO/IR capability is susceptible to retro-reflection detection. The widespread use of unattended ground sensors (UGS) fields, EW, passive radar and acoustic arrays was considered the primary means of threat detection augmented by EO/IR - both ground and air based (UAV). The UGS field could be deployed via UAV and potentially mounted on UGV to give a fluid UGS field able to respond to the tactical situation. Active sensing would be applied when the risk of detection is consider low including ground surveillance radars and laser mapping/target detection.

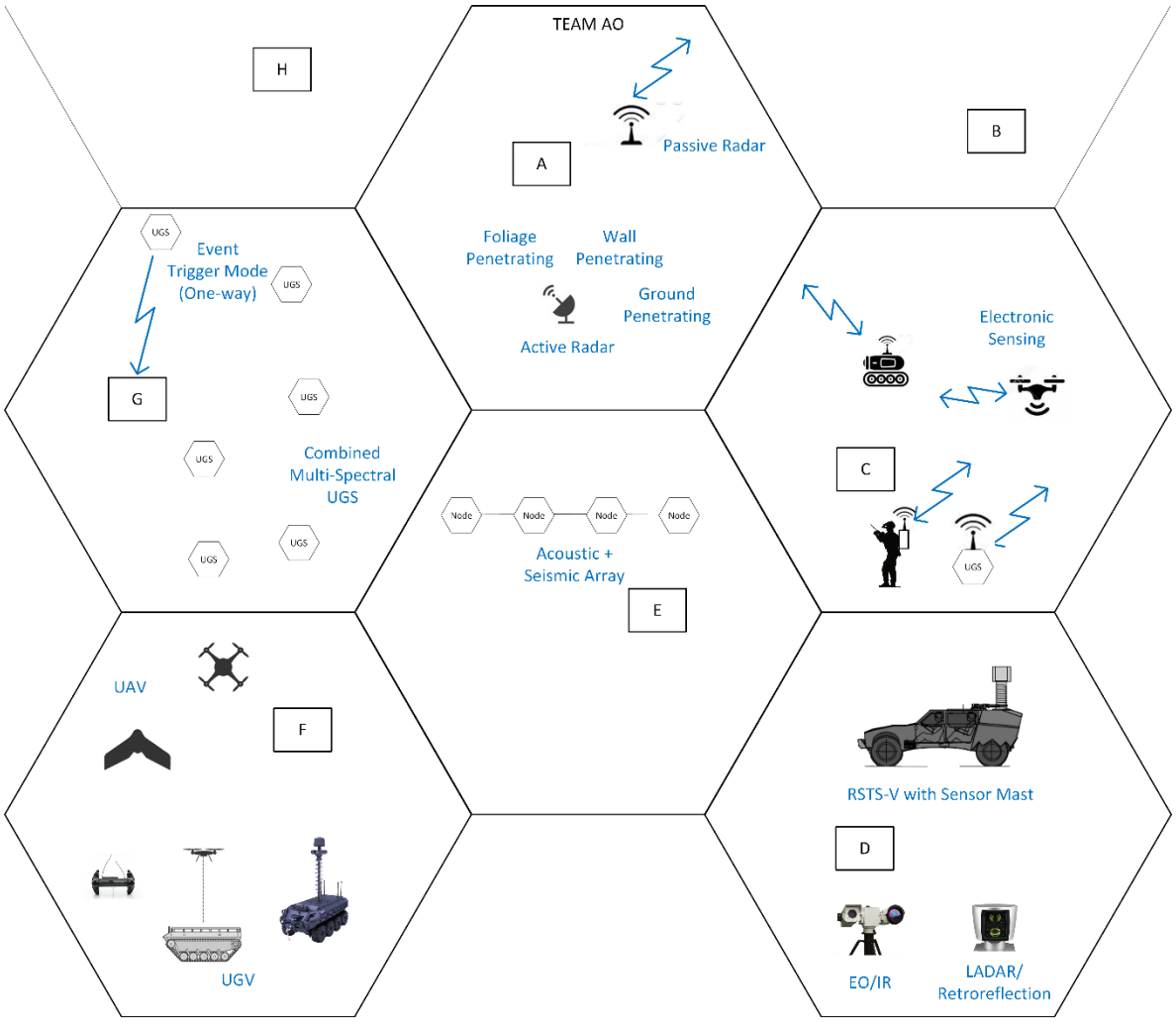

Figure 5 Skirmishing mist sensing sub-concept

2.5. Denial and Deception Sub-Concept

The ability to operate effectively below the detection threshold, achieve tactical surprise and survive is paramount to this concept. The concept embraces the ability to passively and actively conduct denial and deception through[15]:

- Concealment
- Imitation
- Simulation
- Demonstration
- Disinformation.

The denial and deception countering improved broad-spectrum multi-sensor/platform collection systems, overhead imagery, persistent collection means; intelligent and multi-sensor capable smart munitions; and data-processing, fusion and exploitation capabilities.

[15] The five elements of the maskirovka model of denial and deception

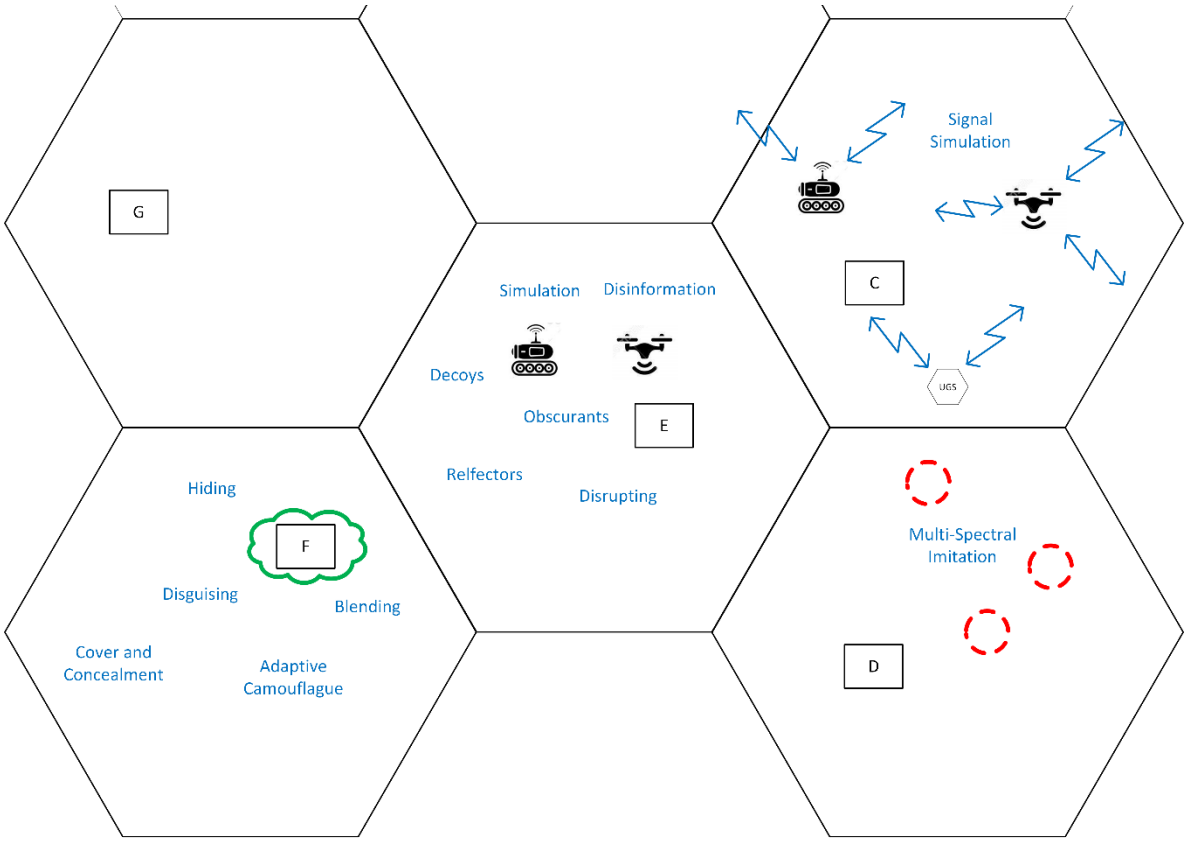

Figure 6 Skirmishing mist denial and deception sub-concept

The denial and deception occurring across all potential detection means including acoustic, seismic, chemical (smell), optical, thermal, RF, informational and cyber. There is significant potential to use UAV and UGV to raise the background noise level with EW, acoustic, and other signatures to aid concealment.

2.6. Service Support Sub-Concept

The term austere is vital to the success of this concept, where the teams are designed not to rely on external supplies in support of operating below the detection threshold. This would be achieved through foraging and enabling technologies such as hydrogen fuel cell vehicle power generation delivering exportable power and water as a by-product, water from air systems, limited additive manufacturing, high-lethality smart weapons using precision over volume/mass fires and electric weapons such as directed energy weapons.

