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LP 7.2.1
Edition 1, 2024

LP 7.2.1 – Olvanan Small Un-Crewed Aerial Systems (SUAS) tactics at CDET and below, Edition 1, 2024

Sponsor:
Army Battle Lab

Developer:
Battle Lab – Training Adversary Cell

Publishers:
Directorate of Communications, Change and Corporate Graphics
Doctrine Directorate

ADF ADVERSARY DOCTRINE

Olvanan Small Un-Crewed Aerial Systems (SUAS) tactics at CDET and below

LP 7.2.1 | Adversary Tactics|

Edition 1

Australian Defence Force – Adversary Doctrine – LP 7.2.1 – Olvanan Small Un-Crewed Aerial Systems (SUAS) tactics at CDET and below, Edition 1 is issued for use by the Australian Defence Force and is effective forthwith.

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DATE OF APPROVAL

Preface

1. Adversary doctrine describes fundamental principles that guide actions by opposing forces to achieve their objectives. While authoritative, doctrine requires judgement in application.

2. The content of this publication has been derived from general principles and doctrine contained in other relevant publications, Defence manuals, and allied publications and agreements. Every opportunity should be taken by users of this publication to examine its content for applicability and currency. The Doctrine Directorate invites assistance from you, the reader, to improve this publication. Please report any deficiencies, errors or potential amendments.

3. **Aim.** LP 7.2.1 – Olvanan Small Un-Crewed Aerial Systems (SUAS) tactics at CDET and below, Edition 1 aims to provide guidance as to how the training adversary force known as the Olvanan Peoples' Army, established under the Decisive Action Training Environment (DATE), construct is likely to tactically deploy small unmanned aerial systems against their enemy combatants from the echelon of platoon to company detachment. The principal uses at this level are strike, ISTAR – intelligence gathering, surveillance, target acquisition, reconnaissance and fire control.

4. **Audience.** This publication is for use by commanders and their staff at operational and tactical levels.

5. **Scope.** This document describes the Olvanan usage of unmanned aerial systems up to NATO Class 1 Mini (gross take off mass under 15 kg), from platoon up to company detachment (CDET) level. This includes: Types of small unmanned aircraft systems in use, overarching capabilities, Tactics & usage, Types of munitions used, Counter UAS capabilities and Counter-counter UAS capabilities.

Amendments

Proposals to amend LP 7.2.1 – Olvanan Small Un-Crewed Aerial Systems (SUAS) tactics at CDET and below, Edition 1 may be sent to:

Assistant Director Operating Environment

Army Battle Lab

Training Adversary System Support Centre

Victoria Barracks Sydney

Paddington | NSW 2021

Amendment number	Chapter(s)	Amendment	Effected date

Doctrine publication hierarchy

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Chapter 1 – Introduction

Scope

1.1 The purpose of this document is to describe how the Olvanan Peoples' Army would use small uncrewed aerial systems up to company detachment (CDET[1]) level. This includes

- An overview of small UAS use globally
- OPA Types of UAS and munitions used
- OPA Platoon allocation of UAS, munitions and counter UAS equipment
- OPA Tactical use cases
- Counter UAS capabilities

Background

1.2 This document refers to the fictitious nation of Olvana, part of the Decisive Action Training Environment – Indo-Pacific (DATE-IP). DATE-IP is a common training environment used across the Australian Defence Force and by the armies of the United States, United Kingdom, Canada, and New Zealand. Olvana is the land mass shown in red in Figure 1 below. Further information on Olvana and DATE-IP can be found at https://date.army.gov.au/

[1] As defined in TC 7-100.2 Opposing Force Tactics, US Dept. of Army HQ, Dec 2011. Essentially, a company of combat power (infantry, purely mechanised/ motorised infantry, combined armour & infantry) supported by platoons of specialised combat arms and combat support services.

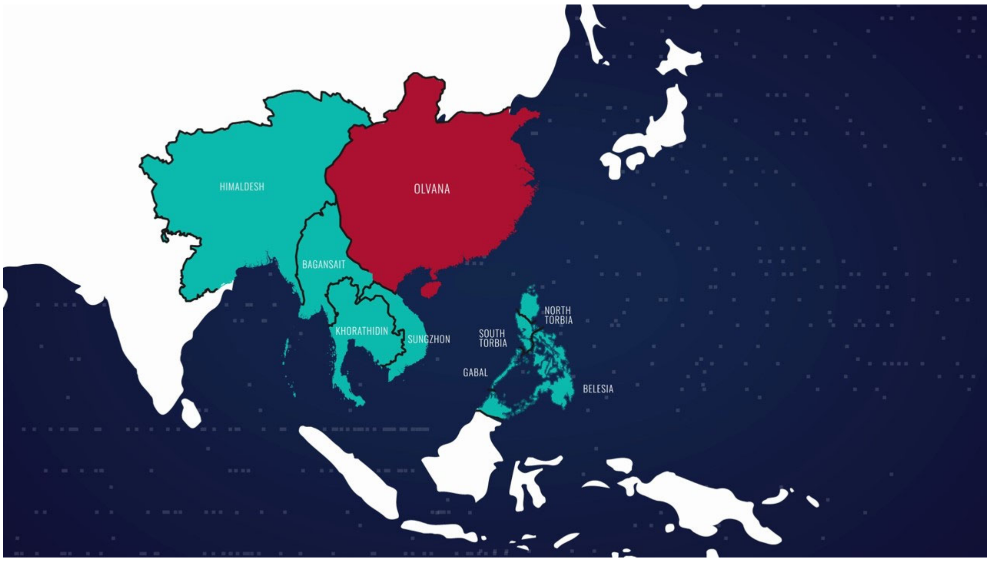

Figure 1.1: DATE Indo-Pacific

1.3 This volume considers the tactical deployment of small UAVs as at 2024. It also includes an assessment of a possible trajectory of development for the more advanced deployment and use of UAS within the next two years.

1.4 The insights described throughout this volume takes into consideration the following factors:

- Observations and public domain reporting of the deployment of drones by sovereign nations, non-state actors, criminal enterprises, and law enforcement organisations, in order to understand the spectrum of technical capability, potential use and resultant effects that sUAS provide.

- Command and control likely to be encountered in Olvanan military formations. In particular, that of retaining command authority at the ranks of commissioned officers rather than delegation of authority to junior non-commissioned officers.

Basis

1.5 This document will limit its assessment to the usage of NATO Class 1 drones up to 15 kg gross take off mass.

Table 1.1: NATO classification system of UAS

NATO UAS CLASSIFICATION						
Class	Category	Normal Employment	Normal Operating Altitude	Normal Mission Radius	Primary Supported Commander	Example Platform
Class III (>600 kg)	Strike or Combat	Strategic/National	Up to 65,000'	Unlimited (BLOS)	Theater	MQ9 Reaper
	HALE	Strategic/National	Up to 65,000'	Unlimited (BLOS)	Theater	Global Hawk
	MALE	Operational/ Theater	Up to 45,000' MSL	Unlimited (BLOS)	JTF	Heron
Class II (150 kg – 600 kg)	Tactical	Tactical Formation	Up to 10,000' AGL	200 km (LOS)	Brigade	Hermes 450
Class I (<150 kg)	Small (>15 kg)	Tactical Unit	Up to 5,000' AGL	50 km (LOS)	Battalion, Regiment	Scan Eagle
	Mini (<15 kg)	Tactical Sub-Unit	Up to 3,000' AGL	Up to 25 km (LOS)	Company, Platoon, Squad	DJI Mavic 3
	Micro (<66 J)	Tactical Sub-Unit	Up to 200' AGL	Up to 5 km (LOS)	Platoon, Squad	Black Hornet

1.6 This document is the result of the analysis of independently verifiable facts and observations. It relied on open source publications and intelligence analysis for its knowledge base.

1.7 No artificial intelligence was utilised in the formulation of this document.

1.8 Examples were drawn from all over the globe.

1.9 The depiction of combat action was taken from a functional perspective. That is, how a well-resourced and intelligent enemy would use straightforward tactics to defeat its opponent.

1.10 Some degree of interpolation was used, based on analogous development pathways that occur for the development of any technology. For example, the jet engine was independently developed over multiple continents by independent teams of engineers.

1.11 In terms of the command, control and deployment of UAS on the battlefield, this document examines the tactical use of UAS up to company detachment level[2]. It outlines but does not examine in detail, the use of drones at higher echelons of organisation.

1.12 Assumptions were made regarding the differences between western and eastern modes of operation, stemming from a difference in culture:

- Power-distance[3] effects in interpersonal relationships that apply in nations analogous to Olvana[4].
- The impact of political liaison elements within the Olvanan military command structure.
- Reliance on battle drills, effectively limiting a unit commander's ability to exercise discretion in a battle, in order to remain within the broader campaign/ war plan.

1.13 The purpose of deploying UAS on the battlefield is to support the destruction of an opposing force. The aforementioned factors are nuances that could result in differences how that effect is achieved, when compared to how it may be achieved in the western hemisphere.

Unpredictability of future developments

1.14 Humans are limited only by their imagination. We can conceive ideas which don't yet exist, but if their existence is within the realm of the possible and achievable, we can engineer those concepts into reality.

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2 This is where tactical use of UAS is most likely to occur. More complex systems & attacks are assumed to require higher echelon 'release authority' based on the resources required to support the mission, (manpower and materiel) and the nature of the target, however, the document will consider the potential use of swarming.

3 A concept first described by Hofstede in his book *Organisation and Culture* 1991. Briefly, it means the extent to which the members of a society accept that power in institutions and organizations is distributed unequally.

4 There is considerable difference in the autonomy delegated to the front-line foot soldier between the western and eastern hemispheres. This document takes a position that an Olvanan commissioned officer will be accountable for offensive/ defensive actions.

1.15 Developments in small UAS are no exception, now that we have employed them on the battlefield. The pace of technological developments in hardware, software and adoption of artificial intelligence is rapid and accelerating. There are breakthrough collaborations with fields of study traditionally outside the bounds of military research.

1.16 This will result in the rapid evolution of novel drone usage in the legitimate civilian markets as well as developments in the criminal use of drones. We cannot accurately predict what awaits us in the future. Several elements of this document will be superseded by the time of its publication.

1.17 For example, during the development of this document between April and October 2024, the following innovations in sUAS came into use on the battlefield:

a. AI & recognition of human faces was added as a capability to first person view drones.

b. Numerous man portable ECM 'drone rifles' have been released.

c. Several electro-optically guided, small arms based anti-drone systems have been released.

d. Light and heavy wheeled platforms for anti-drone swarm microwave directed energy weapons have come on to the market.

1.18 This same degree of unpredictability applies to counter-counterdrone measures – defeating technological attempts to thwart the operation of drones used for military purposes. Drones have been modified to use fibre optic cable guidance to become almost invulnerable to electronic countermeasures.

Chapter 2 – Global small UAS usage

Definition of small unmanned aerial system

2.1 Inclusion criteria:

- A re-useable airframe,
- Vertical take-off & landing, hand launched or conventional take-off and landing,
- fixed or rotary wing,
- with a gross take off mass of up to 15 kg including payload,
- using a control system with a human-in-the-loop.

Examples of UAS

Figure 2.1: Example of a Hummingbird "nano drone"

Figure 2.2: Hummingbird "nano drones", charging unit and control pad

Figure 2.3: Biomimetic Bird drone

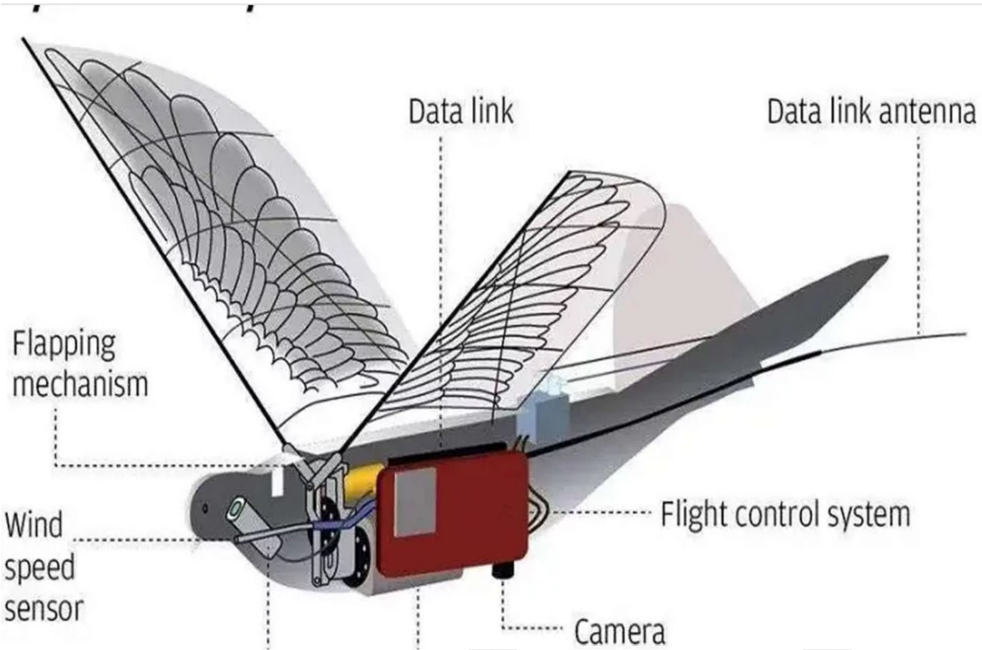

Figure 2.4: Biomimetic Bird drone cutaway diagram

Figure 2.5: Tianyi quadcopter (four rotor) “Killer”drone

Figure 2.6: Tianyi quadcopter – alternate view

Figure 2.7: DJI Mavic 3 – typical quadcopter

Figure 2.8: FPV drone with an RPG warhead

Figure 2.9: Prototype maritime surveillance hexacopter (six rotors) drone with flying time of 75 min

2.2 Exclusion criteria

- Loitering munition

A loitering munition is a single use (expendable, non-returnable) delayed or non-delayed attack system which is launched and flown to the general target area. It then maintains its position for a variable period of time ranging from immediately to its 'dwell time' or until a target establishes its presence within the period. It then informs a human operator of the target's location. The operator then executes the terminal approach to target.

Loitering munitions fall outside the definition of a small UAS, and will be considered as ammunition.

Overview

2.3 Since the early 2000s, we have seen a swift evolution in the military use of small UAS. There has also been a steady fall in the purchase price and a significant advances in technology. Coupled with the ubiquity of 3D printing capability and its ever decreasing cost, UAV components (fuselage, wings) are becoming cheap to produce en-masse. Their usage has had wide implications for traditional military forces, as well as for law enforcement.

2.4 We are yet to reach the apex of UAS capability. A summary of existing usage is given below[5]:

- Military
- Law enforcement & other government agencies
- Media
- Criminal enterprises.

2.5 The military usage of UAS has been adapted from developments in the civilian/ recreational market. This document will not consider the civilian/ recreational usage of UAS. However, as new sensor technologies and capabilities emerge in the recreational arena, the usage categories mentioned in the list above will rapidly adopt them for their own purposes.

2.6 A brief note on unit price of commercial off the shelf UAS. As is the case for the wider category of consumer electronic goods, historical observation of pricing of drones is that they start off as high-priced and reasonably unsophisticated items. Over time, the price point for equivalent capability falls, often dramatically.

2.7 This incentivises manufacturers to bundle more technology and capability into the package to justify higher prices. Drones are no exception, and manufacturers now offer longer flight times by squeezing the most efficiency out of a battery, offer higher resolution optics, built in thermal imaging, automated flight control, guidance,

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5 Excluding private recreational, aerial photography and aerial surveying usage.

and a range of other features. However, there is a limit as to how much can capability be wrought from a basic drone, and we are at a stage of development where prices are either stable or decreasing.