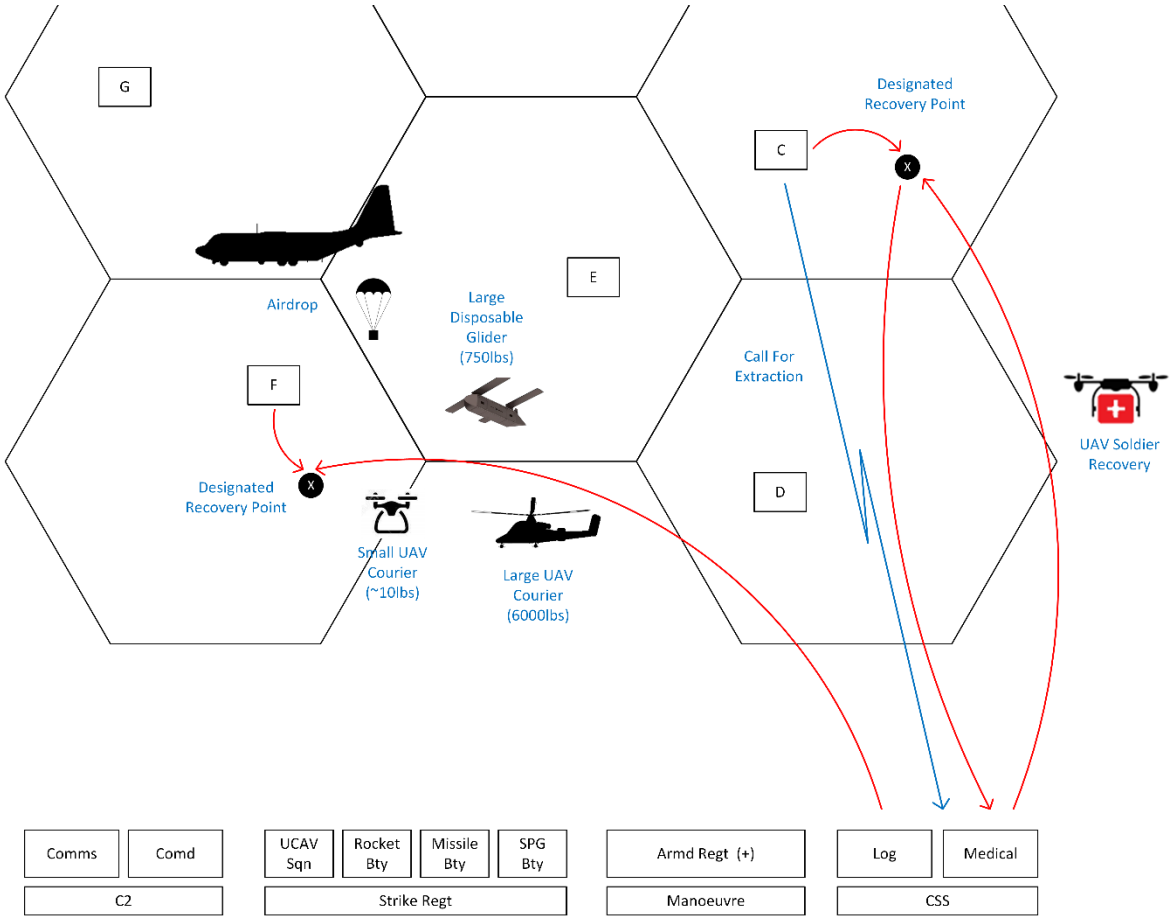

Figure 7 Skirmishing mist service support sub-concept

When resupply is required a range of air delivered systems were identified depending on the mass, volume, urgency and range the cargo has to be delivered over. Systems considered viable include small quick and light UAV couriers (e.g. Amazon delivery service), larger helicopter based UAVs (e.g. Kaman K-MAX), large disposable glider (e.g. Logistic Gliders LG-1K) and airdrop by fixed wing aircraft (e.g. C27/C130). Ground resupply was not considered viable given the signature of any potential resupply mission and the requirement to infiltrate enemy held territory.

Injured soldier extraction and recovery is via on-call UAV medical system with the injured soldier placed within a trauma care system (e.g. trauma care in a rucksack, or TRACIR) increasing the likelihood of soldier survival.[16]

[16] https://www.nationaldefensemagazine.org/articles/2019/8/20/army-developing-robotic-trauma-care-system

3. SKIRMISHING MIST STRUCTURES

3.1. Formation Structure

During the workshop the focus was on the development of the skirmishing mist element with limited amount of time assigned to exploring the wider Bde level impact of the 'infantry concept'. Accordingly, the Bde level structure (Figure 8) is incomplete but contains the essential elements required to support the teams when deployed.

The main focus of the workshop was the development of the Skirmish Bn element. The Bn contains 25 teams under the command of an enlarged Bn HQ reliant on AI-enabled C2 systems to provide effective command and control of the teams. Each team comprises 20 soldiers contained in five functional cells (four soldiers per cell) – command, reconnaissance, pioneer (or combat engineering), cyber-electromagnetic activities (CEMA) and strike. The team structure can be augmented with supporting elements delivering psychological operations (PSYOPS), air defence, human intelligence (HUMINT) and medical capabilities depending on the operation and tactical situation. Sections 3.2 and 3.3 detail the structure and capabilities of the cells.

A Strike Regt delivers persistent battlefield effects through a combination of systems. Figure 9 describes the UCAV Sqn and the 'Flying Arsenal' platform that is capable of delivering sensing and strike capabilities complemented by land based fires capabilities – the rocket, missile and self-propelled gun (SPG) batteries (Figure 10). The Tiltrotor UCAV operations are significantly influenced and impacted on by adversary air defence capabilities although this risk is offset by the persistent long-range land fires element.

The Armoured Regt element provides the capability to conduct traditional manoeuvre generating decisive 'shock and awe' land effects and have the ability to 'own the terrain.' Given the development of advanced C2 capabilities it was judged that an increased span of command was viable. The Regt is a permanent cross-functional entity containing tank, armoured infantry, combat engineering and support services. It will exploit the capabilities of the skirmishing Bn when required.

A Support Bn provides a vertical lift component able to uplift and deliver at range and high speed all the elements of the Skirmish Bn including light vehicles, provide logistic and medical support, and deliver communication capabilities.

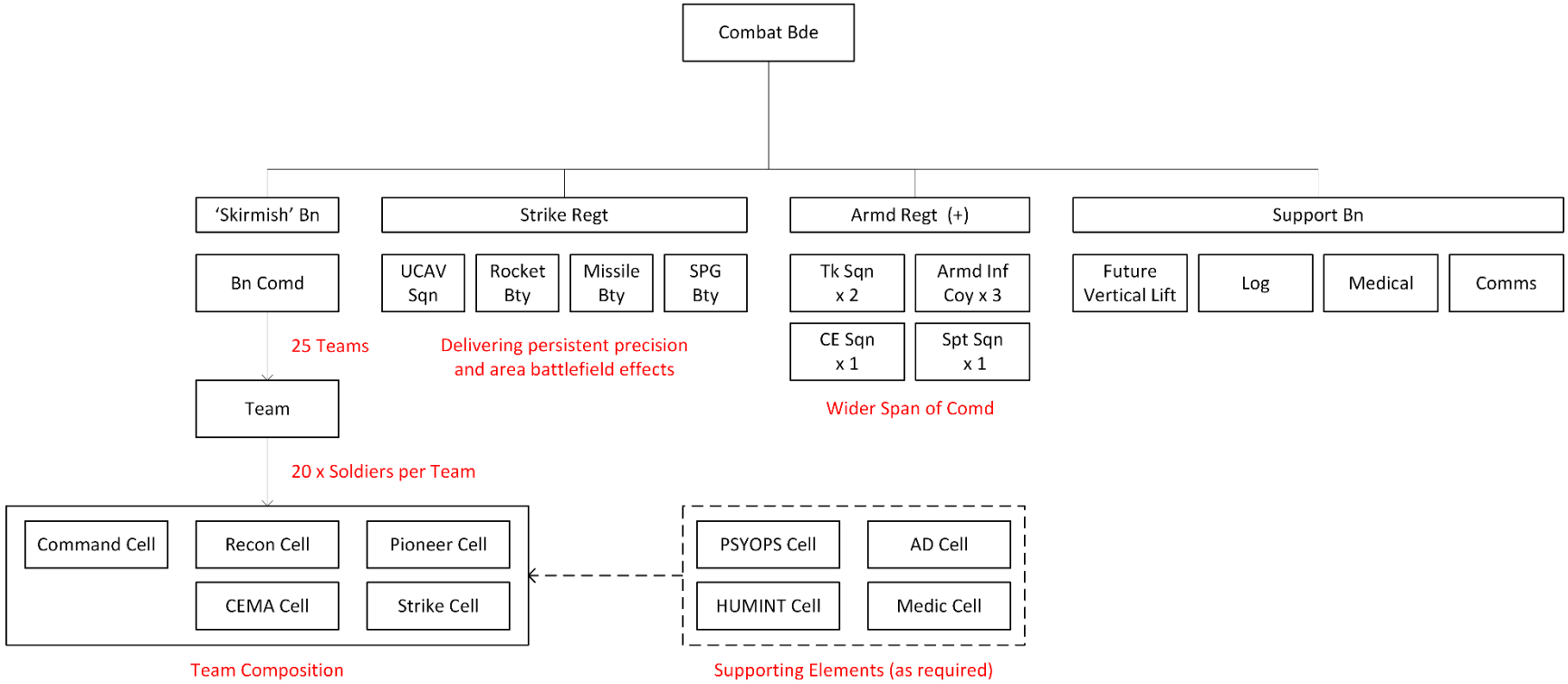

Figure 8 Skirmishing mist formation structure

UCAV 'Flying Arsenal'

- UCAV Sqn Capabilities
  - Persistent – 12/24 hour coverage at range (VTOL Tiltrotor e.g. V247 Vigilante)
  - Overhead strike capability (configurable)
    - Precision munitions
      - Bombs (SDB), Rockets, PGM incl Anti-Radiation
      - Multi-mode scalable munitions
    - Direct Fire
      - DEW (Laser/HPM) and Cannon Turret
    - Electronic Attack (EW)
    - Mothership for UAV/Weapon 'swarm'
  - Autonomous tag detection and engagement
  - Responds to 'Call for Fire'
  - Performs surveillance and reconnaissance using on-board multi/hyper-spectral sensors
  - Usage dependent on threat AD capabilities
  - Analogy – AC-130 Spectre Gunship

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Figure 9 Skirmishing mist UCAV Sqn capabilities

Land Based Fires

- Capabilities
  - Persistent and responsive delivery of fires
    - 24 hour all weather coverage
    - Rocket Bty
      - Autonomous, modular launching system, capable of firing various artillery rockets and tactical missiles, from 122 to 300mm
      - Precision and area fires to 300km
    - Missile Bty
      - Autonomous launch system capable of firing precision and loitering attack missiles to 150km
    - SPG Bty
      - 155mm autonomous system
      - Delivers sustained precision and area fires to 70km
  - Strike capability munitions:
    - Sensor Fused Munitions, Anti-armour, Thermobaric, multi-function scalable warheads, anti-radiation
    - EMP and RF jammer effects (attack and decoy)
    - Hypersonic Missiles
      - Time Sensitive Targets
      - Hardened Targets
    - Dispenser for
      - UAV/Weapon 'swarm' systems
      - Smart Mines
      - PSYOPS
  - Can deliver reconnaissance payload for targeting and BDA






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Figure 10 Skirmishing mist rocket, missile and SPG battery capabilities

3.2. Team and Cell Structures

3.2.1. Team structure

The 20 person team is the baseline configuration of the Skirmish Bn force structure. In the baseline configuration each cell contains four personnel in five functional cells – command, reconnaissance, pioneer, CEMA and strike. The baseline structure has the ability to adjust to the scenario, mission and threat through the variation in the number of personnel per cell and the addition of supporting elements. For example the baseline 20 soldier team could generate (Figure 11) a light version with 12 soldiers and reduced capacity or adjust the team for stability operations with the inclusion of, for example, PSYOPS and HUMINT elements.

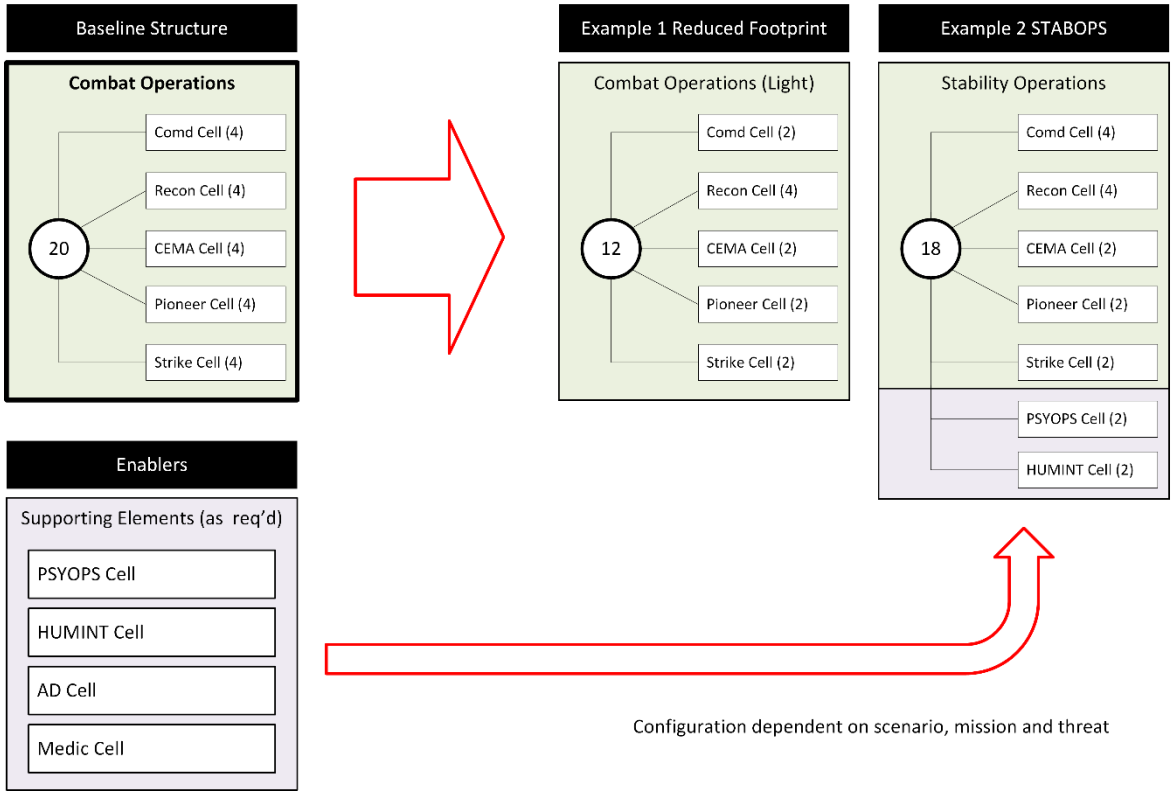

Figure 11 Skirmishing mist team structure

3.2.2. Generic cell structure

As described above, the generic cell structure contains four personnel with a selection of mobility options (Figure 12). The mobility options provide the soldiers with a suite of capabilities to enhance movement and manoeuvre, and for the carriage and operation of equipment that exceeds individual soldier capacity.

Soldiers

The soldiers in this concept were based on the Australian Army Soldier Combat System Future Soldier vision 2040[17]. The future soldier possessing technologies such as exoskeletons, advanced multi-spectral camouflage, integrated information systems including soldier monitoring, and load carriage systems (Figure 13).

Whilst the future soldier presents a technological aim point, in some scenarios and situations the signature profile of the future soldier concept would not provide the ability to blend effectively with the operating environment; it would generate a unique and distinct signature. In this situation, selected sub-systems would be employed to provide best effect without presenting a unique signature.

Agile individual mobility

A small agile electric drive ATV that was readily transported by all lift means and able to operate in constrained environments was considered a potential extension to a soldier's ability to operate. The exemplar shown is the EZRaider HD4 electric-powered scooter with a range of around 80 km on a single charge with top speed of 50 kph and weighing only 130 kg. It can transport one soldier and 75 kg of equipment. A powered electric trailer with its own battery can allow an additional 250 kg of cargo, or a stretcher rack, and when coupled to the scooter can double the operating range.

Reconnaissance Surveillance Targeting Strike Vehicle (RSTS-V)

The primary mode of transport and operations for the cell is the 4×4 vehicle that is designed to accommodate the four soldiers in a full electric drive vehicle with organic mast plus reconfigurable cargo area. The exemplar shown is modelled on the GD RST-V Shadow vehicle developed in the early 2000s (Figure 14) as a long-range stealth reconnaissance vehicle. The vehicle was constructed with fully active suspension to adjust ride height and signature depending on context. It was designed to be internally transported in CH47 and V22 airframes. A modernised 2030 version of this vehicle would employ advanced signature management technologies[18], employ hydrogen fuel cell delivering silent non-detectable propulsion power source driving electric in-hub motors[19]. A by-product of the hydrogen fuel cell being water and exportable power. The elevating mast providing sensor, communications and other elevated services. A remote weapon station equipped with light weapons completes the vehicle.

[17] https://groundedcuriosity.com/meet-carl-australias-future-soldier/ and https://www.dst.defence.gov.au/news/2018/10/02/next-generation-soldier-—-towards-2035

[18] For example 'Meta-skin' or tunable electromagnetic filters to create 'invisibility cloak'

[19] For example the GD Surus platform (https://www.gmhydrotec.com/product/public/us/en/hydrotec/Home.html#surus)

Multi-purpose medium UGV

A multi-purpose medium UGV was seen as an essential enabler for the teams providing a range of services both under control and in a semi/fully autonomous mode for dangerous activities. The medium UGV has the ability to accept alternative and/or multiple payloads depending on the role and mission. The exemplar shown (Figure 15) is the HDT Protector system and potential configurations achieved using a range of add-ons. For longer range movement the UGV would be towed by the RSTS-V.

Summary

The smallest and lightest cell that can be generated is the four soldiers acting independently however this capability is limited by soldier endurance and load carriage. Augmenting the soldiers with support systems enhances their capability and capacity at the cost of system support requirements and signature/profile of the cell. The four soldiers can be augmented by some or all of the mobility systems dependent on mission and role to be performed.