2.8 Certain nations, particularly those known to have non-capitalist economic systems, have a government subsidised manufacturing base, enabling them to mass produce drones cheaply[6]. This keeps unit costs low. This capability can be replicated in the west with similar subsidies, however at present, there are few drone manufacturers that are either state-based enterprises or government subsidised.

Military

2.9 The categories of military usage listed below is based on reported patterns of use across numerous conflicts current and historic, however the military usage of UAS is only limited by the imagination. The first four are conventional uses, and the fifth has been included for its tactical application, and is lifted from the criminal applications indicated as distraction. To give it the appropriate military task classification, it has been renamed as 'deception'. A sixth category, logistics, has been excluded from this document. Note that a complex military task may require more than one usage category.

- **Communications** - extending the range of a network by acting to boost the signal over longer distances, to increase the effective radius of communications, and therefore the range at which strike, targeting, ISTAR and deception missions can be executed.
- **Deception** - Misdirect focus from one location to another in order to draw forces to investigate, and or to lead the enemy to expend valuable ammunition on decoys, leaving it vulnerable to defeat when an actual attack is executed.

6 This is just one factor in the development of high technology, and also goes hand in hand with a highly developed and co-ordinated research and development capability.

- **Electronic warfare** - use of signal generation devices to overwhelm specific communication frequencies with noise to block communications

- **Intelligence, surveillance, target acquisition & reconnaissance (ISTAR)** - Observation, detection, identification and tracking of items of interest to the drone operator that provide the formation commander situational awareness and early warning, as well as identification and nomination of targets for direct and indirect fires, as well as correction of indirect fires in order to achieve target neutralisation

- **Strike** - Direct delivery of ordnance against a ground or aerial[7] target, including by the following means:

  – As a re-useable launch platform for a guided, unguided weapon or other UAS

  – As a single use (expendable) system directed towards a ground-based target or towards another drone, often referred to as FPV (first person view).

2.10 ECM requires considerable electrical power, as well as dwell time over the target area. On an airframe with a gross take-off mass of 15 kg, whilst it is possible to build an ECM UAS, we will place the capability into a higher order, class 2 or higher UAV.

2.11 Similarly, load carriage over a distance as would be required for logistical drones would raise gross take-off mass to over 15 kg.

[7] This includes the use of drones for the purpose of aerial route denial, that is, the positioning of FPV drones in the flight path of enemy drones.

Law enforcement & other government agencies[8] [9]

2.12 Law enforcement & other government agencies use drones in a largely intelligence gathering, surveillance and reconnaissance and forestry management, as manifested in the following diverse range of tasks:

- Traffic monitoring
- Industrial, commercial & domestic fire monitoring & damage assessment
- Crowd monitoring & allocation/ redirection of personnel and other resources
- Suspect tracking
- Crime monitoring (e.g. real time monitoring of street-level drug deals)
- Incident response (e.g. toxic chemical spills, vehicular accidents - rail, road, maritime).
- Search & rescue
- Police operations (SWAT, counter-terrorism, apprehension, manhunt etc.)
- Natural disaster survey/ monitoring (e.g. Fires, floods, earthquake damage)
- Initiating controlled burn-offs in forested areas to reduce fuel loads prior to summer[10].

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8 https://www.police1.com/2018-guide-drones/articles/cops-weigh-in-the-impact-of-uas-on-policing-26X2IyulRx9yQzM1/

9 https://www.commercialuavnews.com/public-safety/drone-adoption-in-law-enforcement-continues-to-rise

10 This is achieved using a purpose designed binary fuel-oxidiser deflagration cartridge. It uses Potassium permanganate and Glycerine held in separate compartments, but when dropped, upon impact the two components mix and ignite spontaneously.

Media

2.13 Media includes the use of **drones as flying still image and/or audio visual recording cameras**, for the purpose of inclusion of recorded imagery in collating stories and reporting them to broader audiences.

2.14 The low cost of entry in terms of both image capture and the ability to share imagery on social media has seen the emergence of 'citizen journalists' or one-man media 'organisations' alongside the adoption of drones by traditional transnational media corporations, public broadcasters and state-owned media organisations.

Criminal enterprises[11]

2.15 Drones have been used to conduct the following criminal activities:

- **Distraction** - Misdirection of attention from specific areas in order to exploit the lack of observation in other areas
- **Intelligence gathering**, surveillance and reconnaissance to disrupt law enforcement operations, to observe protocols and routines, to survey weak points in structures, to unlawfully observe specific individuals to determine 'pattern of life', and unauthorised surveillance of government buildings
- **Interfere with aircraft operations** near airports
- **Smuggling** - of illicit items across borders, and of prohibited items (cell phones, weapons, drugs, money, black market and other items) into prisons
- **Strike** - Weaponised drones with explosive payloads used to target fossil fuel, hydro, nuclear power plants in order to disrupt the normal distribution of electricity, or other public

11 Summarised from url: https://sentrycs.com/the-counter-drone-blog/misuse-of-drones-drone-attacks-and-incidents/

utilities as well as to kill law enforcement personnel executing their duties.

Chapter 3 – Olvanan UAS employment framework

UAS employment supports military operations

3.1 Military operations are means of executing the will of the Olvanan Communist Party in order to achieve the Party's objectives.

3.2 UAS employment is along an axis moving from less complex to more complex operations. These are[12]:

- Fleet operations
- Informatised Group operations
- Intelligentised Swarm operations.

3.3 "Informatised" means the following:

"Characterized by digital networks that enable modern precision--guided munitions, platforms, and information related capabilities such as electronic and cyber warfare. Informatised warfare places a central and critical emphasis on information superiority [13]."

3.4 "Intelligentised" means the following:

"Integrated warfare waged in land, sea, air, space, electromagnetic, cyber, and cognitive domains using intelligent weaponry and equipment and their associated operation methods, underpinned by the internet of things information system.[14]"

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12 US TRADOC Mad Scientist 352. The PLA and UAVs – Automating the Battlefield and Enhancing Training, 13 Sep 21

13 url: https://www.airuniversity.af.edu/JIPA/Display/Article/3371164/finding-the-right-model-the-joint-force-the-peoples-liberation-army-and-informa/

14 Yatsuzuka M, PLA's Intelligentized Warfare: The Politics on China's Military Strategy, Security & Strategy, Volume 2, January 2022

Fleet operations

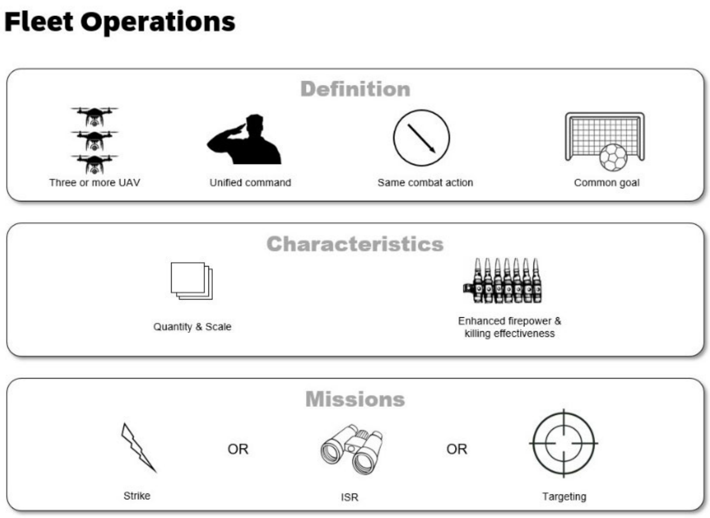

Figure 3.1: Characteristics of Fleet Operations

Informatised Group operations

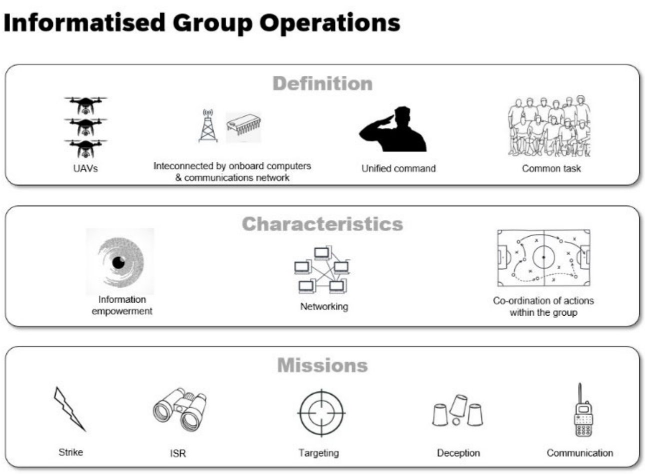

Figure 3.2: Characteristics of Informatised Group operations

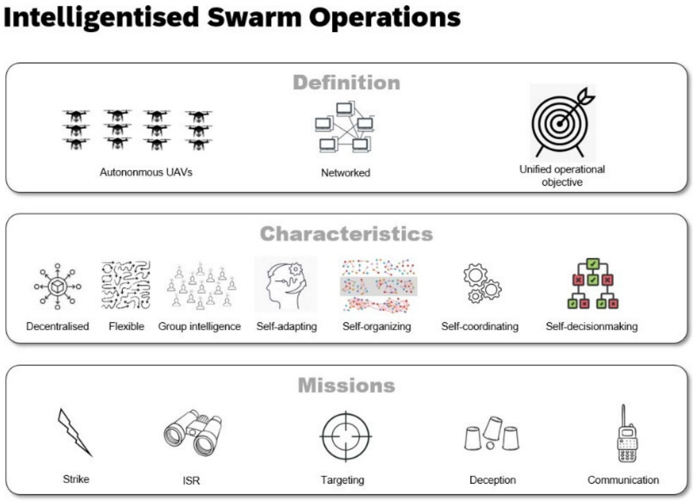

Figure 3.3: Characteristics of Intelligentised Swarm operations

3.5 The advantages and limitations of these modes of operation are discussed in Table 3.1.

Table 3.1: Summarised advantages & disadvantages of Olvanan modes of UAS Operations

Attribute	Fleet Operations [FO]	Informatised Group Operations [IGO]	Intelligentised Swarm Operations [ISO]
Advantages	• Centrally managed • High efficiency for simple tasks	• Efficient task coordination • Operational flexibility • Perform distributed combat tasks • Scalability	• High efficiency task coordination • Strong operational flexibility • Battlefield adaptability • Strong capability to conduct distributed tasks • Scalability
Disadvantages	• Low efficiency for task co-ordination • Weak distributed task capabilities • Poor scalability • Not adaptable	• High requirement for information technologies • Complex UAV design • Vulnerable to electronic interference	• Large numbers of advanced drones • High/ intensive research efforts in biological simulation technology

3.6 The following insights can be reasonably deduced from these three categories of operations.

- Task complexity increases from FO to IGO to ISO.
- FOs execute the same combat action, hence multiple UAS are deployed for a single purpose, and each UAS is controlled by a single operator.
- IGOs can be considered as multiple FO sized groups, all directed to achieving the same mission. Each FO sized group within the IGO is deployed for a single purpose. For example, one group might be dedicated to ISTAR, another to deception, and yet another to strike. Each UAS would be controlled by a single operator.
- ISO can be considered as multiple UAS, which are subdivided into specific functional groups, with each group conducting one specific task. It is fast approaching the realm of the possible that a swarm can be used to conduct the five military tasks indicated, and be initially directed to an objective by a single operator, but largely act independently once the objective is set.

Operations below Fleet

3.7 The deployment of individual UAS is placed outside of fleet, group and swarm operations. Hence individual small UAS can be used for the purposes of ISTAR and strike on the order of the commissioned officer in command of a platoon, on the battlefield.

Chapter 4 – Olvanan Military UAS usage

Roles of UAS

4.1 Olvanan forces use UAS for the following military purposes:

- ISTAR
- Strike
- Electronic warfare
- Deception
- Communication

Roles of small UAS at Platoon – CDET echelons

4.2 At the Platoon - CDET level, we will focus on the role of small UAS in

- ISTAR
- Strike

4.3 Stated below are the assumptions and imputed allocation of UAS and counter UAS equipment in a platoon. The allocation gives each platoon the ability to achieve a spectrum of general purpose tasks in support of its mission as part of the broader campaign.

4.4 This allocation is in addition to those of small arms [rifles, assault rifles, sniper rifles, anti-materiel rifles, grenade launchers, machineguns, light anti-armour weapons] ammunition, radio communications, night vision devices and soldier personal equipment.

Assumptions

- The primary purpose of the platoon is to achieve military objectives in support of executing the will of the Olvanan Communist Party
- The platoon consists of three squads of nine soldiers per squad, a Junior NCO, a sergeant and a platoon commander for a total of 30 personnel per platoon[15]
- There is no separate UAS attachment. The skills and capabilities necessary to execute ISTAR, strike, targeting or deception are organic to the platoon
- The role of UAS is to provide the platoon manoeuvre support by ISTAR, strike
- An UAS/ FPV drone is deployed at the discretion of the platoon commander in the situations described in Table XX
- A UAS platform is considered an expendable item[16]
- The UAS operator needs a cleared launch/landing site with dimensions 2 × 3 m
- This same area can be used as a launch area for an XS101 or an FH901
- When using a returnable UAS, the UAS operator uses different flying routes on the outbound [towards a target] leg of the flight and the inbound [towards its landing location]
- The drone operation team, the operator and the support team member remain under visual and IR concealment.

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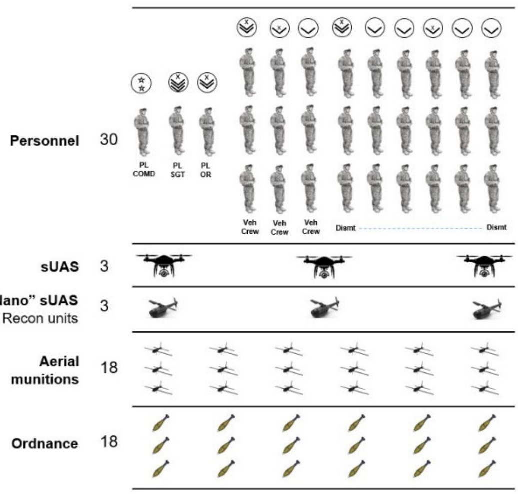
15 Mechanised/ motorised/ armoured unit Squad have 3 vehicle crew and 6 dismounts. Each Squad has its own vehicle.

16 This is tempered by the platoon commander's decision to expend or re-use the returnable UAS, and the reality of logistics [based on stock levels, storage location, competing demands] of replacement in their situation.

Imputed allocation - UAS, munitions, operators & level of training

Mechanised/ Motorised INF Platoon sUAS assets



Mech/ Mot INF PL		
Pers	PL HQ Veh Crew Dismounts (Note 1)	3 9 18
sUAS	Mavic 3 equivalent Hummingbird Nano (Note 2)	3 3
Aerial munitions	XS101 (Note 4)	18
Ordnance	MOTS (notes 3,5)	18

Notes
1. All dismounts trained in Operator and Team Support roles
2. Recon units equipped with Nano drones in addition
3. sUAS capable of Strike using MOTS
4. Aerial munitions can be FH901 if anti-armour mission
5. 60 mm HE mortar bomb, specialised ordnance on order

Figure 4.1: Imputed Olvanan platoon UAS and aerial munitions capability

4.5 Each squad is equipped with/ has:

- 1 × lightweight UAS for ISTAR/ targeting capable of a return strike mission
- Specialised close reconnaissance squads have 1 × Hummingbird "nano" drone
- 6 × rounds military off-the-shelf [MOTS] drone-portable explosive ordnance
- Up to 6 × XS101/ FH901 loitering munitions
- 3 × Drone operators/ pilots
- 3 × Team partners.