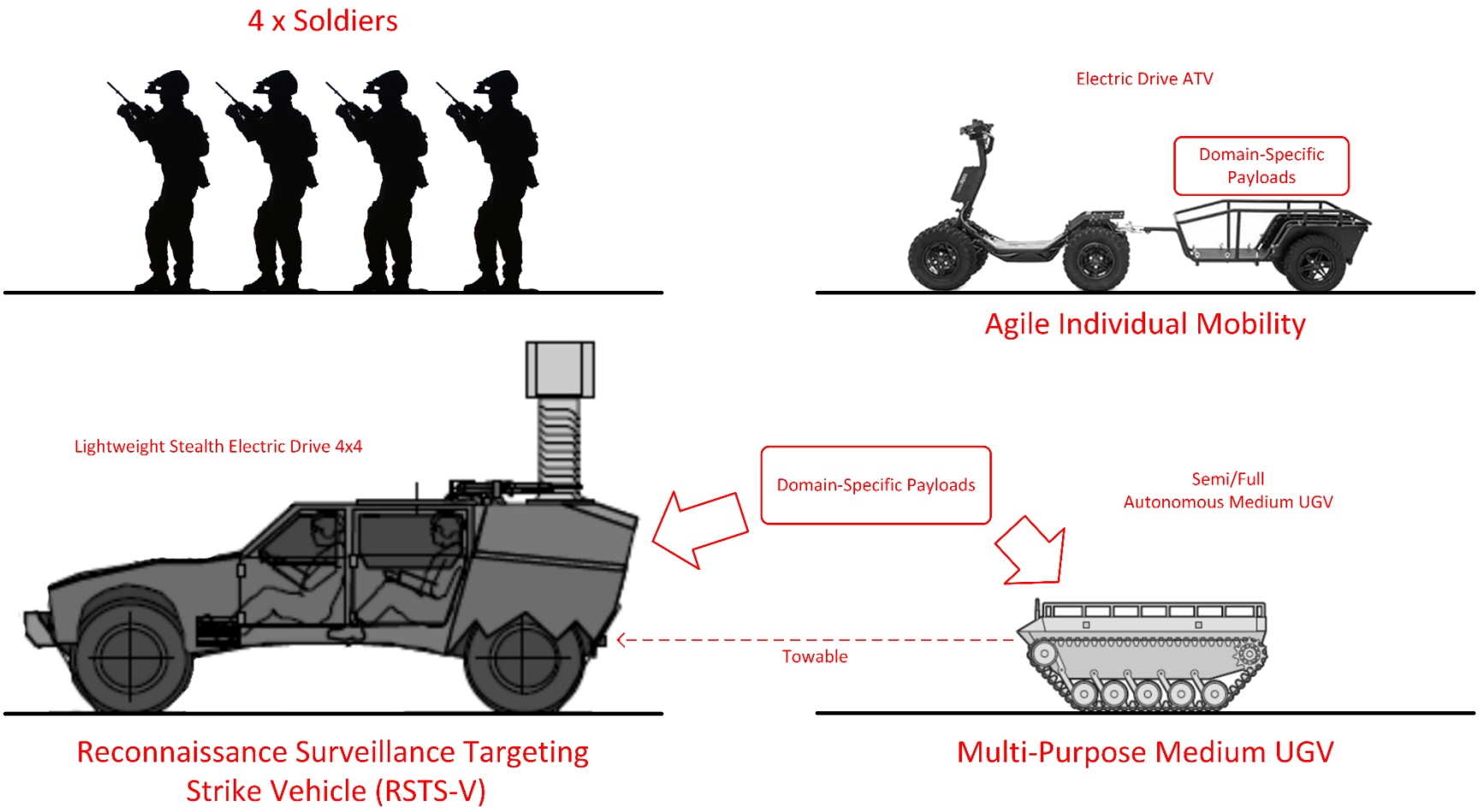

Figure 12 Skirmishing mist generic cell structure

Figure 13 Soldier Combat System future soldier example technologies

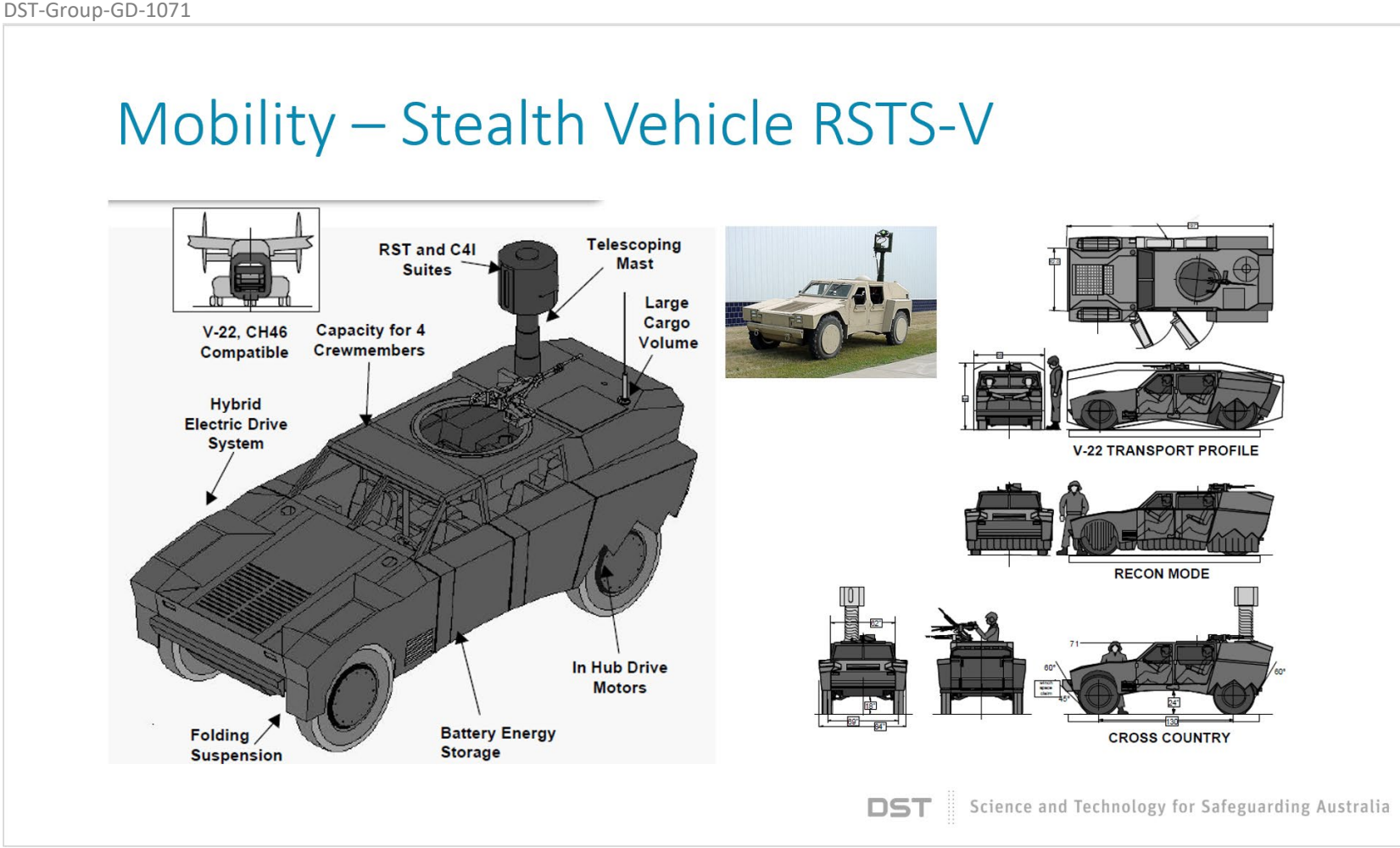

Figure 14 Skirmishing mist Reconnaissance Surveillance Targeting Strike Vehicle (RSTS-V) (Images sourced from GD US)

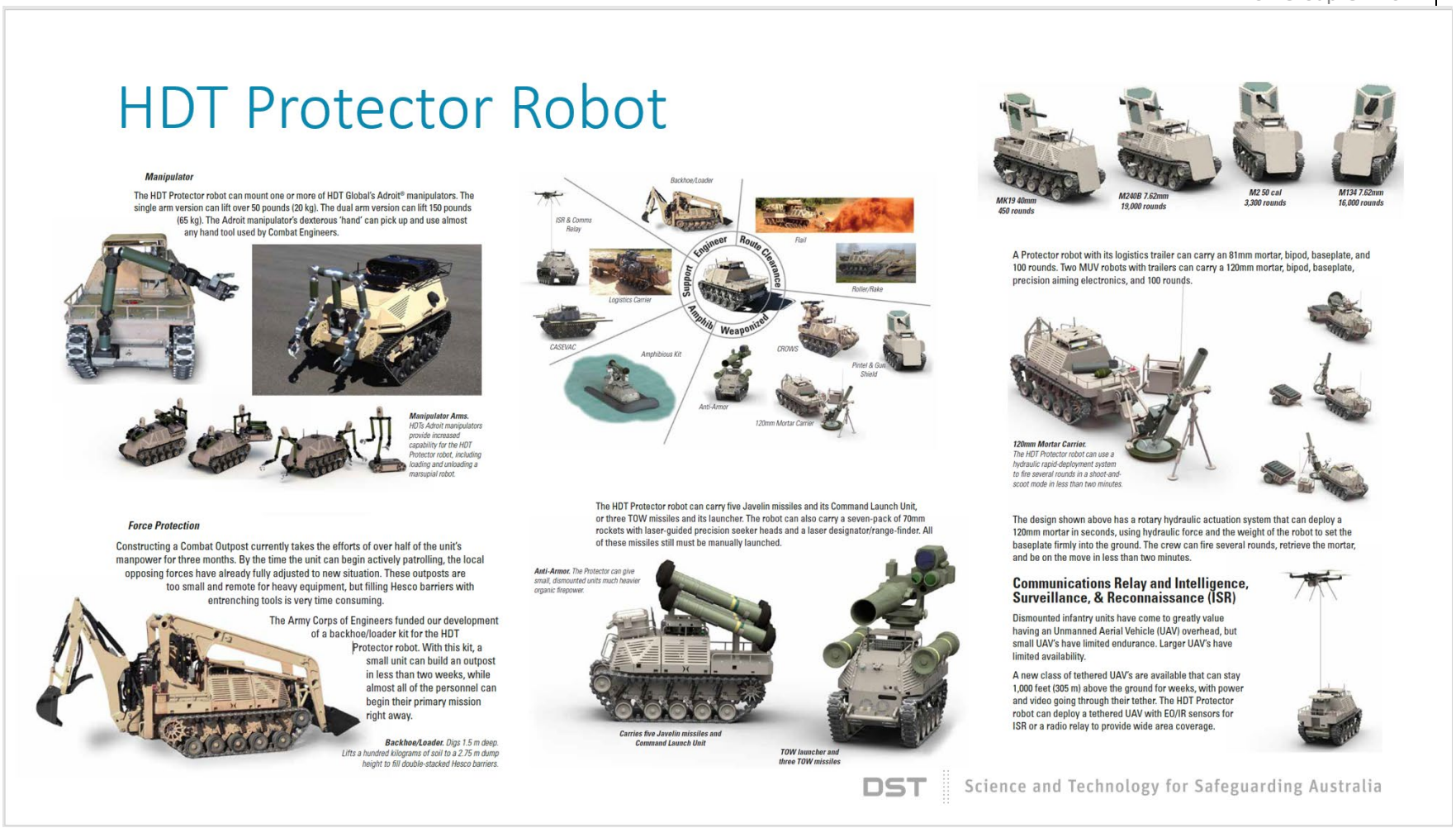

Figure 15 Skirmishing mist multi-purpose medium UGV example (Images sourced from HDT Global)

3.3. Cell Capabilities

The following sections describe the basis for each of the cells developed as part of the concept. The descriptions provide a simple statement of the functions the cell could perform, a range of technologies that could be used and a basic structure. The technologies listed provide insights in to what effects the cell could generate but are in no way a definitive set of capabilities for the cell – consider them purely indicative. Additional work is required to refine what are the cells' capabilities when operating purely as a four soldier dismounted section, when supported by an UGV system and finally when employing the 4x4 RSTS-V.

3.3.1. Command cell

The command cell provides the HQ and C2 capabilities of the deployed team. The functions it performs, indicative technologies and structure is described in Figure 16.

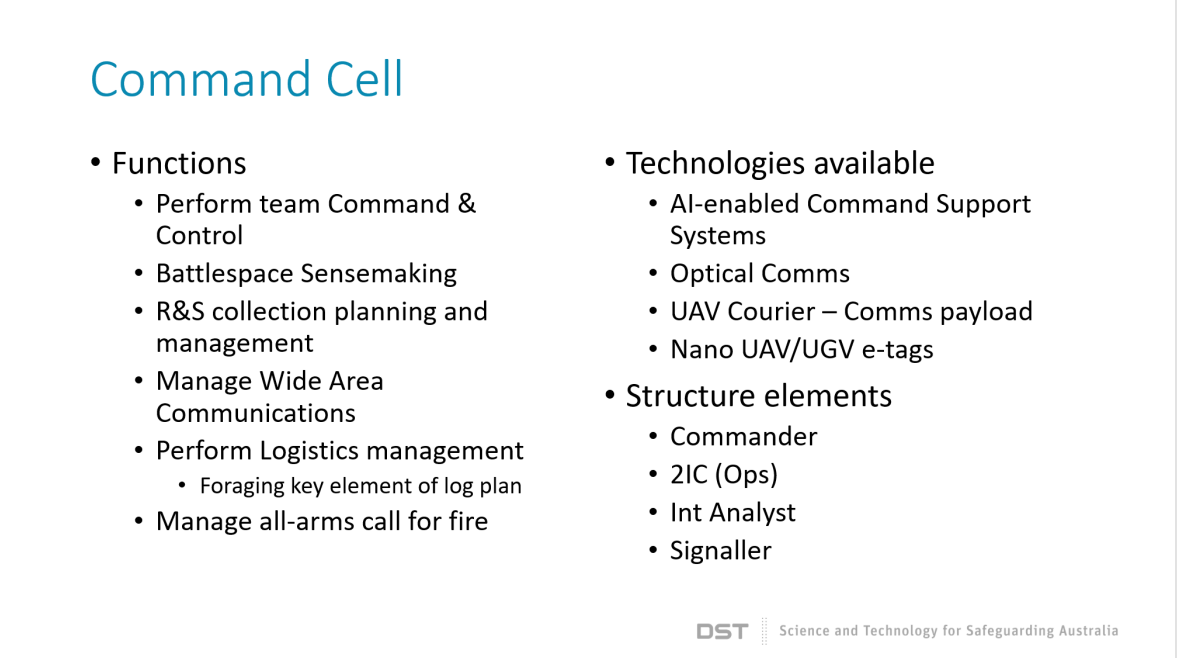

Figure 16 Skirmishing mist command cell

As an example of the technology anticipated is the use of an AI-enabled command support system that provides individual soldiers, cells and teams to track friendly forces and assets, identify enemy targets, markers, chat data, video and bio-med monitoring. The capability would also enable cooperative engagements using both direct and indirect fires, executing sensor to shooter target hand-off in decentralised operations while optimising utilisation of effects – 'any sensor / best shooter'. A key component of the command support system is an

'AI judge' to guide the commander on the application of rules of engagement and legal aspects of warfare.

The C2 system would be uploaded with data at the commencement of the mission and maintained by the cell during the operation and through the use of the UAV courier for major information exchanges.

The 'Int Analyst' position developing in-situ situational awareness of the adversaries and neutral to enabled intelligence informed effects based planning of the team actions.

3.3.2. Reconnaissance cell

All cells have the requirement to be sensors and generate battlespace information but the reconnaissance cell provides dedicated capabilities to conduct battlespace reconnaissance and surveillance. The functions it performs, indicative technologies and structure is described in Figure 17.