4.6 Each platoon's skill set is as follows:

- Senior NCO is an experienced UAS/ FPV operator who may be designated as an operator by the platoon commander

- Commander is a qualified UAS/ FPV operator, who has the training but is highly unlikely to operate the UAS.

4.7 This allocation holds true for armoured, mechanised and motorised formations. Vehicle crews remain with their vehicles unless ordered otherwise by the platoon commander, when dismounted and act as dismounted combatants.

4.8 Nano drones have an effective range of 1,000 m and a battery life of 25 min

4.9 Small UAS have an effective range of 5,000 m and a battery life of 40 min.

Logistical support

4.10 Replenishment of depleted UAS and munitions is through the established Brigade support structure.

4.11 Technical support of electronic equipment, hardware and software of flight controller handsets is provided by a squad-platoon of specialised technicians that are attached to the CDET organisation. Replacement parts are provided through the established Brigade support structure.

Imputed Anti-drone equipment – Squad

4.12 Each squad has the following items

- 3 × Acoustic sensors & hand-held monitoring 'tablets'

- 1 × Anti-drone ECM 'rifle'

- 3 × 12 Ga Shotgun with specialist wire-net and conventional shotgun ammunition

Table 4.1: Olvanan UAS missions at platoon level

Mission	Purpose	Authority	Delegation	Remarks
ISTAR	Provide the platoon commander with situational awareness of the enemy, the terrain and his own troops' disposition in order to select a course of action	Platoon Commander	Platoon commander can delegate the task of operating drones to any qualified platoon member, via the senior NCO – the Senior sergeant/ Squad leader	
ISTAR	To provide target location and correction of indirect fires onto enemy personnel and/or vehicles	Platoon commander	Platoon commander can delegate the task of operating drone and providing fire control commands to any qualified platoon member, via the senior NCO – the Senior sergeant/ Squad leader	
Strike	Destruction of enemy personnel and/or vehicles or counter UAS using a re-usable UAS	Platoon commander	Platoon commander can delegate the task of operating drone and delivering ordnance to any qualified platoon member, via the senior NCO – the Senior sergeant/ Squad leader	Platoon commander will designate the target Payload can be one or more of pyrotechnic [WP, obscurant] or explosive [HE, fuel-air explosive, so called "thermobaric"] grenades, other military-off-the-shelf explosive ordnance or anti-drone net/ cable

Platoon Skills and Roles

4.13 An infantry platoon equipped with small UAS has:

- Operators, who focus their attention on the device screen that provides feedback from the UAS/ FPV drone.

- Team partners provide the operator with local situational awareness, as well as monitoring for potential communication problems and enemy countermeasures.

- Senior platoon sergeant and the platoon commander will also be qualified operators, for differing reasons.

4.14 The platoon commander will be a qualified operator in order to be aware of system capabilities and limitations. He delegates the operation of the UAS to either the sergeant or a qualified squad member depending on the criticality of the drone mission. This permits the platoon commander to maintain his attention to the overall co-ordination of the platoon. This is achieved by collating the various inputs from the battlefield – his mission, terrain, weather, circumstances, physical limitations, and the enemy, to guide his actions.

4.15 If greater experience is dictated for the specific sortie to be flown, the platoon commander will delegate the sergeant as operator, and the team partner operator will be the platoon NCO.

Platoon UAS ordnance characteristics

4.16 The purpose of a strike sortie is to destroy the platoon commander's designated target. A range of MOTS ordnance can be used to achieve this effect. Not all possible types of ordnance will be at the platoon commander's disposal, unless he has been ordered to pack them, or has intelligence on the possible targets he will encounter and equipped the platoon with the appropriate ordnance, prior to stepping off on the mission. At minimum, high explosive ordnance is carried, for anti-personnel/anti-unarmoured vehicle use.

4.17 The principal limitations on ordnance that can be delivered by an FPV drone are those of:

1. Mass that the UAS platform can carry, and

2. Distance between the launch point and the target.

4.18 High mass payloads and long distance are unlikely to be employed, given the gross take-off mass of 15 kg.

4.19 A UAS can be adapted to deliver any form of ordnance that can be projected by the human hand, be it a purpose built military munition or an improvised one[17]. Global examples of ordnance delivered includes hand grenades, rifle grenades, mortar bombs and glass bottles of self-igniting liquid fuel-oxidiser mixtures, often referred to as 'Molotov cocktails'.

Figure 4.2: Ukrainian mail-order improvised drone munition bodies ready for shipment

[17] Ref: url https://www.forbes.com/sites/davidhambling/2024/04/02/steel-hornets-ukraines-amazon-for-drone-bombs/

Figure 4.3: Improvised munitions Ready for use. Fuses added, explosives filled at the front by operators

Figure 4.4: Soviet manufactured drone bombs – using steel rings, PVC moulded stabilising fins and protective fuse cap

4.20 At present, the types of ordnance that can be carried are: high explosive, shaped charge, pyrotechnic [smoke/white phosphorus], fuel-air explosive [‘thermobaric’ for use in confined spaces, such as bunkers, trenches and in urban environments with other built-up/ confined structures]. These can be initiated by electronic/ chemical/ mechanical timed/ piezoelectric, impact, delayed impact, or proximity fuses.

4.21 The munitions employed are adapted from existing inventory, such as mortar projectiles, hand grenades, thermobaric and shaped charge rocket projectiles as used in RPG and PZF warheads. Current developments in drone dropped munitions are unlikely to stray too far from conventional design [fuse, HE/ steel fragmentation casing/ tail], less the propellant charge component. This leverages existing technology and production techniques, making costs low.

Figure 4.5: Olvanan 60 mm HE mortar bomb

4.22 However, developments used for warfare leave no opportunities unexploited. By 2030, Olvana is likely to have developed shaped charge and thermobaric ordnance, specifically designed for drone delivery. It is unlikely, but not improbable that it will develop guided munitions for drone delivery, given its co-ordinated industry-military- science approach to problem solving.

Figure 4.6: Romanian drone-dropped munitions (L-R: 60 mm, 81 mm, 82 mm, and 120 mm), showing the polymer fins on the smaller calibres to reduce weight

4.23 The recently developed phenomenon of 3D printing raises the possibility that outer casings and fins can be mass produced, by anyone, anywhere. In future, we may see the manufacture of munitions closer to the battlefield, with specialised components manufactured at industrial centres then brought forward and assembled by specialised logistics battalions. This also raises the requirement for operators to take on additional training in the safe handling of explosive ordnance when arming these items of ammunition and securing them to small UAS prior to launch.

Loitering munitions

4.24 At present, there are two loitering munitions in use:

- XS 101 General purpose HE loitering munition
- FH 901 Anti-armour HEAT loitering munition

4.25 XS 101 Loitering munition has been sighted by western observers, and is widely held to be similar in design and performance to the US Switchblade 300 loitering munition. It is a ground-mounted, self-contained unit launched from a box launcher. Wingspan is estimated at 900 mm, length 600 mm, mass 2.5 kg with a range of approx. 10000 m. It requires minimal operator assistance and is believed to be highly accurate. It has a dwell time of approximately 15 minutes.

Figure 4.7: XS101 Launch tube at left, and munition in flight at right

Figure 4.8: XS101 Loitering munition demonstration

4.26 FH 901 has also been sighted by western observers, and is a larger unit. It has an approximate wingspan of 1300 mm, length of

1000 mm a gross take off mass of 9.5 kg including a 3.5 kg interchangeable warhead that can be fitted with high explosive, fragmentation and HEAT. It has a range of 15000 m, and a dwell time of 60 minutes. It is designed as a top attack weapon.

Figure 4.9: FH901 Anti-Armour Loitering Munition demonstration

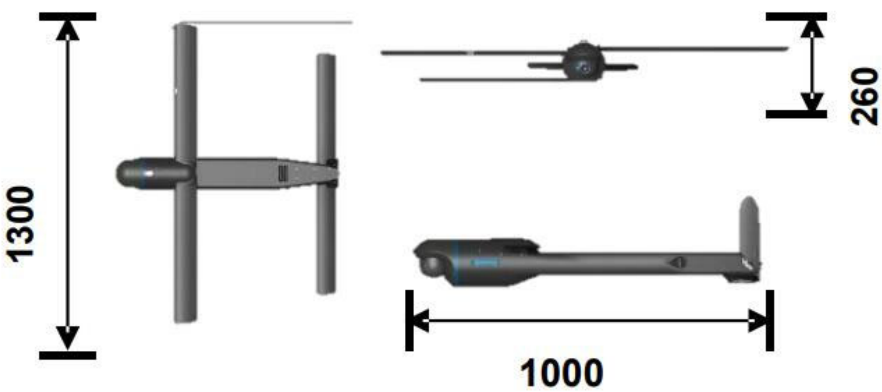


Figure 4.10: FH 901 schematic illustration

Communications/ counter ECM support

4.27 The function of using UAS as communications relay links becomes a necessity for targets that are beyond visual range. This is a consequence of the radio spectrum used for drone operation. All frequencies used to operate, send and receive data and imagery are greater than 40 MHz, which is the highest frequency capable of being reflected by the Earth's ionosphere.

4.28 This is a specialist function. It falls under the responsibility of the Olvanan Peoples' Army [Communications battalion or equivalent]. Post 2017, this function was unified under the Service Support Brigade structure, encompassing communications, logistical and armament [ordnance] elements, which maintains and controls the establishment of long-distance aerial relay links to enable beyond visual distance communication links with UAS. These are purpose built with long duration flight times to maintain their positions for mission duration. They have significant battery power reserves and an array of retransmission electronics, in addition to the avionics, camera and GPS locator. The requirement of long loiter times for communications and ECM support may be circumvented by the use of either fixed-wing systems or balloons.

4.29 The basis of retransmission is an electronic system that detects and receives a weak signal on one frequency, then retransmits it on another frequency. For example, on a voice communication network, the talk signal transmits on frequency A, and the listen signal is received on frequency B, the frequencies are separated by a small variation of a few megahertz.

4.30 Retransmission stations can be linked to one another in a network, and can extend the range of a weak originating signal to beyond visual range. Depending on the mission set, the Support Brigade can emplace and maintain a network of aerial repeater stations to give coverage of a region. Alternatively, the Support Brigade can emplace a set of repeater stations along a specific route or intended drone flight path.

4.31 The area solution is more robust in terms of redundancy. It also makes it difficult for an opponent to determine which direction a potential strike may be coming from, but it is resource intensive. The route based repeater solution is less resource intensive and less robust – if one repeater station along the route becomes unserviceable the reliability decreases. It also may indicate to an observant opponent, the direction of potential attack.

4.32 The use of aerial repeater stations gives UAS operators the ability to send drones that have the appropriate flight characteristics of range and payload to strike targets that are beyond line-of-sight range.

4.33 The capability has been observed to have been used in this manner in the Eastern European conflict of 2022 to the present day.

4.34 At platoon and at CDET level, Olvanans are less likely to use UAS for communication range extension in either attack or defense. This does not preclude these levels of formations from using communications range extension assets. The requirement in terms of manpower, materiel, energy, support services is considerable.

4.35 Getting a single range extending drone into position is relatively straightforward. But it only achieves limited range extension. To be effective, there needs to be a network of multiple such assets, and a CDET sized formation is likely to require support from a higher formation to achieve a wide-area defense or strike targets at range. In addition, for engaging opponent forces at long range, the more appropriate method of attack is indirect fires from mortars, conventional or rocket artillery.

Deception

Figure 4.11: Unarmed Russian deception drone with high radar cross section intended to activate A2AD radars and deplete Ukrainian ammunition stores

4.36 This document acknowledges that small UAS can be used in the military context of deception. However this usage is more likely to be employed at higher echelons - above CDET level - for the following reasons.

- Deception is likely to be employed against systems warfare targets, to locate, confirm and deplete such capability.

For example, it may be a target such as an air defense radar array co-located with an air defense gun/ missile battery, causing locating radar to activate, and running down ammunition reserves in neutralising unarmed targets. The net effect is to weaken the capability for when it is required against an active threat.

- Deception is likely to be employed in concert with other elements at scale, such as strike. This requires a level of co-ordination potentially beyond the capabilities and resource levels of a CDET.

4.37 From observations in the Ukrainian conflict, the first case has been borne out, and the targets where deception has been employed appear to be towards defeating strategic capability rather than at small scale tactical victories.

Chapter 5 – Types of UAS in use and considerations for use

Types

5.1 This section is a listing of types, showing an example of the type, with indicative dimensions and performance specifications. It is not intended to be an exhaustive catalogue of UAS platforms used by Olvanan forces. Some of the examples shown are outside the < 15 kg gross take off mass as defined for UAS.

5.2 **Biomimetic drone** (that which imitates or mimics biological creatures), in this case replicates natural wing 'flap' of birds.

Ornithopter/ biomimetic Drone

Role
ISR – Visible light

Dimensions
Wingspan 380 mm

Mass
1.6 kg

Speed
70 km/h

Ceiling
UNK

Radio range
2 km

Endurance
90 min

Figure 5.1: Example of a biomimetic drone – visually indistinguishable from a bird

5.3 Mono rotor configuration

Hummingbird Drone

Role
ISR – Visible light, IR

Dimensions
Body 139 mm len
Rotor 123 mm dia

Mass
0.035 kg

Speed
23 km/h

Ceiling
4,000 m

Radio range
2 km

Endurance
25 min

Figure 5.2: Example of a mono-rotor UAS, a 'nano' drone

5.4 Co-axial Dual rotor configuration

HENG029-100 Dual-rotor Coaxial Drone

Role
ISR – Visible light, IR

Dimensions
Body 432 mm h x 70 mm dia
Rotor 450 mm dia

Mass
1.2 kg incl. 0.6kg payload

Speed
70 km/h

Ceiling
4,000 m

Radio range
5 km

Endurance
70 min

Figure 5.3: Example of a coaxial dual rotor UAS

5.5 Twin copter dual rotor configuration

XAG V40 Bicopter Agricultural Drone

Role
Dispersal of aerosolised liquid agents, seeds and solid fertilizer

Dimensions
2795mm x 1030mm x 731 mm

Mass
29.8 kg unladen
48.0 kg max gross take-off weight

Speed
25 km/h

Ceiling
4,000 m

Radio range
2 km

Endurance
6-14 min

Figure 5.4: Example of a tilt-rotor bi-copter

5.6 **Quad rotor configuration**

DJI Mavic 3 Drone

Role
ISR – Visible, IR

Dimensions
347.5 × 283 × 107.7 mm

Mass
0.895 kg

Speed
75 km/h

Ceiling
6,000 m

Radio range
1.5-9 km

Endurance
46 min

Figure 5.5: Example of quadcopter[18]

18 Reference url https://www.dji.com/au/mavic-3-classic/specs

5.7 Hexa-copter [six rotor] configuration

RC T60 Drone

Role
Search & Rescue, Survey
ISR – Visible, IR

Dimensions
UNK

Mass
15.2 kg gross take-off mass

Speed
75 km/h

Ceiling
5,000 m

Radio range
8 km

Endurance
58 min

Figure 5.6: Example of a hexacopter[19]

5.8 Octo-rotor [eight rotor] configuration

THEA 200MP Drone

Role
Load carriage

Dimensions
1590 × 1515 × 890 mm

Mass
140 kg gross take-off mass

Speed
90 km/h

Ceiling
UNK

Radio range
UNK

Endurance
18 min w/ 50 kg payload

Figure 5.7: Example of Octocopter

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19 Reference url https://www.jttrescue.com/search-and-rescue-drone-hexacopter-rc-t60_p72.html

Considerations for use: Degrees of human/ machine control in the use of UAS

5.9 Control of UAS occurs along an axis ranging from complete human control to complete machine control.

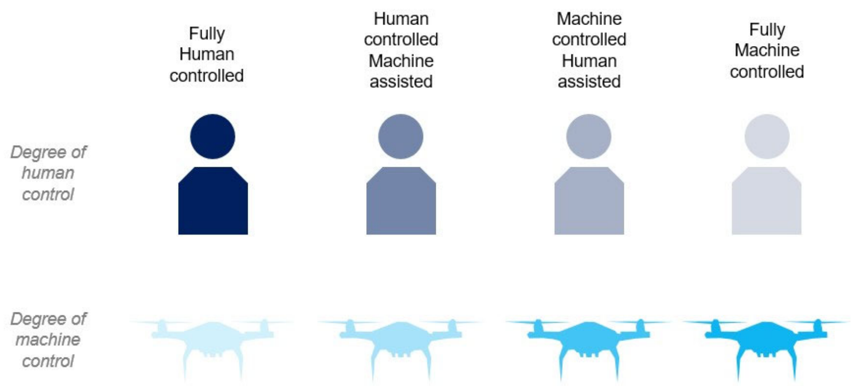

Figure 5.8: Degrees of human and machine control

5.10 As at 2024, we are at the stage of *machine controlled human assisted operation*. This means that flight characteristics such as obstacle avoidance, yaw, pitch, roll, attitude, geographic location, altitude, acceleration, stall and other complex flight variables are under computerised control, as are functions such as take-off and landing. This frees up the operator to concentrate on higher order tasks such as guidance, observation and evaluation of the visible imagery returned from the drone's sensors.