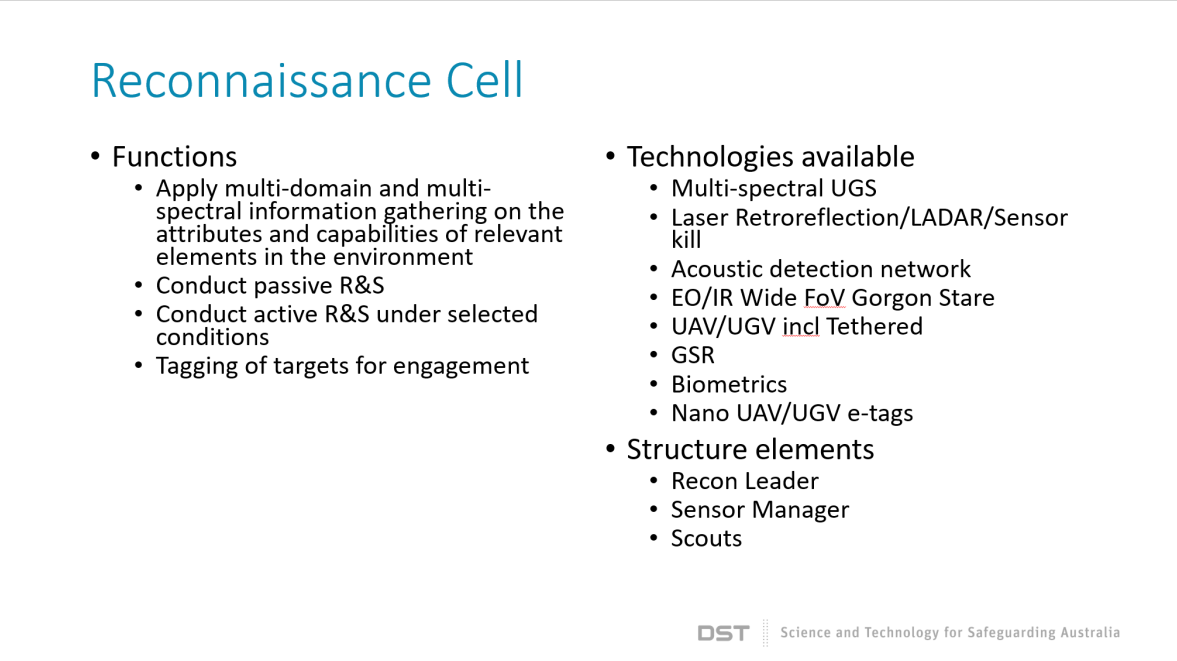

Figure 17 Skirmishing mist reconnaissance cell

During the workshop a range of potential reconnaissance systems were identified which could be used by the cell. The emphasis was on the use of passive technologies such as UGS, seismic and acoustic networks deployed throughout the Team AO. An example technology is the McW RANGER UGS sensor (Figure 18) which provides multimode sensing in a compact form with 30 day operating window.

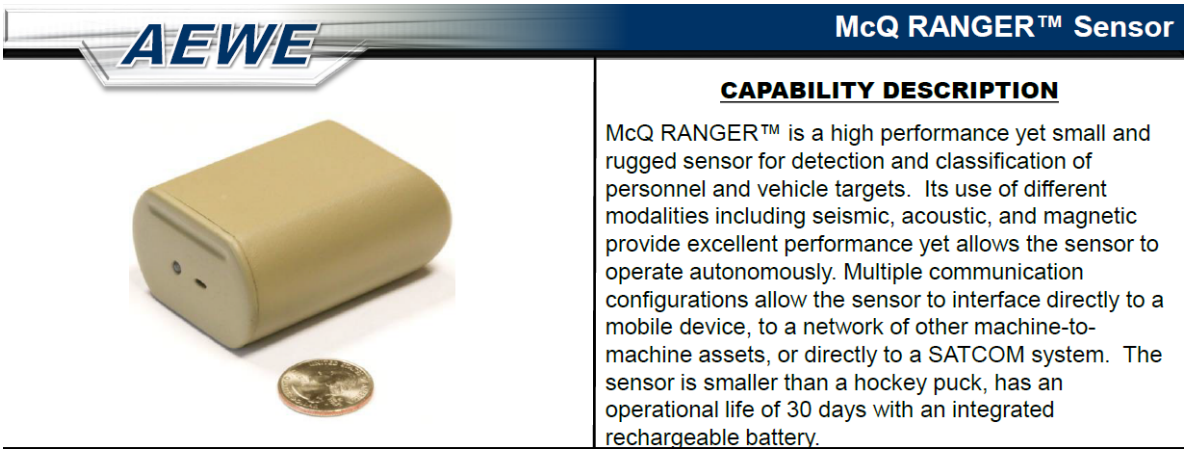

Figure 18 McQ RANGER UGS sensor

Another example technology would be a multirole laser device that offers targeting data, target detection, communications, degradation of opponents' optical sensors, capabilities for illumination, 3D imaging of battlefield and temporary incapacitation of opponent's vision.

When active detection methods are possible this provides the cell with the ability to exploit lightweight ground surveillance radar devices such as foliage penetrating radars (Figure 19) which are available in man-portable and vehicle transportable forms.

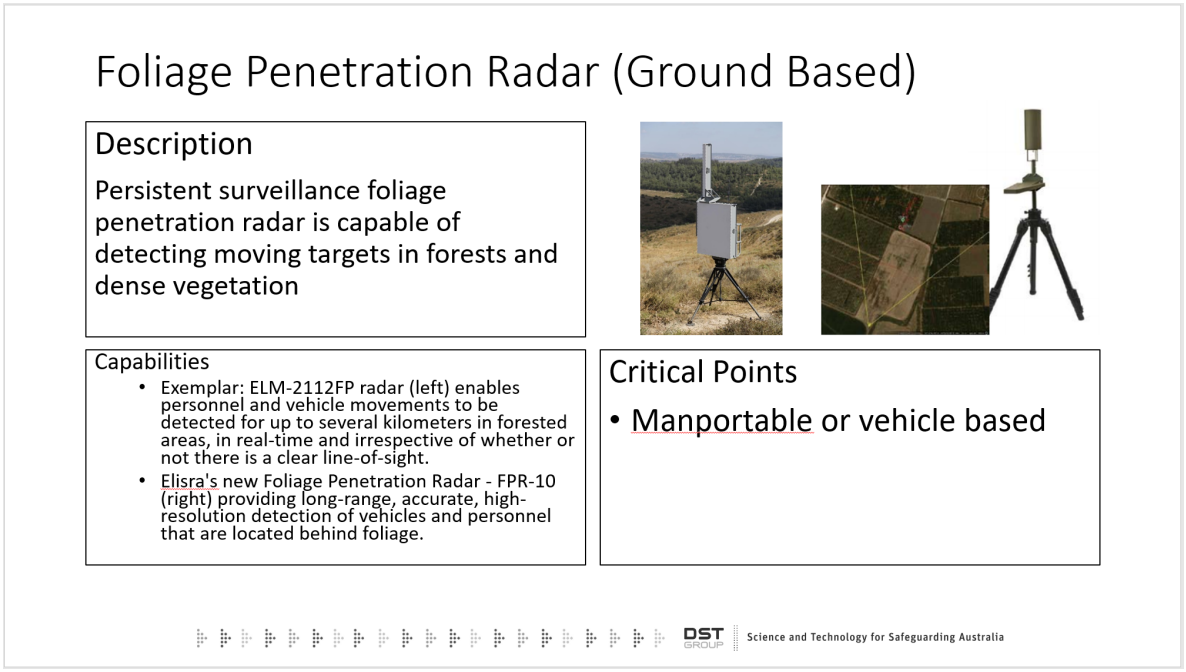

Figure 19 Foliage penetrating radar example

3.3.3. Cyber-electromagnetic activities (CEMA) cell

The CEMA cell (Figure 20) is capable of conducting integrated reconnaissance, strike and deception activities in the RF spectrum and cyber-information domain.

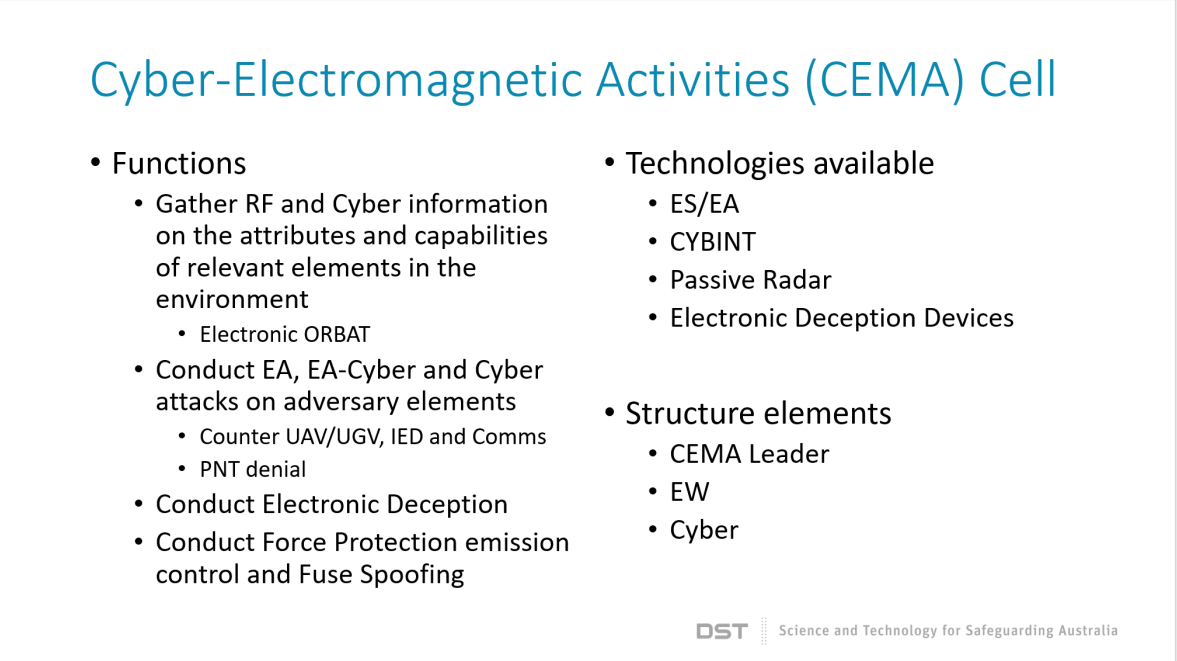

Figure 20 Skirmishing mist CEMA cell

In the 2030 timeframe it is expected that considerable improvements over VROD/VMAX[20] as exemplars of present day capability that can sense, contest, exploit, and potentially dominate EM spectrum and provide masking, probing, spoofing, intelligence gathering, and electronic attack.

Unique to this cell is the provision of a passive radar capability not normally associated with CEMA activities, but included as this cell maintains the teams EM application and exploitation capabilities.

[20] VROD (Versatile Radio Observation and Direction) and VMAX (VROD Modular Adaptive Transmit). (https://www.militaryaerospace.com/home/article/16709607/electronic-warfare-on-the-ground)

3.3.4. Pioneer cell

The Pioneer cell is capable of conducting a wide range of combat engineering functions (Figure 21) appropriate with small teams. There number and type of actions the cell can perform is significantly constrained by equipment mobility demands which can be offset through the use of RSTS-V and/or UGV. A case-by-case selection of equipment is required depending on the scenario and mission.

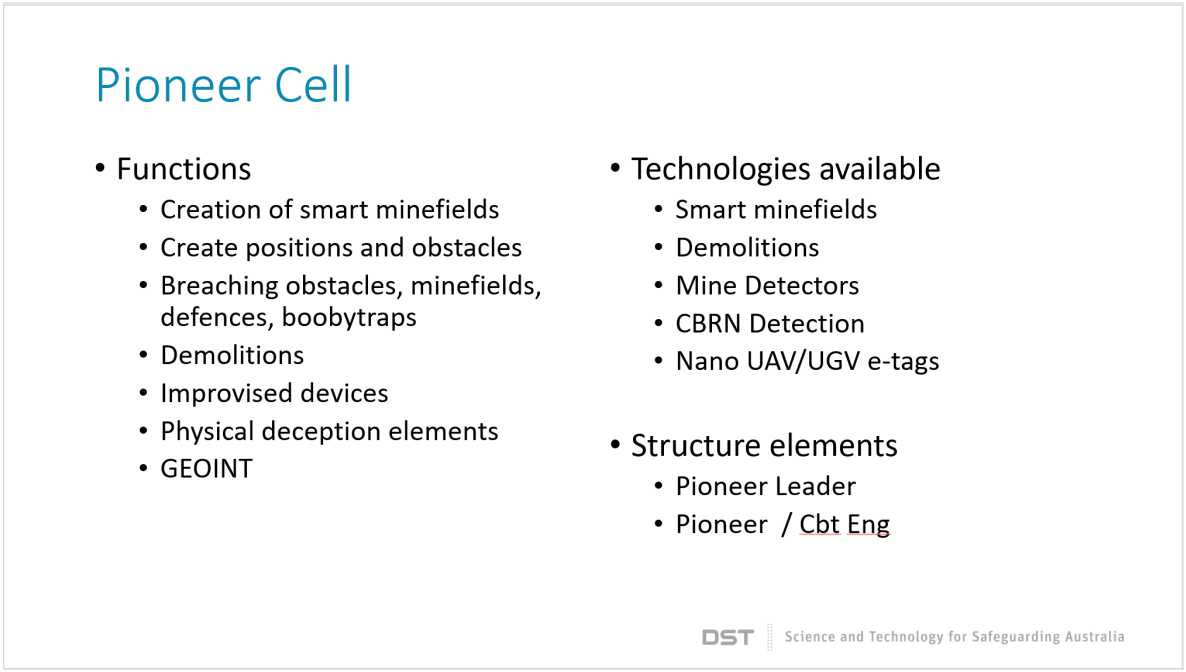

Figure 21 Skirmishing mist pioneer cell

An example of an existing technology smart mine technology is the Scorpion mine (Figure 22) which provides a counter-personnel and counter-armoured-fighting-vehicle effectors using sensor fusion with the potential for coordinated attacks. Combining this technology solution with an UGV frame basis would then permit the concept of a self-healing minefield to be developed (Figure 23) which adjusts and responds to breaches.

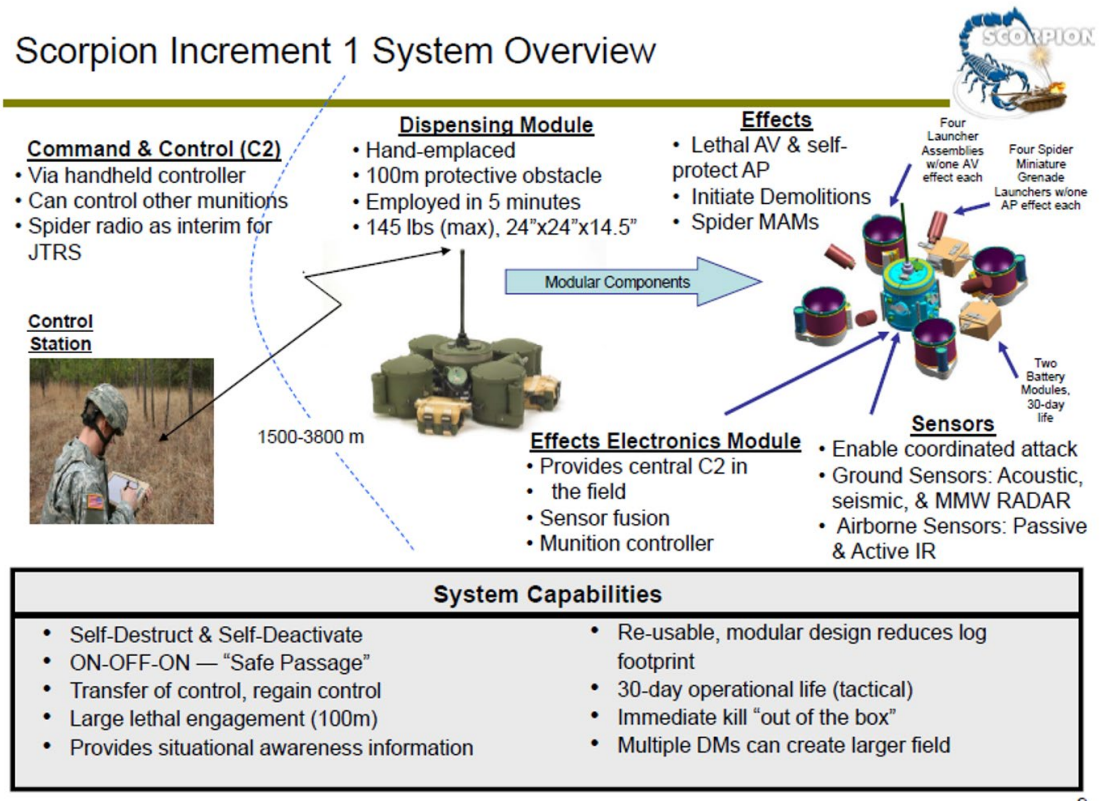

Figure 22 Scorpion smart mine

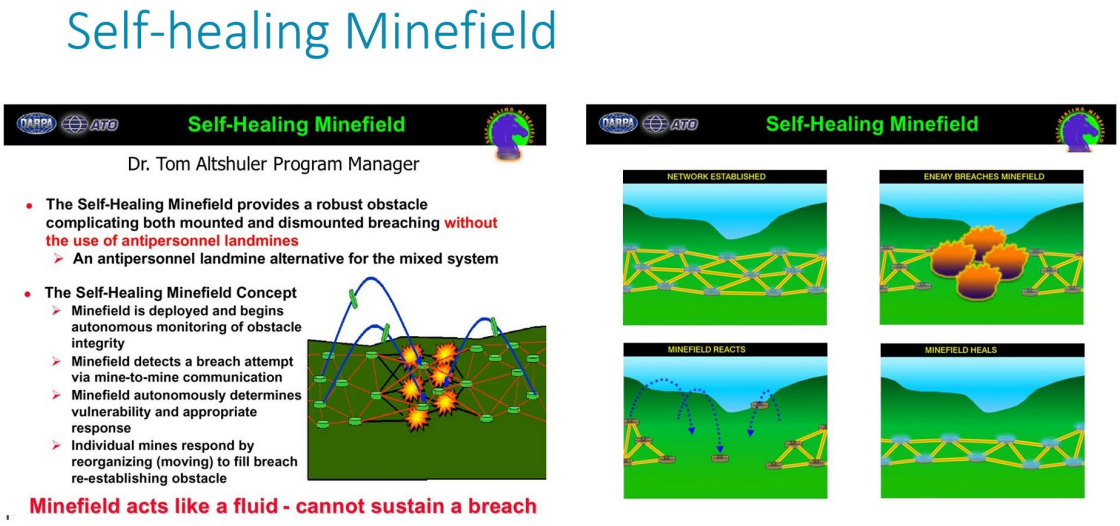

Figure 23 Self-healing smart minefield

3.3.5. Strike cell

The purpose of the strike cell is to deliver the localised lethal effects in combination with the other teams when opportunities arise to engage local targets. The cell also provides the major self-defence reaction capability of the team.

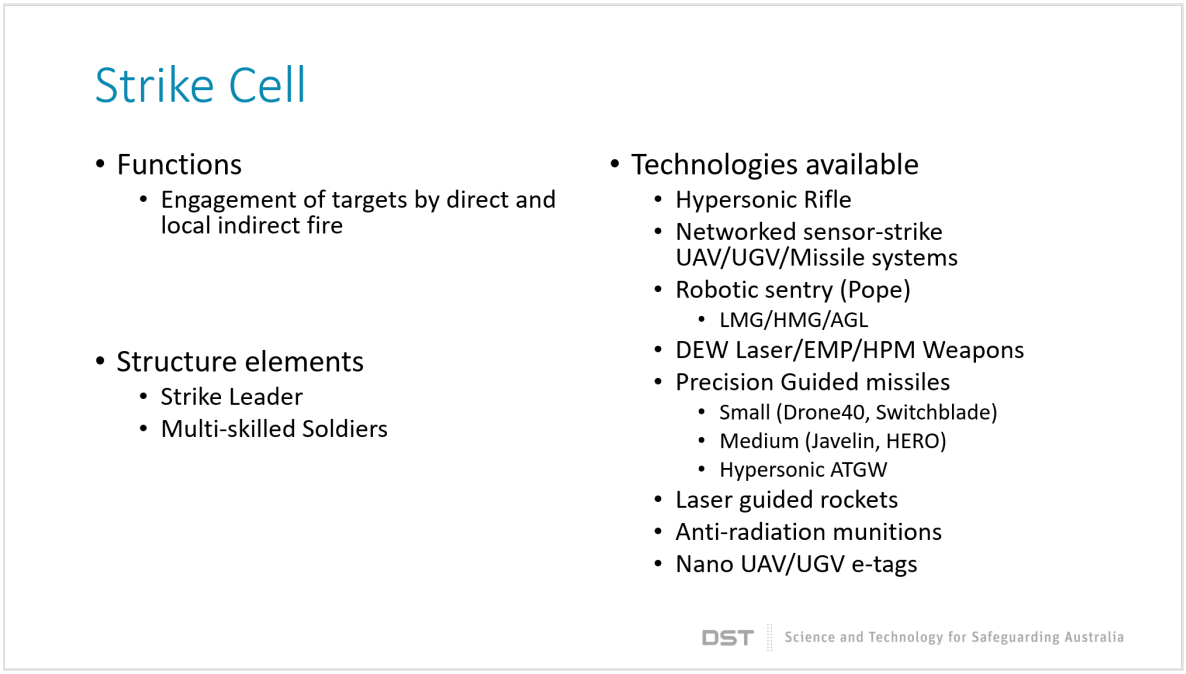

Figure 24 Skirmishing mist strike cell

The technological kitbag list in Figure 24 provides a wide range of capabilities that could be employed. In the 2030 timeframe it is anticipated that a networked sensor-strike missile systems (a micro swarm) would be a core capability, augmented by precision attack missiles and rockets. An equivalent ground based system was devised by the syndicate during the workshop called 'Pope', which would have several interconnected robotic sentry light weapons (behaving like pop-up sprinklers) able to detect, track, target and autonomously engage threats with the aid of the 'AI judge'. It would operate under the 'human-starts-the-loop' paradigm whereby human operators set the basic rules of engagement and then it is able to perform. The Pope would also be used offensively, setup equivalent to the smart minefield, prosecuting tagged targets and targets of opportunity. For significant effect and to defeat 'high-hardness' targets a hypersonic anti-tank guided weapon (ATGW) would be available based on the Mach 6.5 compact kinetic energy missile, and hypervelocity anti-tank missile (CKEM; and HATM)[21] technology demonstrators (Figure 25). Large weapon requiring the use of the 4x4 RSTS-V platform.