5.11 A brief summary of the degrees of human-machine control indicated in Figure 5.8 is given below.

5.12 Fully human controlled

Under this regime, the drone operator controls all aspects of flight – altitude, direction, airspeed, location, obstacle avoidance, situational awareness if more than one UAS is in the aerial formation. This is the most demanding of operating regimes, as not only is the operator responsible for executing a sortie's aerial component of keeping the vehicle airborne, but also for observation and evaluation of the target picture returned from sensors and telemetry.

An example of a fully human controlled system is a radio controlled toy car or toy helicopter. These have the operator in complete control of speed and direction. First person view drones also fall under this category.

5.13 Human controlled machine assisted

As previously described, several flight parameters, those directed at maintaining stable flight are delegated to machine control. This makes the operator's job less demanding in terms of splitting focus between flying and observing. It also permits the operator to focus on the higher order task of evaluation of the target picture.

An example of a human controlled machine assisted system is that of an advanced driver-assistance systems (ADAS) in modern cars, where the vehicle can maintain lane position and adjust speed autonomously, but the driver remains in control and responsible for steering and overall decision-making.

5.14 Machine controlled human assisted

Often referred to as the "human in the loop", in this regime, human control is required when a decision needs to be made in terms of flight parameters, or any situation that is beyond the scope of the complete aircraft/payload systems' programming. This can be for the purpose of maintaining flight, corrections, or actions to be conducted upon identification of an item of interest.

An example of a machine controlled human assisted system is an autonomous shuttle operating on a predetermined route within a fixed, limited route such as a university campus or an airport.

5.15 Fully machine controlled

Under this regime of control, which today at face value seems unlikely, but likely to a certainty by 2030 will see a 'set and forget' drone mission which will execute any mission with a pre-defined objective with complete autonomy. Besides mission selection, human control will largely not be required. The only likely exception could be that human monitoring and evaluation of relevant imagery is used to modify mission parameters.

Consideration: Noise signature of UAS

5.16 The DJI Mavic 3 will be used to represent the sound characteristics of drones.

5.17 Note that larger drones – hexacopter and octocopters, with the addition of further rotors and engines, will generate considerably more sound energy. Conversely, smaller drones such as the 'Hummingbird' or biomimetic ornithocopters will generate considerably less sound energy.

5.18 We also need to understand what objectively measurable levels of sound equate to in terms of commonly referenced human experiences. This is best represented graphically.

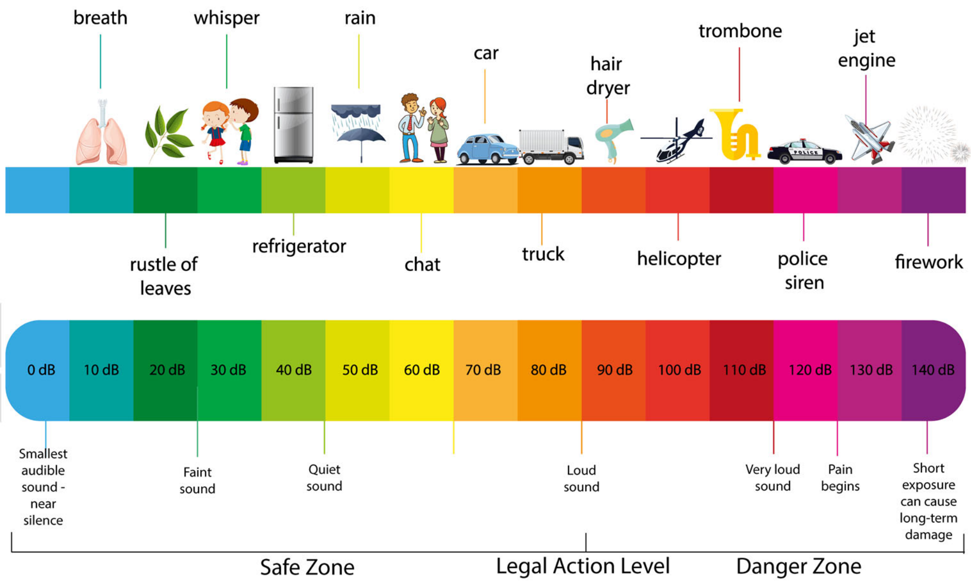

Figure 5.9: Sound levels and reference of human perceptual experiences

5.19 A DJI Mavic 3 generates 85 dB, sampled at directly next to it. In terms of human reference, it lies between the sound of a truck engine and an operating hairdryer. It is distinct and noticeable.

5.20 Sound dissipates in intensity to the inverse square of the distance from the point of origin.

5.21 The factors that affect sound attenuation are:

- The sound level at the point of origin
- Distance of the observer/ listener
- Absorbance/ reflectivity of environment
- Local weather conditions

5.22 The sound level at the point of origin gives us the scalar of energy that originates. It 'radiates' as a point source, outwards in a conceptual three-dimensional sphere. The louder the source, the more energy that needs to be dissipated.

5.23 The distance informs us as to the unattenuated diminution of energy along a straight line path between the origin and the observer or recorder.

5.24 The absorbance/ reflectivity of the environment informs us as to how much energy is absorbed or reflected by the surface. A hard surface such as concrete reflects sound with almost no attenuation. A forest/ treeline canopy of leaves is softer and more porous works to mostly absorb and only partly reflect sound waves.

5.25 Local weather conditions have several potential effects.

- Storms and heavy rain can provide high levels of background noise which drown out the specific sound of an airborne drone by masking it with sounds of rainfall and thunder.
- High winds both drown out sounds and redirect sound waves in different directions.
- Note that in adverse weather conditions, whilst providing adequate background noise to mask the sound of a drone, at present, NATO Class 1 Mini drones, under 15 kg are unlikely to be capable of operation.

5.26 It has been claimed that drones can be heard out to 800 m with a clear line of sight. In a military context, with a canopy of trees, the distance at which a drone cannot be heard by the unaided human ear is 100-200 metres.

5.27 The UAS operator must be aware of the wind direction on approach to the target site, and will typically approach from downwind of the target, to minimise the possibility of rotor noise being carried by the wind announcing the presence of the UAS to personnel at the target site.

Chapter 6 – Authorisation for use of UAS

Platoon level usage

6.1 For the scenarios described in Chapter 9, the **release authority is the platoon commander**, the commissioned officer leading the military effort at the front end of combat operation. He has the sole authority to designate the role of the UAS to execute his mission. These missions are ISTAR, targeting with organic or external fire support, and strike.

6.2 He is authorised by his commander, the company commander, and his allocation of the type and quantity of UAS and all aerial delivered ordnance is scheduled in tables of equipment allocation and allowance for the specific task and purpose.

CDET level usage

6.3 At the CDET level, the **CDET commander can authorise the use of single use/ non-returnable UAS, as well as anti-armour loitering munitions**, which can then be allocated for use by platoon commanders. These assets are still employable in straightforward missions, which increase the platoon's capability to deal with better protected and more numerous targets in their range.

6.4 They are not able to allocate communications range extension drones, nor are they able to allocate ECM drones. The supporting requirements and power to use these specialised assets are within the Brigade structure.

Higher echelon level usage

6.5 Brigade level authorisation is required for complex tasks. Complex tasks combine multiple elements of the five[20] missions

[20] ISTAR, Strike, ECM, Deception, Communications

previously described, and are typically directed to strike 'systems warfare' targets, such as nodes [storage of fuels, rations, weapons, ordnance, command, intelligence] which when struck, cause system-wide, consequential effects that reduce the enemy's ability to maintain combat operations.

6.6 Brigade level authorisation is also consistent with the scale, scope and level of resource usage – personnel, equipment, munitions, aerial platforms and the multitude of other elements that need to be brought to bear in order to conduct a strike using a swarm.

Swarming

6.7 Swarming is a complex drone strike involving significant numerical and capability superiority and is likely to be executed when

- targets are of significant military importance,
- targets are not within reach of conventional means of attack,
- targets are critical parts of a complex enemy system such as the power generation train of an air defence radar system, a communications hub, a UAV control centre, or the supporting elements such as water purification site or a bulk fuel/ ammunition storage facility which, if crippled, have systemic, widespread effect on the enemy.

6.8 Examples of such complex system attacks are suppression of enemy air defense or destruction of enemy air defense.

6.9 Swarming to achieve the destruction of a systems warfare target is an example of a complex task.

6.10 Swarming relies on scale, meaning numerical superiority. To demonstrate by example – from the opponent's perspective, one drone can be countered, if detected early enough. Ten drones are a problem. A hundred drones is a complex and overwhelming threat.

6.11 Scale relies on two factors for success. One is physical. No matter how effective the opponent's defences, a quantity of the attacking units will penetrate them. The second is psychological –

having the opponent know that despite their best counter systems, they are going to incur losses.

6.12 We are unlikely to see swarming attacks targeting personnel, though personnel will no doubt be casualties in any strike. We are more likely to see swarming attacks used against systems warfare targets[21]. Systems warfare targets are those that limit the opponent's ability to conduct military operations by causing second, third and subsequent order effects downstream of the immediate strike. For example, systems warfare targets include C2/ C3/ C4 nodes, logistics nodes, short range air defense systems, Engineer equipment, communications networks, power plants/ generator arrays. In Eastern Europe whilst we have not seen swarming attacks used by either side in the conflict, we have seen multiple co-ordinated strikes targeting specific facilities and systems.

6.13 Systems warfare targets including those struck by either UAS or non UAS means include:

- Distribution nodes - railway lines, bridges, port facilities
- Utilities - power generation facilities including conventional and cooling systems at nuclear power stations, hydro-electric generation systems at dams
- Combat power & support - ammunition storage facilities, fuel storage areas, manufacturing plants for war materiel, surface and submersible combatant vessels in port or under refurbishment

6.14 On the battlefield, we are concerned with the 'minimax' principle – what is the minimum force that can be expended for the maximum yield in terms of system-wide disruption caused. It is to those locations where Olvanans will direct swarms.

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21 These can be determined by either analysis using one of many techniques [AUS - Fundamental Inputs to Capability, the US DOTMLFP-P or the UK TEPIDOIL], which then indicate which nodes are vulnerable in the overall capability to wage war. From the pacing threat's perspective, systems warfare targets are defined in ATP 7-100.3 sections 4.1-4.3.

6.15 Scale deters the potential use of swarms against low-value targets. The organisation of resources in targeting and execution of a strike is considerable.

6.16 Swarm operations are also reliant on several technical and human factors, such as artificial intelligence, data and communications transmission networks, reliable and high speed CPU power, and a pool of trained operators, or co-ordinators who can program swarms to execute complex tasks.

6.17 Complex tasks rely heavily on drawing together multiple elements from a range of military functions. This includes at the minimum, intelligence, signals/ communications, electronic warfare, complex computer systems requiring hardware and software specialists, air traffic controllers, ordnance, combat support services for specialised systems support such as fuel, power generation, UAS operators, forward observers on the ground and relays to earth observation satellites and communications systems.

6.18 The execution of complex tasks will need to consider:

- Priority
  - the military necessity of the destruction of the target
  - the assessed strategic importance of the target to the enemy
  - the priority allocated to that target, in relation to competing targets.
- Friendly force disposition
  - air corridors between the point of origin and target
  - OPA airborne platforms crossing the intended flight path
  - operational ceilings of UAS platforms and other airborne assets during the operation
  - OPA ground forces in the vicinity of the target
  - eliminating/ reducing the risk of fratricide.

- Targeting 'calculus'
  - the alternate means of destruction of the target
  - the elements that need to be co-ordinated such as the strike, deception, communication and post-strike damage assessment
  - the usage of resources required to achieve target destruction.
- Other considerations
  - the political implications & symbolic value resulting from destruction of the target
  - consequences of non- or incomplete destruction of the target.

Chapter 7 – Counter small UAS capabilities & Counter-counter small UAS capabilities

Olvanan approach to counter small UAS

Platoon level

7.1 Olvanan tactical defence against UAS up to platoon level comprises basic detection and countermeasure systems, as well as a reliance on the non-technical elements of counter UAS defence, namely **visual camouflage, thermal masking and structural hardening**.

7.2 In terms of technological aids, **man-portable optical or audio sensors with a detection range out to approximately 100-500 metres** are used.

7.3 Whilst this is adequate for the purpose of warning against observation, such measures are unlikely to be effective against attack, given that a FPV drone travelling at 100 km/h can traverse a distance of 500 m in 18 seconds, which is insufficient reaction time to deploy countermeasures.

7.4 This could be potentially supplemented by the use of a higher echelon provided electronic detection coverage.

7.5 In terms of countermeasures, **a combination of defences anti-drone 'rifle' combined with shotgun or standard small arms**. With respect to shotguns, in addition to conventional metal shot of various sizes, there are now specific anti-drone shotgun cartridges which deploy a five-point star shaped wire consisting of multi strand steel wire rope, anchored at the centre. When fired, upon leaving the barrel, the projectile splays apart and creates a multiple-point steel wire net, designed to tangle the drone's rotors. This is a reasonably low-tech and effective approach. However, it requires additional training in the weapon platform and proficiency in consistently hitting a rapidly moving and fleeting target.

Figure 7.1: Drone Defender Rifle, Skynet shotgun ammunition – Olvanan replicas are similar design

Figure 7.2: Soviet LPD 820 ECM Anti Drone Rifle – operates at 2.4 GHz & 5.8 GHz

CDET Level

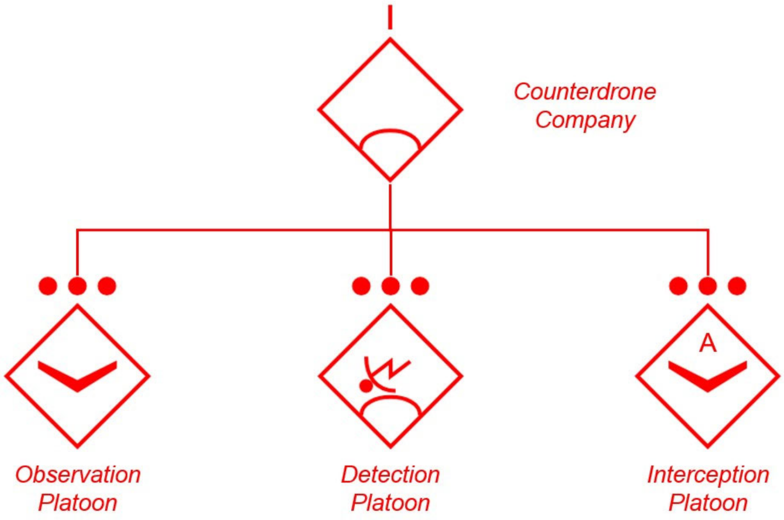

Figure 7.3: Combat elements likely deployed in defense of Company and higher formations – ADA, Radar and ECM

7.6 A CDET defense can be achieved with a counterdrone company in support. Given the purpose of a CDET – with functional and supporting combat units, as well as combat supporting units, the on the ground footprint is extensive. Defending that size of a ground force is highly unlikely to be achieved by a platoon of specialised defenders, and will take substantial manpower and resources.