[21] https://arc.aiaa.org/doi/abs/10.2514/6.2005-4171

Figure 25 CKEM and HATM

3.3.6. Support cells

Four supporting cell capabilities were identified which would augment or replace selected elements in the team for different operations and missions. Figure 26 to Figure 29 provides basic information on the cell capabilities. Further work is required to develop a mature description of the functions, capabilities and structure of these cells.

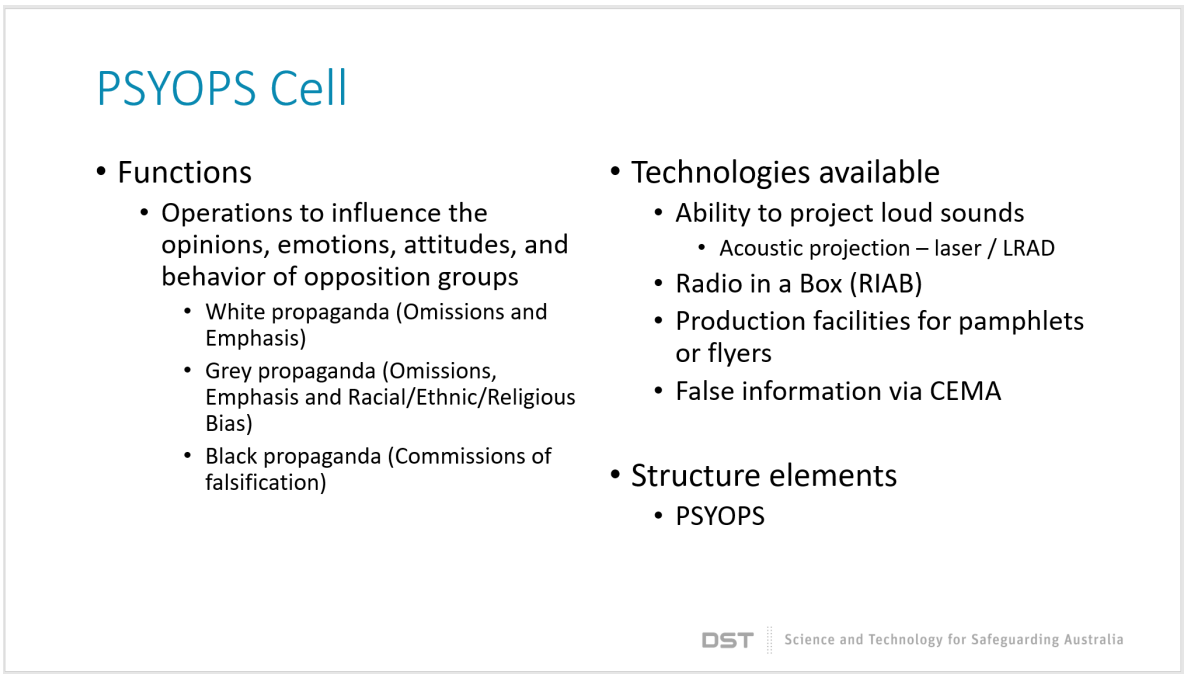

Figure 26 Skirmishing mist PSYOPS cell

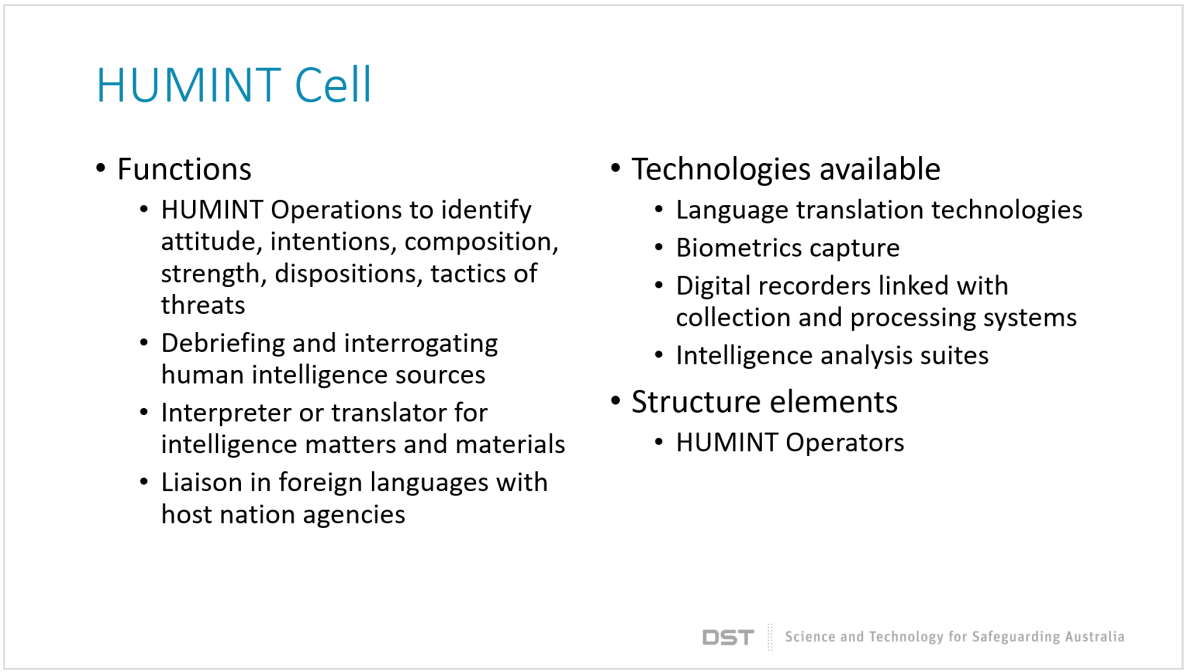

Figure 27 Skirmishing mist HUMINT cell

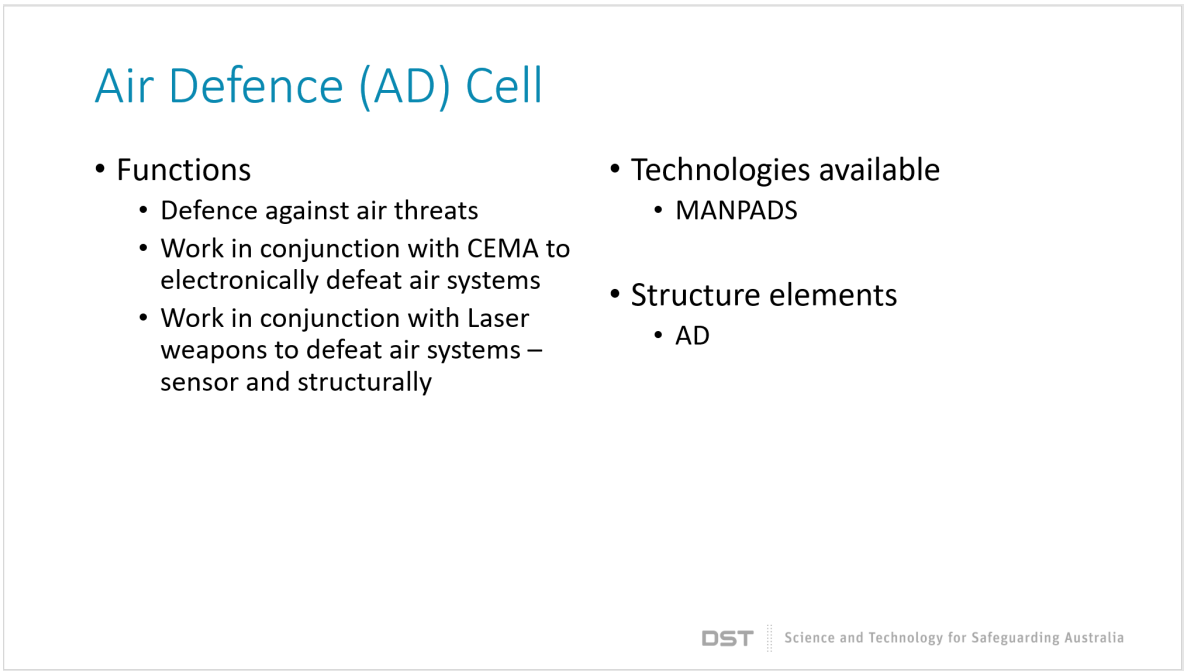

Figure 28 Skirmishing mist air defence (AD) cell

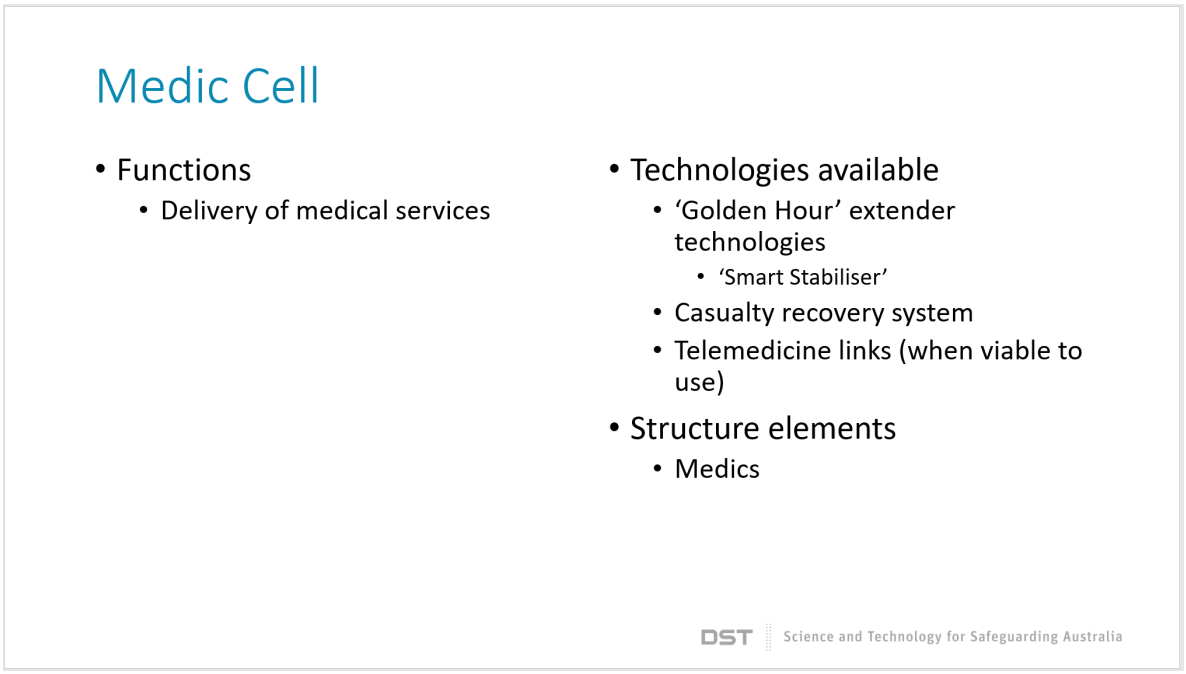

Figure 29 Skirmishing mist medical cell

4. PERFORMANCE EXPLORATION

4.1. From–To Paradigm Shift

The systemic design process requires the designers to review the concept developed and articulate the paradigm shift in comparison to extant concepts. The syndicate self-assessed the transformations represented in the concept against the existing concepts and capabilities (Table 2). The three most significant transformations identified were:

- Being stealthy and operating below the detection threshold
- Flattening of the C2 structure
- Enhanced ability to influence the battlespace and enable fires.

Table 2 Skirmishing mist from–to paradigm shift

Shifting from…	**…to**
*** Traditional C2 structure**	**Flat C2 (Bde → Bn → Teams)**
Modular at the Company level	Modular at the team level (lower effective level of command)
On-call close support fires	Organic fires exploiting remote engagement using flying armour and smart mine and weapon systems
Fires through JTAC → JFECC	Direct to Bde Strike Regt
Carriage of fires type/volume limited	Access to multiple effects at the team level
*** Being observable**	**Being stealthy/below threshold**
Active communication signals	Passive receive and low signature communications
Combat mass to defend	Disaggregated teams
Prescriptive manoeuvre	Freedom to move
High cost (personnel, material)	Lower cost (WRT from)
*** Limited combat influence/fires**	**Improved combat influence/fires**
Higher risk	Lower risk due to enhanced survivability

Shifting from…	…to
Lower SA at Bde level	Enhanced and distributed SA at Bde level (number of elements in AO and in depth)
Centralised/inefficient logistics (pull)	Forage, on-demand or print in location
Standard military model (global)	Uniquely organised force (niche capability)
Hierarchical/centralised model	Distributed/decentralised (enhanced resilience/adaptive)

* Denotes the top three paradigm shifts present in the concept

4.2. Identified Risks / Issues with Concept

The main issues or risks with the concept are:

- Ability to remain below detection threshold given advanced sensing capabilities and operating adjacent to and interacting with local populations. The 20-person team was considered the upper limit in size that could operate and remain below the detection threshold. Army subject matter experts judged the reduced 12-person team as the best trade-off between detection potential and military utility/performance.
- Low organic combat mass and likelihood of being rapidly overmatched if detected.
- More difficult to bring together and generate coordinated actions due to desire to maintain low communications emissions and alternative means latency issues.
- Requires highly adaptive, confident and aware leaders to operate in a near-full autonomous operations mode.

4.3. Performance against Scenarios Classes – Wind Tunnelling and Wargaming

To explore the performance of the concept and examine its strengths and weaknesses the concept was tabletop wargamed in the Urban Battlefield Marawi scenario. This scenario was a reconstruction of the Battle for Marawi in the southern Philippines against an insurgent force that had occupied and fortified the city and held a large number of civilians as hostages. In the wargamed scenario the insurgents were classed as state sponsored hybrid force with foreign specialist advisors and selected high performance technology weapons insertions (e.g. ATGW/MANPADS). The wargame method involved a two-sided discussion and self-adjudication using an ‘action, reaction and counter-action’ cycle. The conceptual force

(blue) had the initiative and presented actions to which the adversary then responded, and finally blue counter-actions discussed.

The game highlighted:

- The significant find and fix abilities of the conceptual force (blue) forced the insurgents to operate underground, exploit all forms of overhead cover including mouse-holing between buildings.
- The EW sense was considered a significant strength in this context supported by passive radar and wall penetrating radar capabilities.
- Retro reflection detection was an important counter-sniper technology.
- Biometric collection and analysis was considered an essential capability providing identification of targets and potential use of biometrics data for remote strike.
- The use of Blue robotic sentries and smart minefields systems supported creation of denial and control zones inhibiting Red movement. The target engagement enhanced through the use of biometric targeting of the adversary elements.
- Persistent flying armoury supported enforcement of control zones and engagement of time-sensitive targets.
- Conceptual force was ambushed with industrial chemical gases which caused significant problems for the concept including inability to detect form of gases and casualty management.
- Tunnel movement by Red and the use of hostages in tunnels created major challenge for Blue. Blue resorted to UxS reconnaissance in the tunnels and used acoustic weapons and tear gas to suppress tunnel occupants. Tunnel collapsing was used to govern adversary subterranean movement.
- Red use of building collapse as a weapon was not adequately countered by the Blue concept.
- The use of EW attack and cyber was important in controlling the use of UGV and UAV by the adversary denying their situational awareness or generating false targets to shape their understanding of the battlespace.

4.4. Metric Judgement

The concept was self-assessed (Table 3) against a metric objective framework[22] on its ability to deliver the required capabilities and effects in the Jungle Battlefield Borneo vignette and the Subterranean Battlefield Toronto vignette. A 5 point Likert scale from 1 (no capability) to 5 (fully capable) was used.

Table 3 Skirmishing mist concept performance assessment

	Vignettes	
Objectives	**Borneo**	**Toronto**
Respond to challenges in surface and super-surface urban environments	3 or 4	3
Respond to challenges in interior and sub-surface (subterranean) urban environments	4	3
Respond to challenges in non-urban environments e.g. jungle, mountain, desert, riverine, etc	4	no entry
Respond to challenges to the cyber domain including the EM environment	5	5
Respond to changes in the intelligence picture and situational understanding	2	5
Employ a resilient and persistent close combat capability	5	4
Employ an adaptable and flexible close combat capability	5	5
Perform reliable sustainment in the operational environment	3	3
Outlast adversaries in combat	4	2
Maintain freedom of action throughout the engagement	5	2
Maintain defensive advantage and gain offensive advantage	4	4
Apply a compressed kill chain in close combat	4	4
Identify real-time operational environment effects	5	4
Achieve decisive tactical effects	4	3
Outperform the adversaries by exhibiting physical, cognitive, social and cultural resilience	5	4
Synchronise all effects necessary to generate warfighting advantage	4	3
Outsmart the adversary in combat	5	3
Demonstrate leadership, flexibility and adaptability in combat	5	5
Adopt "conditions" command and decentralised decision making when needed	5	5
Identify and exploit potential sources of friction in battle	3	3
Open up constraints in the operational environment	4	4
Control the performance, reliability and security of information networks	5	5

Against the Borneo jungle battlefield the concept was assessed as performing strongly across many objectives. The jungle context presented the best opportunity for small team operations to exploit natural terrain complexity to enhance survivability and deliver short fleeting engagements. Only the ability to respond to changing environment was considered a

[22] *Metrics for Assessing Future Combat Teams*, Defence Science and Technology Group, Technical Note 2020, Lesley Kosowski and Svetoslav Gaidow, in preparation.

significant shortfall in ability. This negative aspect arose due to the constrained communications model which would potentially affect timely information exchanges. The ability to conduct sustained close combat was not considered a weakness in this context.

With the subterranean modern urban battlefield context that was the Toronto underground, the concept performance was considered marginally worse than the Borneo context. The ability to maintain freedom of action was significantly challenging with the fixed underground network canalising all movement to known avenues and restricting planning options. Subterranean mouse-holing between underground sections was considered but assessed as extremely difficult without proper equipment not held in the small teams. Communications constraints also limited ability to synchronise actions in the environment. Many of the limitations identified are not unique to this concept but the consequence of subterranean fighting by any force.

5. CONCLUSION

A systemic design methodology was employed to develop post 2030 dismounted infantry concepts to prepare Army for advances in sensing, precision attack, and decision-making that will fundamentally alter the character of future conflict engagements. The outcomes of the study informing the long-term development of the Dismounted Combat Program and associated capabilities.

The concept described in this report, skirmishing mist, is a top-down paradigm driven concept based on the principle of small independent teams operating disconnected, disaggregated and decentralised below the detection threshold from which remote strikes and direct action could be taken throughout the battlespace.

The coordinated action of the small teams delivering decisive multi-domain effects seeking to dislocate, weaken and exhaust the mind of the enemy. A key tenet is the avoidance of major combat and not becoming decisively engaged. The skirmishing actions setting favourable conditions for decisive action by the formation heavy armour combat elements.

The low signature paradigm requires the small teams to operate for long periods without orders (emphasising local decision making) or direct communications with other groups. One-way theatre broadcast was the primary means of higher command communication supported by UAV e-courier systems. Deception and concealment across all sensor bands forms an essential ability of the small teams. A remote strike sub-concept was developed whereby the small teams would tag targets (electronic or biometric) for prosecution by a flying arsenal UAV, smart-mines or remote sentry turrets. Low signature sustainment achieved via foraging, local manufacture and UAV delivered support.

The teams' only rise above detection threshold and strike for high value effect (the decisive blows) either individually or as coordinated teams, enabled by strike reachback for long-range point and area effects.

The Skirmishing Bn contains 25 teams under the command of an enlarged Bn HQ reliant on AI-enabled C2 systems to provide effective command and control of the teams. Each team comprises 20 soldiers contained in five functional cells (four soldiers per cell) – command, reconnaissance, pioneer, CEMA and strike. The team structure can be adjusted in size and/or augmented with supporting elements delivering PSYOPS, AD, HUMINT and medical capabilities depending on the operation and tactical situation.

Self-assessment and tabletop wargaming of the concept revealed:

- Was resilient, persistent, adaptable and flexible across multiple vignettes.

- Relied on and exploited the strong cognitive capabilities, leadership, flexibility and adaptability of the Australian soldier and officer ranks.
- Had significant organic find and fix abilities including EW sense, passive radar, retro reflection detection and Biometric collection and analysis.
- Persistent flying armoury, robotic sentries and smart minefields systems supported creation of denial and control zones and engagement of time-sensitive targets.
- Would enable operations to remain below detection threshold given advanced sensing capabilities and operating adjacent to and interacting with local populations.
- Had low organic combat mass and was vulnerable to being quickly overmatched if detected.
- Was difficult to bring together and generate coordinated actions due to desire to maintain low communications emissions and alternative means latency issues.

Perhaps most telling, the concept recognises that technology insertion and incrementalism is inadequate and features deep levels of adaption and paradigmatic shifts in response to the future operating environment.

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