7.7 Consider the requirement as the functional tasks of defending a CDET, using a scaled down layered approach to air defense. There needs to be a visual observation 'bubble', an electronic detection system, and finally a means of intercepting and eliminating the threat, once confirmed.

7.8 The Olvanan approach is to provide a company of specialised defenders under the command of a company commander and two staff, comprising the elements shown in the table below.

Table 7.1: Counter Drone Company elements

Name	Composition	Role

Observation Platoon	3 squads Observation drone operators	To provide a continuous visual and IR monitoring of a three-dimensional region of airspace surrounding the area to be defended. This occurs at three altitudes and at three concentric rings of varying distance to provide as complete local coverage as possible.
Detection Platoon	1 Squad Signal Detection 1 Squad Visual Detection 1 Squad Technical support	Detection Squad [EM, IR, Acoustic monitoring, signal analysis] Detect by sensor equipment movements of potential drone borne threats to the location to be defended. Identifies type, quantity and other characteristics of the threat. Visual Squad [visual detection, optics] Identify/ detect/ confirm by visual means potential drone borne threats to the location to be defended. Back up or adjunct to the electronic means of detection. Tech Squad – Maintain, site, fuel and repair sensitive equipment.
Interception Platoon	3 Squads FPV antidrone drone operators	To rapidly respond to and destroy incoming drone-borne threats to the position to be defended, using FPV impact drones.

Higher formations

7.9 At higher formations, [e.g. in protection of battalion sized mechanised/ motorised infantry, artillery, tanks, and other supporting elements], additional countermeasures would be used, such as a combination of sensors and neutralisation elements working in concert.

7.10 The footprint of higher formation and the co-location of more valuable offensive and supporting assets makes a higher formation more vulnerable to drone strikes.

7.11 In defence, the same principles would apply – observation, detection and interception. Higher formations would have at their disposal more complex and heavier anti-drone platforms as well as active jamming and electronic countermeasures. Antidrone measures in addition to counterdrone drones would include SP anti-drone artillery, energy weapons and potentially EMP weapons. The manpower and energy requirements for counterdrone defense would also increase.

Countering small UAS

7.12 We will discuss the following elements of countering small UAS:

- Monitoring
- Detection
- Active countermeasures
- Passive countermeasures

7.13 Monitoring systems

There are two categories of monitoring systems

- **Active**. An active system relies on emitting energy towards a target and reading the reflection of that energy off the target. Examples of active systems are LIDAR or Radar which direct laser or radio frequency radiation towards a target and read the reflected energy to compose an image.
- **Passive**. A passive system does not emit any energy towards a target. It directs a sensor towards the source of energy emitted from or naturally reflected by a target. Once detected, the emitted energy is used to compose an image. Examples of this include acoustic detectors, infra-red detectors and visible and low level light.

Monitoring systems perform four functions:

- Detect
- Alert
- Locate and track
- Classify or identify.

7.14 Detecting small UAS

There are four means of detecting small UAS:

- **Radio frequency analysers** - Detect radio communication between a drone and its controller. High end systems can triangulate locations of controllers. No licence required, as it does not emit radiation. Cannot detect autonomous drones.

- **Acoustic sensors** (Microphones) - Typically works well on short ranges - 350-500m. Does not work well in areas with high levels of background noise.

- **Optical sensors** (Cameras) - Can be visible light or IR/ Thermal. Difficult to use, cannot detect multiple objects, poor performance in darkness, fog, rain. Also includes laser rangefinders used in anti-drone fire control systems

- **Radar** - typically designed to detect larger objects, can be calibrated for smaller objects, works in all weather and visibility conditions, able to track multiple targets simultaneously. Requires licence to operate. Can detect autonomous drones. There is a limit to which radar can detect a UAS, given their small physical size, as well as the extensive use of non-metallic components.

Detection platforms can be:

- **Ground based**. These can be specific-purpose drone detection systems, or those integrated with a countermeasure system.

- **Aerial**. India uses specifically configured Mi 17 helicopters for this purpose.

7.15 Active countermeasures

There are three categories of active countermeasures:

- **Destruction** – physically damaging, disrupting in part or the whole UAS

- **Neutralisation** – rendering the operating system of the drone ineffective so that it cannot execute its intended mission

- **Protocol manipulation** – displacing the intended command signal from the operator with friendly force command.

7.16 Destruction

Figure 7.4: A laser-based counter drone system mounted on a 6×6 IFV base

- Destructive systems can be conventional or directed energy weapons such as laser and EMP.
- Manually initiated small arms fire is the obvious method, but it is literally 'hit or miss' given that current marksmanship practices do not include engagement of UAS threats. This, combined with small and fast moving targets and the dangers posed to those within the splash zone of loosed rounds, is a risky proposition. This can be alleviated to some degree by the use of shotguns which employ scattering ammunition that rapidly loses its kinetic energy at distances beyond 100m.
- There are several systems that couple standard machine gun platforms such as the Type 67 GPMG and later equivalents with an optical tracking and sighting system to target sUAS threats, in a self-contained module that can be mounted on a vehicle.
- Laser-based systems are in development, however these are typically vehicle mounted and consume considerable energy, as well as requiring separate and complex tracking radar

systems. The platforms themselves are also vulnerable to drone attack.

- Electromagnetic pulse can also be used to overload the sensitive electronics within a drone. This runs the risk of unintentionally disrupting friendly force communications and electronics equipment. A rifle mounted directional EMP system has been patented, however its efficacy has yet to be assessed operationally.[22]

- It is entirely feasible to develop a vehicle mounted directional EMP system which can be directed specifically at one area of sky, however it will most likely be similar in effect to a laser-based weapon in terms of energy consumption and vulnerability.

- Counter drones are also being used. These carry a destructive payload and are often actuated by impact detonation against the target drone.

7.17 Neutralisation

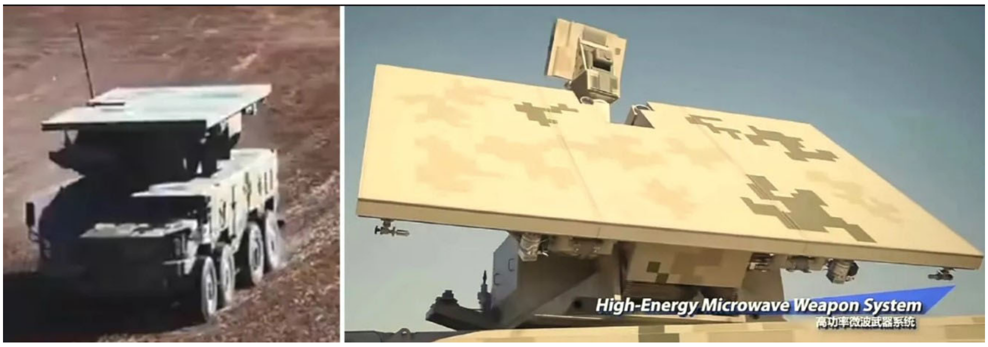

Figure 7.5: Microwave planar array mounted on an 8×8 IFV platform. Note the smaller tracking radar plate on the top centre of the larger microwave plate

- Neutralisation systems can be high tech or no tech based.

- **Nets and net guns** work by projecting a net, which entangles the propellers, preventing their rotation and

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22 Reference: https://techlinkcenter.org/news/heres-the-armys-now-patented-emp-rifle-attachment-for-taking-out-small-drones/

denying them of lift and propulsion. These are relatively accurate and preserve the integrity of the drone, if it is important for forensic examination. There is the potential that nets and guns may actually destroy targeted sUAS.

- **GPS spoofers** can be used to confuse a drone as to where it actually is by sending it spurious and inaccurate GPS locations, so that it moves away from its operator-directed search area.

- **Radio frequency jammers** - these are devices that transmit a large amount of RF energy towards the drone, masking the controller signal, causing it to make either an uncontrolled or controlled landing, fall out of the sky, return to its point of origin, or move off in another direction.

  - Effective anti-drone ECM will need to jam all possible bands: 2.4GHz, 5.8GHz, 433MHz and 915MHz. Unless intelligence indicates otherwise, an enemy attack could be using any of the frequencies to control its drones.

  - Power generation for continuous operation of ECM will be a consideration. Similar to radar batteries integral to air defense battalions, ECM projectors/ arrays will require diesel generators to power them, as well as a logistical support train.

  - Man-portable systems capable of sustained operation, whilst possible, are unlikely due to power consumption demands of multiband jamming. At best, if deployed, such units would operate on one band and operating for short durations before exhausting battery supplies.

  - ECM systems are likely to be part of a layered air defense system.

7.18 Protocol manipulation

This is effectively a cyber systems takeover. These devices passively detect radio frequency transmissions emitted by drones to identify the drone's serial number and locate the pilot's position using AI. If the anti- small UAS operator recognises the drone as a threat, they can send a signal to hack the drone, assume control, and direct it to a safe location.

Figure 7.6: Microwave planar array mounted on an 8×8 truck chassis. Note the smaller tracking radar plate on the top centre of the larger microwave plate

- The inherent problem with radio frequency jammers is that they are non-specific, and they will interfere with all equipment that operates on the targeted bands, including on the side that employs such measures.

- Indian forces have also trained birds of prey to neutralise UAS, it appears to be highly effective against smaller and lightweight drones, however it stands alone in the use of this method.

7.19 Passive counter small UAS techniques

There are five means of achieving this effect

- Visual
- Thermal
- Hardening
- Screening
- Other

7.20 Visual signature management

The understandable use of low cost cameras in commercial UAS results in low resolution images. This lends itself to the following possible non-technical countermeasures.

- **Camouflage** – The basic skill taught to every ground combatant, requires significant attention if it is to be effective against an aerial surveillance threat. The typical problem is that using camouflage poles and netting used to cover trucks, artillery pieces and other ground assets is that it still looks like a piece of military hardware that is covered. There is a distinct need for a new approach to camouflage systems that blend in better with the local topography and vegetation.

- **Light discipline** – Once darkness falls, any artificial lighting or artefactual light source becomes apparent, and can be used for targeting.

- **Counter surveillance** – Decoys. The use of visual deception to simulate a legitimate target. This method is likely to make a comeback, to exploit the low resolution cameras typically used in UAS. This can be achieved by the use of decommissioned real assets, the construction of wooden structures to simulate a real asset, or even as simple as painted aircraft on the hard standings of an airbase.

7.21 Thermal signature management

Infrared shielding. This is an aspect of training ground forces that is often overlooked. And it has been exploited by forces with the drone and sensor technology as well as thermal masking capability against those forces without them.

Particular attention needs to be directed to ensure that the defended location does not show an identifiable thermal difference between it and the surrounding areas. Also, vents need to located so as to diffuse warm gases away from the defended location. This is easier to achieve for a 2-3 man position than it is for larger, more mechanised combat elements, or those requiring considerable electrical power generation such as a battle group command post.

7.22 Hardening

These methods are conventional overhead protection and blast-proofing of entrenched positions.

Taking in the lessons learned from previous wars, especially in terms of artillery attack, if bombardment is inevitable, the best possible protection is overhead protection specifically designed to promote survivability.

The obvious disadvantage of hardening entrenched positions is that it requires planning, time, additional manpower and resources [engineering supplies, possibly plant and equipment, itself a large and strategic target], for positions that may be occupied temporarily, and diverts combat power away from attack, defence or mobility.

This is more appropriate for static positions such as supply depots and air bases, where high value assets and critical inputs to battle are under threat.

7.23 Screening

Figure 7.7: Experimental Russian anti-drone screen. Basic construction of frame, wire and mesh screen

Stand-off screens and structures that diminish the effect of blast and fragmentation. These are of limited effectiveness against shaped charges, and effective against low net explosive quantity munitions.

Figure 7.8: Ukrainian M1 MBT with anti-drone ‘cage’

7.24 Other means

Open source intelligence photograph displayed a Soviet aircraft having their upper surfaces, notably their large wings, covered with rubber tyres. Whilst not obviously or strictly ‘hardening’, a layer of rubber tires could potentially prevent blast and fragmentation damage by either providing a layer of protection against penetration, or to ‘bounce off’ a dropped or projected munition that has not detonated.

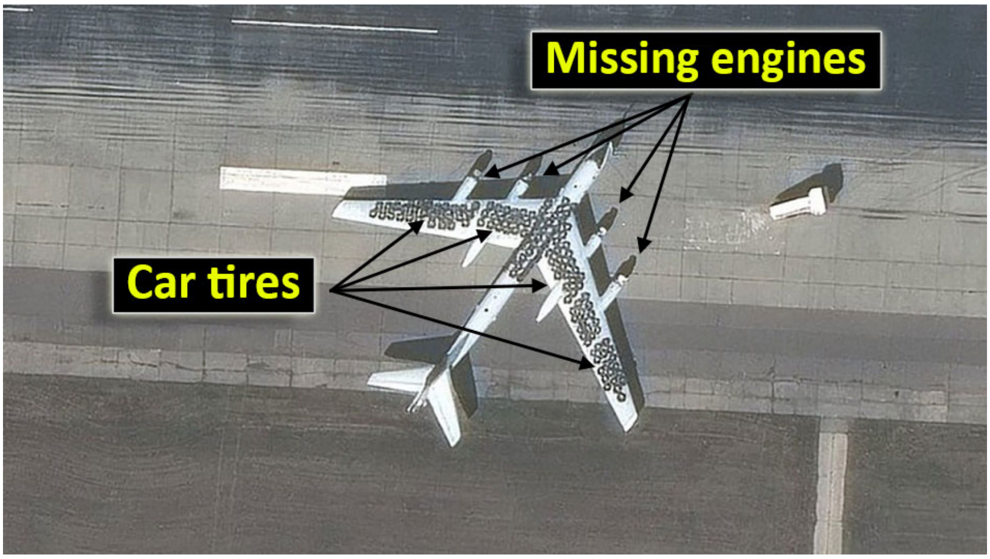


Figure 7.9: Rubber tires emplaced on upper surfaces of a decommissioned Russian bomber

Insights on counter small UAS capabilities

7.25 One-size-fits-all solution unlikely to be able to monitor and counteract UAS

- Any effective countermeasure system needs to anticipate that a sophisticated enemy will use a range of control drone systems from manual to autonomous, and work across multiple spectra – visible for targeting, and across multiple energy bands for guidance and control.

- Physical limitations will come into effect – darkness, limited visibility in the visual spectrum, adverse weather [notorious for affecting communications], high atmosphere electromagnetic phenomena such as solar flares/ magnetic storms are all likely to affect both drone and counter drone operations.

7.26 Integrated platform systems are already emerging

- Rheinmettal Systems has developed Skyranger 30 - a 30 mm gun/ radar system mounted on a Boxer CRV chassis that has been demonstrated against multiple small UAV targets out to 3,000 m, in response to the threats emerging based on the Azerbaijan conflict. It developed programmable proximity airburst ammunition specifically designed to cope with short-range, small, multiple aerial threats. This is already being modified to include a missile system to intercept very close range UAS.

- However, whilst effective, its high rate of fire of 1,200 rounds per minute means that it is difficult to support logistically, especially if it encounters multiple waves of drones. The magazine capacity for this platform is 252 rounds [about 12.6 seconds of fire], thus commanders/gunners may opt for a lower rate of fire to conserve ammunition.

Figure 7.10: Rheinmettal Skyranger 30 anti-UAS system

- In addition, assets such as this are likely to be allocated on a divisional basis, rather than be able to be brought to bear by a Battalion commander in defence of mounted/ dismounted infantry, and is likely to be used to defend high value assets such as artillery or conventional air defence installations.

- The Olvana equivalent is a heavier truck mounted unit, the Type 11 30 close in weapons system, consisting of an eleven barrelled 30 mm rotary cannon with a rate of fire of 11,000 rounds per minute.

Figure 7.11: Type 11 30 CIWS Land based installation

- Adaptation of existing armaments is another approach to the destruction of UAS. British Aerospace has developed the Advanced Precision Kill Weapon System , a semi-active laser homing guidance system/ unit that can be added to a conventional unguided rocket [the Hydra 70 rocket, typically used as an air to surface missile, fired from ground attack helicopters]. This turns an air to surface rocket into a surface to air missile. This is effective against larger UAS. Testing has proved its accuracy, however coming in at 15 kg and approx. USD 22,000 per rocket, whilst far cheaper than a traditional SAM, it requires a vehicular launch platform, as well as a team to lase the target continuously. Whilst the capability is impressive, this is not a practical guidance system/ mass combination that can be fielded by a platoon. It is more applicable to battalion level defense, as it appears to solve a problem at higher than platoon but lower than brigade level formations.

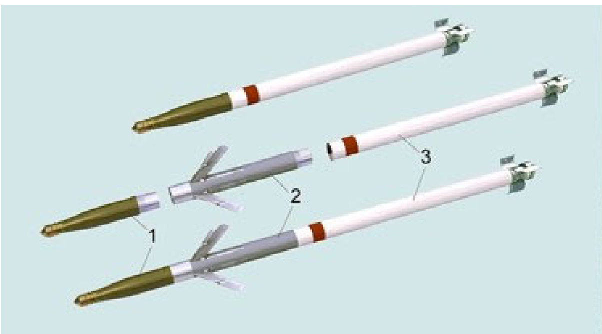


Figure 7.12: Left - Advanced Precision Kill Weapon System – [APKWS] showing components. Item 2 is the add-in laser guidance unit. Right, the envisioned vehicle launch platform

7.27 There is a physical size limit below which counter drone measures are ineffective

- If it cannot be detected, it cannot be engaged. Micro and nano-drones such as the Black Hornet drone has dimensions of 2.5 x 16 cm, and has a mass of 18 g with battery. Such small UAS platforms will be difficult to detect and engage, but they are also capable of performing multiple surveillance missions and are FLIR capable. The Olvanan Hummingbird drone has similar dimensions.

Counter-counter small UAS capabilities

Figure 7.13: Fibre optic cable reel on a fly-by-wire controlled drone in Ukraine 2024

7.28 Technological development in warfare is a constant 'cat-and-mouse' evolution, with each combatant eroding any battlefield advantage its opponent once held. Thus, whilst not an anti-drone countermeasure, for completeness we mention here that as electronic countermeasures emerge, so too do counter-countermeasures.

7.29 To date, there are four methods of counter-jamming to enable drones to continue to receive and transmit communications and data signals as designed. These are:

- Filtering, so that the receiver can block everything except the exact wavelengths used to communicate.
- Using multiple bands to operate on,
- Hopping to a different band where there is no interference and
- Fly-by-wire systems.

7.30 The first three of these systems are unlikely to be encountered on drones intended for civilian use, as the manufacturers of such technology price it for the military market, increasing the unit price, thereby keeping it out of reach of the civilian market.

7.31 In the latter half of 2024, drones have been designed that make use of fibre optic cable 'fly-by-wire' control in order to defeat radio frequency electronic countermeasures. Evidence of this method has been reported in the Ukrainian conflict. Russians have deployed drones controlled by a thin but durable fibre optic connection between the drone and the operator. This method of control cannot be defeated by ECM. Precise details of the Russian system are unknown, however it is anticipated that some will malfunction and be captured enabling them to be forensically examined.

7.32 In what is likely to be an parallel development, the German company Hightcat GmbH has developed an experimental system, the HCX drone. It is a conventional quadcopter design. The innovation is that its control signal and image return feed is carried along an optic fibre that is dispensed from a rotary canister.

7.33 Whilst this makes it invulnerable to jamming by ECM, it comes at a trade-off. The payload it can carry is limited to a low mass explosive device, as it carries 10.8 km of fibre, with a mass of 1.3 kg. This also implies that as range is extended, the lower the mass of ordnance that can be delivered to target. This type of drone can be used for both ISTAR and strike.

Chapter 8 – OPA Tactical small UAS use cases

Platoon launch & recovery procedure

On order, when a UAS team consisting of an operator and a team partner are commanded to deploy their drone, it follows a procedure to minimise the formation's chances of being detected by enemy forces.

A launch point is selected. A launch point is a clearing free of trees, approximately a square measuring 2 × 3 m.

The operator is positioned in a location that with concealment and preferably overhead cover and IR shielding, along with their team partner.

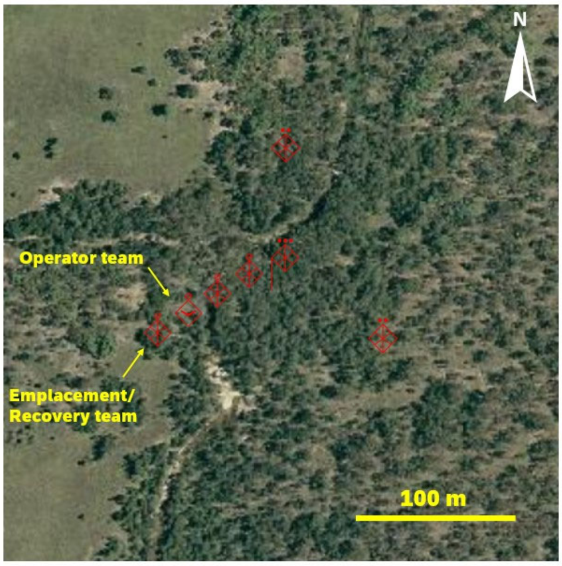
Figure 8.1: Drone Operator Team

Two other team members of the squad are selected as a carrier and his security element. One of them carries the drone to the selected launch point. The security element provides covering fire and situational awareness for the carrier. The carrier unfolds the drone, and primes it for its flight. This includes connecting the battery, conducting pre-flight system checks, disabling the return-to-home on disabled function, erasing the memory, and if it is to be used to conduct a strike, to arm it with munitions. He then places it in the centre of the launch site.

Figure 8.2: Drone Emplacement/ Recovery Team

The carrier and his security element return to the squad location under concealment while the operator & team partner conduct the mission. The returning drone never returns to the launch point, in order to not set a pattern. Typically, it is recovered anywhere between 200 – 600 m from the launch point. The team carries with it specialised, lightweight extensible poles, nets, ties and an articulated claw to recover UAS that may be tangled in forest canopy.

At the completion of the mission, the carrier and security element move at a rapid safe pace to recover the returned drone on foot, turning off battery systems to conserve power. Once recovered, they return to the squad position, and continue with their mission.



Initial state

The Platoon Commander requires a reconnaissance overflight of the terrain to the northwest of the Platoon location

The aerial view shows the disposition of the platoon.

There are three squads in total, and the Platoon Headquarters, set in the 'Y' harbour formation

The squad conducting the aerial mission is expanded out into four teams.

There are three teams of two soldiers, and one team of three

The team located second last from the southwest tip of the formation is the Drone Operator/Partner team.

The Drone emplacement team is located at the south west corner of the formation.

Figure 8.3: Start state for launch & recovery drill

Platoon ISTAR mission

An Olvanan dismounted platoon is advancing towards its objective through a forested area, in daylight with a canopy at around 15-20 metres average height. The troops are proficient at operating in these environments and their audio signature is close to silent.

Its UAS is to conduct an ISTAR mission, and it flies approx. 500-600 metres ahead of the formation. It is operated by the platoon HQ NCO. This gives the platoon commander situational awareness and early indication of possible threats.

The operator identifies a concealed squad position of three enemy personnel. The information is relayed to the platoon commander, and in his assessment, he considers that it is likely to be an observation or listening post. The commander verifies with his company HQ that there are no other Olvanan elements in the AO. The platoon commander orders a halt and the platoon takes up a 'Y' harbour formation. The UAS operator confirms the enemy squad position by conducting a confirmatory flyover.

The platoon commander assesses the threat. He determines that it is best not to eliminate it, as it would give away his platoon's general location. The enemy position is radioed to the company headquarters and also assimilated into higher formation headquarters.

The platoon commander orders the platoon HQ NCO to reconnoitre a square grid, with a side length of about three quarters of a mile [1200 m] keeping the enemy position at the centre.

The platoon HQ NCO positions the UAS at one corner of the square and flies a path to scan areas within the indicated grid.

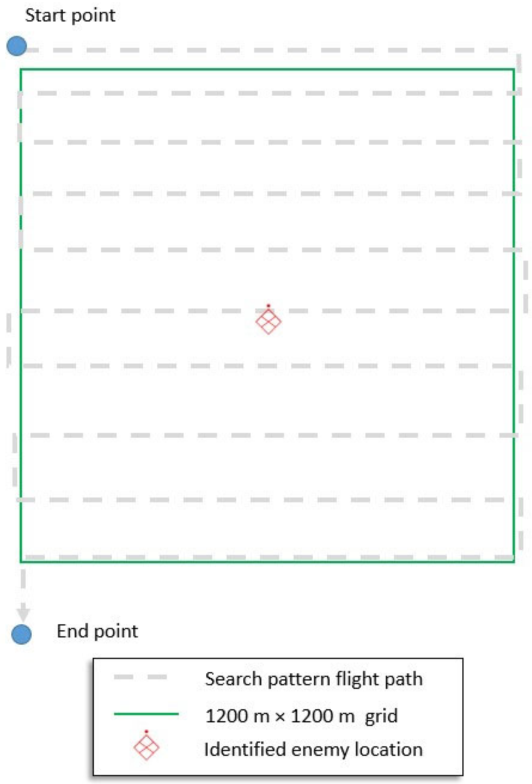


Figure 8.4: Predesignated search pattern for 1200 × 1200 m square

Using a sweep pattern of about twelve traversals from side to side of the grid and one traversal along the length, a total of 13 traversals gives a flight path 15.6 km in length. At an average ground speed of 40 km/h to ensure a high quality visible light & IR sweep, this takes around 25 minutes.

The platoon commander then uses the information to determine how to skirt around the enemy position without giving his own position away. He selects a path that keeps the enemy out of visual distance, using the local terrain, defiles, the canopy of the forest itself, as well as dead ground, to avoid detection from both the ground and from the air. His intention and intended path is relayed to the platoon's squad leaders.

Finally, the platoon commander gives the command to break the defensive position and proceed to his objective using the platoon commander's intended path.

The platoon commander then orders his platoon to continue with the advance on the track, with the drone continuing to provide ISTAR.

Platoon ISTAR mission with supporting fires

An Olvanan mechanised platoon of three IFVs is progressing towards its objective along a track.

Its UAS is on ISTAR, piloted by the platoon sergeant, flies about 1000 metres ahead of the lead vehicle, to give the platoon commander situational awareness and early indication of threats.

It identifies a squad position, dug in and concealed. The UAS operator confirms the position by conducting a pan and sweep of the position, this time using IR to verify heat signatures as well as the visual signature.

He advises the platoon commander of the location and the number of enemy, and adds that the enemy could be either a reconnaissance element or an early warning element for an ambush.

The platoon commander assesses the threat, and determines that should eliminate the position before progressing. He orders the platoon to halt, break track and take up a defensive position.

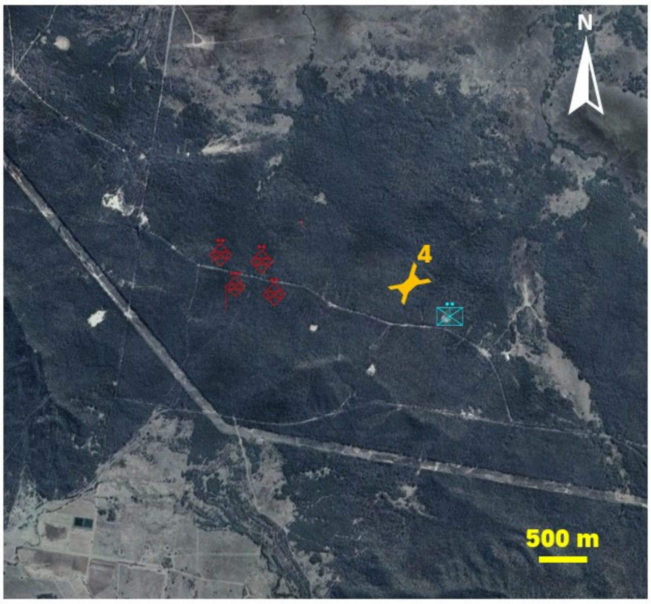
He then orders the platoon sergeant to recon further along the track to identify additional threats. He does so and does not identify any in the next 1000 metres.

The platoon commander then orders the platoon sergeant to bring the drone back to the enemy position, and he calls in an indirect fire mission from his company's integral mortar section.

The platoon sergeant uses the drone to adjust fires until the rounds impact on the target. Once the fire is accurate, he orders another ten rounds for effect.

Once the smoke clears to provide sufficient visual clarity to the scene on the ground, the drone conducts a battle damage assessment, in the visible and IR spectra. There is no movement and there are no survivors from the enemy squad.

The platoon commander then orders his platoon to continue with the advance on the track, with the drone continuing to provide ISTAR.



4. During the grid sweep, the fire mission has been authorised at the company detachment level

The platoon has been allocated a heavy mortar [120 mm] squad of fires

The Platoon sergeant is co located with the drone operator platoon SNCO.

The Platoon sergeant is in radio contact with the mortar squad fire controller

The platoon sergeant relays the location of the enemy squad to the mortar squad fire controller

Figure 8.5: Platoon ISTAR mission with supporting fires – locating the enemy threat

Platoon ISTAR mission with organic support

An Olvanan motorised platoon is on patrol along a predesignated route in vicinity of its FOB.

Its UAS is flying 1,000 metres ahead to provide the platoon commander with situational awareness.

The operator, in this case the platoon sergeant identifies a squad position approximately 500 metres ahead of the lead vehicle. He immediately notifies the platoon commander, who then orders the formation to halt and take up a defensive posture, off the main route. This formation is similar to the dismounted platoon 'Y' harbour.

The platoon commander then commands the platoon sergeant to conduct an aerial reconnaissance of the surrounding area to the position. He specifies a square grid approximately 600 m side length, with the enemy squad at its centre, to locate further enemy positions, and enemy strength.

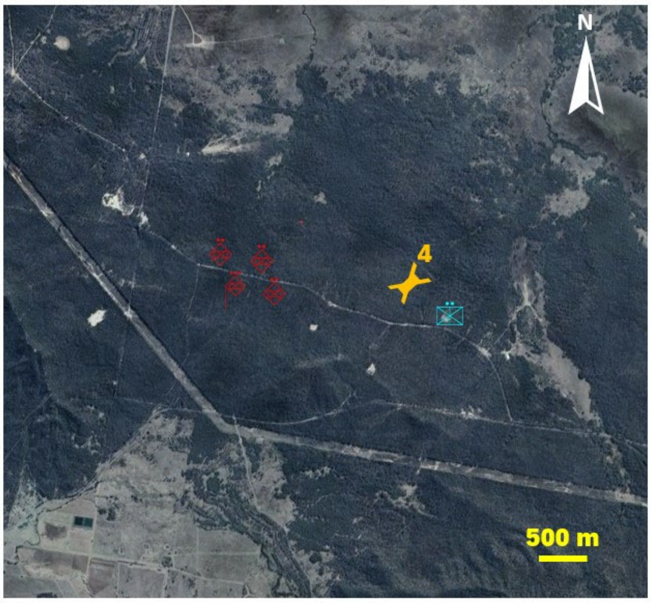
The sergeant executes the orders using visible and IR spectra, and a search speed of 40km/h. He flies a grid search pattern over the designated area at an altitude beyond audible distance. This takes approximately twelve minutes to complete. He reports back to the platoon commander that there are no additional positions, and that there are four enemy soldiers in a shallow trench, with only concealment and no overhead protection. He advises the platoon commander of its grid location using GPS. He keeps the UAS in position nearby the enemy position.

The platoon commander's orders are to eliminate enemy positions within a specific distance of the FOB. He has the authority and the capability to execute his orders, and does so. He opts to use three of the squad's XS101 loitering munitions, which will be directed by the UAS.

One soldier from each of the three squads is instructed to set their XS101 for operation. They dismount from their vehicles, with another soldier each, to provide security. They individually prepare each XS101 for firing, ensuring that the munition has sufficient clearance at the front, and avoids any canopy or other possible obstructions in the flight path.

The XS101 operators guide their munitions towards the target area, using the GPS location provided by the platoon sergeant. Individually, their LM locates the enemy position, and they then steer their LM onto the target.

The target is destroyed. The platoon sergeant confirms the destruction with a damage assessment overflight, once the smoke, dust, debris and blast effects have subsided. The ISTAR UAS returns to the operator's vehicle using a different route to its outbound flight.



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The platoon has been allocated a heavy mortar [120 mm] squad of fires

The Platoon sergeant is co located with the drone operator platoon SNCO.

The Platoon sergeant is in radio contact with the mortar squad fire controller

The platoon sergeant relays the location of the enemy squad to the mortar squad fire controller

Figure 8.6: Platoon ISTAR mission with organic fires

Platoon multi-drone attack on a dismounted formation

An Olvanan motorised platoon of three IFVs is progressing towards its objective along a track.

Its UAS is on an ISTAR sortie, piloted by the platoon sergeant, at 1000 metres ahead of the lead vehicle, to give the platoon commander situational awareness and early indication of threats.

It identifies a platoon of enemy soldiers formed in a defensive position, in a set of zig-zag trenches. The UAS operator confirms the location of the position and the number of soldiers, using IR to verify heat signatures in addition to the visual signature.

He advises the platoon commander of the location and the number of enemy.

The platoon commander assesses the threat, and determines that it should be destroyed before he can progress. He orders the platoon to halt, break track, take up a defensive position, and apply their own counter-drone procedures of masking IR signatures, using natural features in the surrounding landscape, and applying camouflage nets.

Concurrently, the platoon sergeant is ordered to conduct an additional reconnaissance of a grid of 600 metres side length, positioning the centre of the enemy position at the centre of the search area to assess if there are any additional threat elements.

The additional reconnaissance flyovers and the concealed platoon harbour are completed in approximately fifteen minutes. The UAS is maintained out of earshot of the enemy position.

The platoon commander determines that it will require six XS101 single use munitions and three FPVs to reduce the target, and he orders each squad to prepare these [one FPV armed with HE and two XS101s per squad]. These are prepared for firing and launch. Once all systems are checked and ready, he gives the order to initiate the launch and the sergeant co-ordinates the strike.

The strike comes in from three directions – above, left and right, with impacts within and on the edges of the enemy trenches. The FPV drones are equipped with impact fused 60mm HE mortar bombs, and the XS 101s with around 0.6 kg of high explosive each.

The effect is immediate and incurs heavy losses on the position. Once the smoke has cleared and the debris has settled, the sergeant conducts a battle damage assessment overflight, using visible and IR spectra to search for signs of life. There are four wounded survivors. The sergeant notifies the platoon commander.

The platoon commander determines that the threat has been neutralised, and recalls the UAS.

The platoon breaks down its position and moves on with its prior mission.

Platoon countersurveillance UAS strike

An Olvanan motorised infantry Platoon commander on patrol with his formation is advised from a higher formation that an enemy drone is in the vicinity of the platoon. He assesses that he must eliminate the enemy drone before it overflies his company location. He acts rapidly and decisively to eliminate the threat and remove the enemy capability.

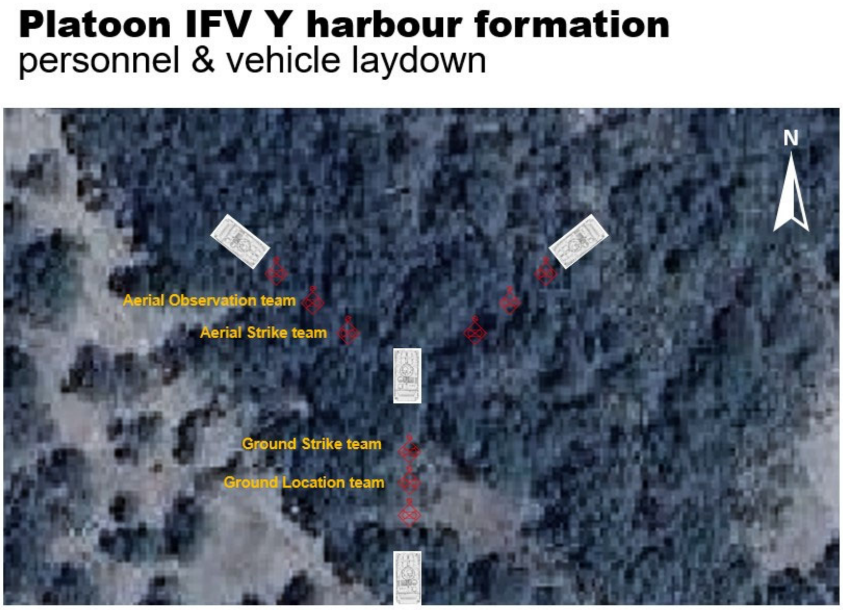


Figure 8.7: IFV Platoon harbour and Counter surveillance UAS Operator Team layout

His priority is to find and destroy the UAS operator team, as it is likely to be static and large, and therefore a less difficult target than a fast moving, small aerial target. But if he can engage both, all the better.

He orders a battle drill to halt the platoon and take up defensive positions. Hasty camouflage and concealment procedures are executed and the platoon has a defensible location.

His next drill is to rapidly deploy four teams:

- Aerial Observer team to observe and track the aerial threat using a DJI Mavic drone

- Locator team to find and observe the aerial threat Operator team using a DJI Mavic drone
- Aerial Strike team to engage the aerial threat using an FPV 'suicide' drone
- Ground Strike team to engage the Operator team, once located using an XS101 munition

These actions are executed and within minutes. The Aerial strike and Ground strike teams have emplaced their aerial vehicles on launch stations, ready for flight, on the Platoon commander's orders, as soon as their targets have been identified.

Within another few minutes the Aerial threat tracking team has not detected the enemy UAS. The Locator team has found the enemy operator team. It is within range of the Ground Strike team's XS101. The platoon commander orders the strike on the enemy operator team, using the Locator team to call fire in on target. The Ground Strike team's XS 101 is launched. It closes the distance to its target, and makes impact.

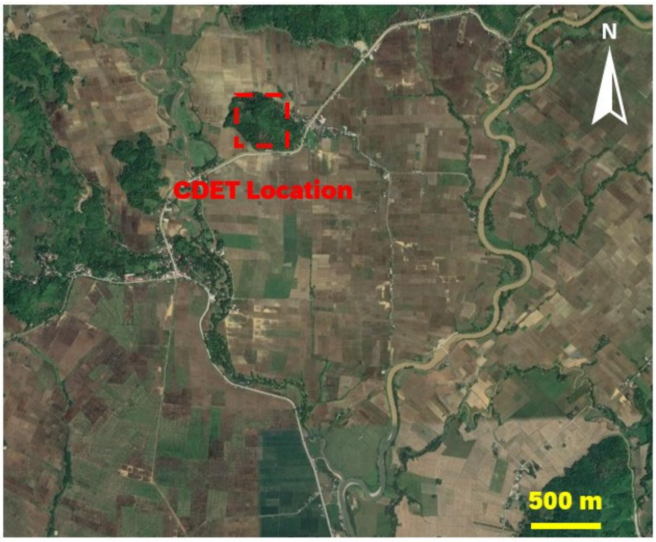
The Locator team conducts a post-strike assessment and confirms the destruction of the enemy UAS operating team.

CDET defence – Counter-drone Support Company[23]

An Olvanan CDET is situated in a defensive position. The detachment commander requires the position to be protected from drone observation, and against a non-swarming attack. He has ordered the

23 It is a conceptual stretch to employ a company of specialists to protect a company sized formation, but that is the approach taken. It is difficult for a platoon to provide coverage for a perimeter of approximately 2,000 linear metres. Therefore, manpower has been substituted for automation. The task is to provide a scaled-down, layered defense against omnidirectional surveillance and strike by an enemy force using small UAS. Presently, the technology permitting a single operator to reliably control and direct a swarm of observation drones and a separate single operator to direct a swarm of FPV drones to intercept enemy drones is not sufficiently robust and reliable. At some point between today and 2034 when automation [such as human assisted AI] is sufficiently advanced to the point it can substituted for manpower, it is almost certain that counterdrone support capability could be provided by a specialised platoon, with one squad each dedicated to the functions of observation, detection and interception.

CDET position to be hardened with locally available materials, such as felled timber and earth, as well as visually and thermally camouflaged.



Initial state

An Olvanan CDET is situated in a defensive position. The detachment commander requires the position to be protected from drone observation, and against a non-swarming attack.

He has ordered the CDET position to be hardened with locally available materials, such as felled timber and earth, as well as visually and thermally camouflaged.

Figure 8.8: Start state requirement for Counter-drone company mission

Whilst the combat elements of his CDET are equipped with UAS capability to support their primary combat roles, these combat elements are not capable of the specialised task of defending a CDET location.

Therefore, in addition to the direct and supporting combat power, as well as combat support services of the CDET, he has attached to his formation a Counter-drone Support company, comprising the following:

- An Observation platoon manned with drone operators, capable of operating a total of nine UAS simultaneously.
- A Detection platoon, with radar, acoustic, frequency analysis, ECM and technical support capability
- A Strike platoon, with FPV counter-drone drone operators
- These three platoons are unified under a company commander, with support from a senior and junior NCO.

The CDET commander's C3 is routed through the counter-drone support company commander. The CDET commander gives the counter-drone company commander his orders to set security for the location. He states the physical boundaries of the location on the digital map. He requires constant coverage of the position for a 72-hour period, day and night.

The Counter-drone company commander executes a pre-set counter-drone protocol, Observation, Detection and Strike.

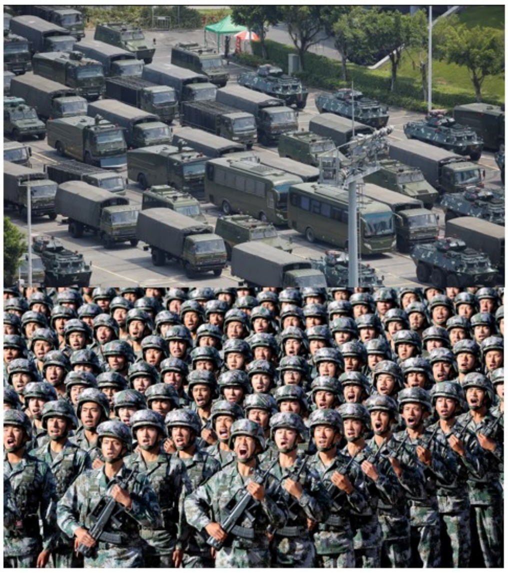
Aerial surveillance commences with the Observation drone operator platoon splitting into three squads and locating themselves at equidistant points along the perimeter of the CDET location boundary, in defensive positions with overhead protection and concealment. They execute patrols at high, medium and low altitudes. Once launched, the drones survey in concentric circles around the location. First squad, using three drones conducts its survey at an altitude of 2 km, with a 1 km radius. Second squad using three drones, conducts its survey at an altitude of 1 km with a radius of 3 km, and Third squad using three drones, conducts its survey at treetop height with a radius of 5 km. The drones have fish-eye lenses for high magnification, high-resolution visible light detection as well as thermal detection capability. Each squad has three teams of two on task and three men at rest, these are rotated through at intervals.

Concurrently, the Detection platoon deploy sensor/ ECM towers at the approximate vertices of the CDET position. The technical support squad emplaces the towers securely. These mini-towers are robust collapsible structures mounting acoustic, radar, frequency spectrum analysis, and ECM capability. They require power generators and fuel, as does the monitoring station where inputs from all sensors in multiple directions is collated, analysed and evaluated. The generators are shielded and their visual, acoustic and thermal signature is dampened and masked. The monitoring station is centralised, sited underground with blast-proof overhead protection. The visual observation squad is divided into three, and sited at three locations along the periphery of the CDET site. They are equipped with high magnification optics. Their role is to scan the skies to visually by day and thermally by night to confirm signals detected by the radar and frequency spectrum analysis.

The Strike platoon prepares its position. FPV counter-drone operators array their counter-drone drones for launch. As their interception window is limited, upon confirmed enemy drone targets within the defensive zone they must act swiftly. Their FPV drones are specifically designed as 'hittiles', which detonate their payloads on impact. These are kept under concealment, but ready for rapid deployment. Their flight profile upon launch is such that the enemy's drones don't see them coming. Their terminal flight path to the enemy drone makes use of the enemy drones' blind spots. There are three launch sites, dispersed throughout the CDET area to minimise the loss of capability that would result in centralising the location.

Communications linkage between the Observation, Detection and Strike platoons is critical, and the platoon senior sergeants are in constant communication with each other. Reaction times in response to threats are critical, and the Counter-drone company is well drilled in responses to threats.

Company Detachment – 50+ vehicles, 200+ personnel



Military symbol for Company Detachment
(A task organised formation)

Table of Equipment & Personnel for a typical Company Detachment

Formation	Personnel	Vehicles
Mechanised Infantry Company	107	18
Self propelled Mortar Platoon	13	3
Combat Engineer Recon Platoon	43	10
Combat Services Support Squad	16	14
Radio Squad	12	7
Medical Suport Squad	21	4
Totals	**212**	**56**

Figure 8.9: A CDET – Company Detachment – casts a significant ground 'footprint'

Figure 8.10: Schematic layout of counter-drone patrols over CDET location

CDET defence - Avenue of Approach

An Olvanan CDET is situated in a defensive position. The detachment commander determines that there are two principal avenues of approach that his enemy could use to infiltrate and attack. One lies to the north and the other to the southwest.

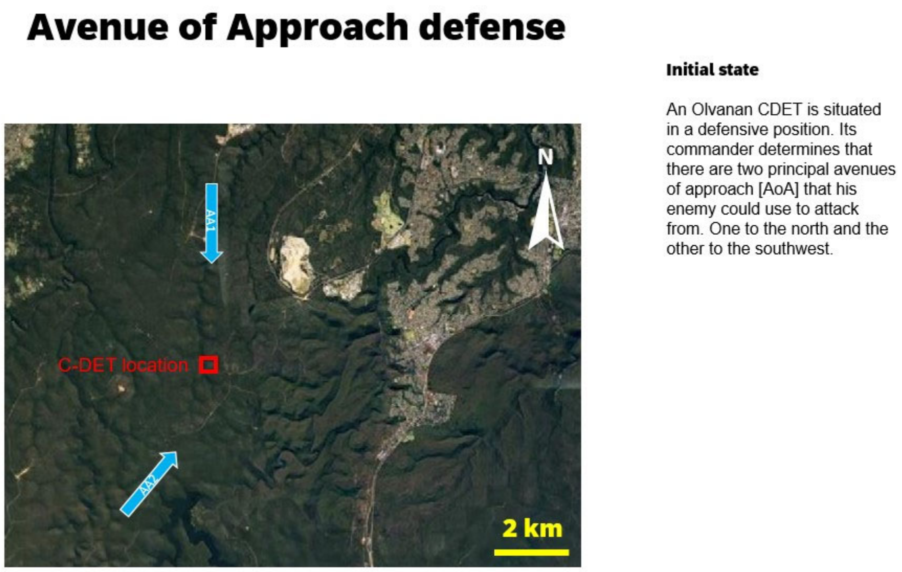


Figure 8.11: The military mission: Surveillance and fire control over the avenues of approach

The CDET commander has authorisation to call for artillery fires from higher formations. This includes the GP6 155 mm semi-active laser homing anti-armour artillery munitions. SALH munitions require an observer to lase the target.

He requires a squad to provide observation on each avenue of approach. He assigns a platoon to provide the observation posts and call in fires, should the need arise. The platoon commander determines that he can assign one squad per location with one squad in reserve to provide immediate QRF should one of the positions come under attack by enemy combatants. This QRF squad also serves as ‘rest’ squad to rotate through.

Based on the threat assessment, the platoon commander makes a tactical decision to increases each squad’s allocation their observation drones to three per squad, so that there can always be one drone on active observation tasking, one on charge, and an additional unit on standby if one of the others becomes inoperable.

The platoon sergeant ensures that every drone is fitted with a laser designator as this is likely to become the primary mission, rather than observation alone. He orders his squad commanders to test all drone and supporting equipment, and to ensure all communications equipment is serviceable and on the net, prior to stepping off. He also includes extra batteries and solar powered recharging units. He prepares all the squads for a 48 hr. duration mission, with additional rations and ammunition. In addition, he checks the 72 hr. weather forecast for the locality and prepares them for adverse conditions.

Each squad is motorised. They stow the extra equipment and stores in and on the exterior of their Type 19 IFVs. On dismount, the three vehicle crew members for each squad [Commander, Driver, Gunner] become part of the squad as ground combatants, and take their orders from the dismounted Squad commander.

Each squad moves into the location approximately 3 km from the CDET position, and conducts a rehearsed occupation drill once the squad commander has selected its specific site. This includes digging in and providing overhead concealment of visual and IR signatures.

Once their position is prepared, they execute the launch drill. They conduct a pre-configured scanning overflight grid pattern to detect indications of enemy approach, out to 1,200 metres from their location. These observation missions are flown continuously, to provide real-time assessment of approaching threats.

At first light the next day, the Squad located to the north of the company formation detects a squad sized enemy foot patrol with an armoured personnel carrier trailing 150 m behind. It is approximately a kilometre from the Squad, approaching southwards at a slow walking pace, around 4 km/h. The operator's team partner radios the platoon commander with a pro-forma report indicating location, heading, speed, description, date time group. They are ordered to standby for further actions.

Figure 8.12: The threat emerges on the northern approach

In the meantime, the operator flies the drone in a search pattern on a 600 × 600 m grid to assess if there are any additional enemy units nearby. His search locates no additional units within the area.

The platoon commander calls the report from the drone operator in to the CDET HQ. The CDET HQ obtains the authority to conduct a fire mission, and advises the platoon commander. The platoon commander communicates with the north located squad that a fire mission has been authorised, and that the squad is to communicate directly with the fire battery signal squad to call for fires for this specific mission. He sends the predesignated battery signal squad's frequency to his north located squad. The drone operator's team partner and the battery signal squad establish radio communications.

The drone operator flies the drone and calls out targets and positions to his team partner. The team partner uses their call for fires procedure to relay the information to the battery signals squad. This fire mission requires mixed munitions – HE to neutralise the dismounted infantry and anti-armour munitions to destroy the enemy APC.

The drone operator prioritises the threats. He assesses the vehicle to be the greater threat. It has mobility, troop carrying capacity, and firepower, being armed with a 25 mm cannon as well as ATGMs. Once it is neutralised, the dismounted threat can be targeted. He tells his team partner the order of priority for destruction. He then commences to lase the target vehicle from out of audible distance from the squad.

Figure 8.13: With the drone lasing the target, the fire mission commences

The team partner sends the battery signal squad the information required to call in the fire on the enemy APC. The first anti-armour round strikes within half a minute of the call. It strikes the side skirt of the tracked APC, the shaped charge blows out a significant section of track along with two road wheels. It is an M-kill. The crew conduct their immediate action drills and attempt to escape the now burning and disabled vehicle. The commander and the gunner make it out. Try as they might, they cannot disentangle their driver, who has a badly injured leg, from the hull of the vehicle. He is haemorrhaging and has lost consciousness. The commander, who has his wits about him makes a distasteful but pragmatic decision, to abandon his team mate and driver, to save his and the gunner's lives. The driver is unconscious and most likely, beyond suffering. Disorientated and with minor injuries, the commander and gunner grab their carbines and webbing and run towards the dismounts.

The dismounts ahead of the vehicle immediately conduct their own battle drills, and take up defensive positions, with their squad commander assessing that the threat is to the front of their axis of advance.

The drone operator then prompts his team partner for a follow up shot on the APC. The team partner calls for one more round fire for effect. This time, the round lands on the top armour, and the shaped charge ensures destruction of the vehicle.

The drone operator then repositions the drone to provide observation of the dismounts, who have taken up a defensive position. The dismounts are joined by the APC commander and gunner, and they attach to each team.

The drone operator uses the thermal imaging capability of the drone to detect the location of the enemy squad. They are spread out over an area of two roughly curved 'lanes' approximately 20 × 4 m, spaced about 15 m apart, with the team leader placed centrally. From the air, it looks like an ellipse with a band taken out of its mid-section.

The operator gives his team partner the grid location of the centre of the formation. The team partner calls the battery signal squad and relays the information. The first HE artillery round strikes and it is approximately 150 metres long of the position, in the vicinity of the burning APC. The operator advises his team partner to correct by dropping the fall of shot by 200 metres. This is relayed to the battery signals squad. The next round impacts. It is on target, near the dismounted Squad leader. The drone operator then advises the team partner to fire five rounds for effect. These rounds arrive within seconds of each other, straddling the enemy position. The enemy formation is destroyed.

The operator then conducts a damage assessment using both visual and thermal detectors, overflying the position held by the dismounts as well as surveying the burning hulk of the APC. There are no survivors. The team partner relays the information to the battery signals and closes the fire mission. They return to their previous patrol/ observation post radio networks, and send reports on a pre-scheduled basis.

The drone operator team continues with its early warning surveillance mission, until it is relieved by the QRF Squad.

Route check & surveillance

An Olvanan CDET task force is operating in Africa under the United Nations. Its task is to defend an aid distribution depot. The depot is expecting a delivery of much needed medical supplies from Red Crescent. The supplies are for use by Medicins Sans Frontieres and the World Health Organisation, both of which are desperately attempting to stem the outbreak of M-Pox virus in the region.

The supplies will be moved by road from the neighbouring airfield on the outskirts of a close by district. Warring factions control the black market, and medical supplies are highly sought after.

This is a demonstration of capability, the world will be watching. Olvanans are keen to show the world that despite having both economic and military power, they have compassion for less fortunate nations.

The Olvanan the CDET commander has tasked his Combat Engineer platoon to conduct an UAS-assisted route clearance, prior to moving the medical supplies along a 10 km long route between the delivery airfield and the depot.

The Combat Engineer platoon's tasks are:

- Assess vulnerable points, identifying potential IED/ mine locations
- Reduce the explosive hazard threats, in advance of road moves.

Two road moves are required:

- The first is to send a military escort from the depot to the airport to collect the supplies

- The second is the return to the depot with the medical supplies.

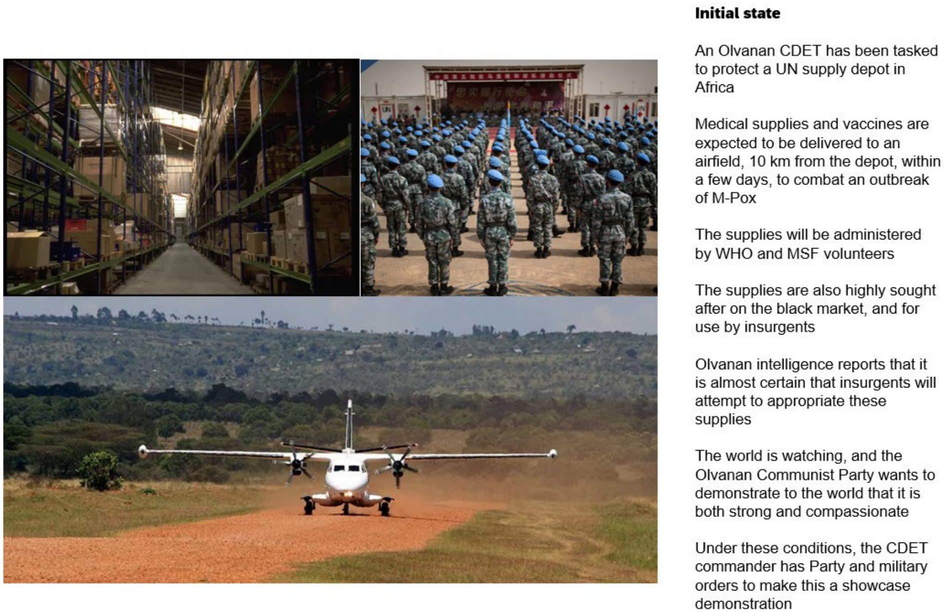


Figure 8.14: Scenario for route check and surveillance task

The Platoon Commander briefs the CDET commander on his plan, and formally requests the additional manpower to ensure route sterility – the additional platoons of mechanised infantry to conduct the surveillance. Given the circumstances – high visibility on the world stage, these are granted, and are co-ordinated so that surveillance of the cleared stretches of MSR commences immediately after the clearances have been completed.

The task commences with the departure of the engineer platoon and the additional two mechanised infantry platoons at first light the next day. The mission is executed largely to the Platoon Commander's plan.

The aerial survey is conducted by First squad. The ground proving is conducted by Second squad. The first three sections of MSR totalling around 1.7 km are surveilled by two soldiers from First squad of the combat engineer platoon. On the fourth stretch of MSR approximately two kilometres from the start of the search zone, the aerial survey marks out what appears to be a slight depression in the road, where there shouldn't be. This information is marked on the networked digital map.

When the Second squad approach this location, they detect a faint metal signature under the road surface. A timber plank, electrically activated IED, linked to a Soviet 152 mm artillery shell is partially exposed by careful uncovering. The Second squad conduct further detection in a diamond pattern around the first find. Another two similar devices are located, marked and partially exposed.

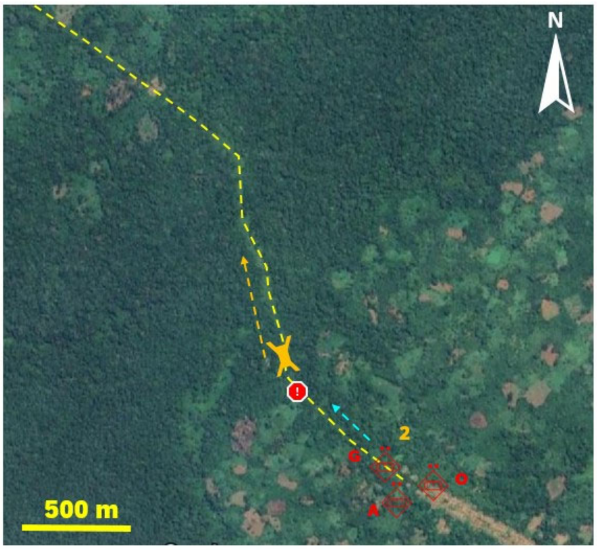
On order, the Second squad place reducing charges on the finds. Using radio controlled firing devices, they withdraw to a safe distance from the finds, and initiate the reducing charges. Sympathetic detonation of the IEDs ensues. The MSR is cratered, but vehicles can manoeuvre around the craters.

The remainder of the 10 km of MSR is searched, and no further finds are made.

The mechanised infantry squads are deployed along the length of the MSR and maintains its surveillance using their Mavic 3 drones on continuous operation stopping only to swap out batteries, for the remainder of the day, and overnight.

The transport and security elements are dispatched to the airfield the next day, and the medical supplies arrive at the aid distribution depot without incident, ready for use by MSF and WHO.

Task progression stages



2. Ground Proving squad steps off once the Aerial Survey squad has radioed them with the GPS co-ordinates of suspicious locations

The Ground Proving squad move with cautiously, but confident that they can anticipate threats and identify any that the aerial survey missed

They use hand-held metal detectors to read metal signatures

Overwatch squad is in line, behind Ground Proving squad, but does not enter the stretch of surveyed but unproven route

The Aerial Survey squad commences surveying the next stretch of track

Suspicious location

Drone

Figure 8.15: Military symbol overlay – early stage route check & surveillance

Chapter 9 – Conclusion

9.1 This document is indicative and evolving. It is an informed perspective at how an well-resourced, intelligent, sophisticated, nation state-backed opponent would deploy small unmanned aerial systems against opposing forces, at company detachment level. It takes its cues from observations on how UAS are being employed in civilian, military and criminal environments in the present day.

9.2 The tactics and mission profiles described are plausible based on what we know at the date of publication.

9.3 It has deliberately limited its scope to aerial platforms with a gross take-off weight under 15 kg so that it does not attempt to interpolate and extrapolate too far from real-world observations, nor does it wander into the realms of improbability and speculation.

9.4 Additional addenda to be completed in future are likely to describe systems with higher gross take-off weights, systems that are capable of swarming, that are employable over maritime environments, and beyond our present day horizon of capabilities.

Glossary

The source for approved Defence terms, definitions and shortened forms of words is the Australian Defence Glossary (ADG), available on the Defence Protected Network at http://adg.dpe.protected.mil.au/. Note: The ADG is updated periodically and should be consulted to review any amendments to the data in this glossary.

Terms and definitions

Shortened forms of words

ADF	Australian Defence Force
AO	Area of operations
APC	Armoured personnel carrier
ATGM	Anti-tank guided missile
CDET	Company detachment
CDF	Chief of the Defence Force
COA	course of action
C2	Command and control
C3	Command, control, communications
C4	Command, control, communications, computers
COTS	Commercial off the shelf
CRV	Combat reconnaissance vehicle
DJI	Da Jiang Innovations (loosely translated as 'general innovations', a commercial brand and manufacturer of small UAS
DOTMLPF	Doctrine organization training materiel, leadership (and education) personnel and facilities
ECM	Electronic countermeasures
FO	Fleet operations
FIC	Fundamental inputs to capability
FPV	First person view
HEAT	High explosive anti tank
HQ	Headquarters
IED	Improvised explosive device
IFV	Infantry fighting vehicle
IGO	Informatised group operations
IR	Infra red
ISO	Informatised swarm operations
ISTAR	Intelligence, surveillance, target acquisition and reconnaissance
LIDAR	Laser image detection and ranging
LM	Loitering munition
M-Kill	Mobility kill
MBT	Main battle tank
MOTS	Military off the shelf
MSF	Medicins Sans Frontieres
MSR	Main supply route
NCO	Non-commissioned officer
OCP	Olvanan Communist Party

OMM	Olvanan Maritime Militia
OPA	Olvanan People's Army
QRF	Quick reaction force
sUAS	Small uncrewed aerial systems
SALH	Semi active laser homing
SAM	Surface to air missile
SEAD	Suppression of enemy air defense
SHORAD	Short range air defense
SOCMED	Social media
TEPIDOIL	Training equipment personnel information; (concepts and) doctrine organisation infrastructure and logistics
WHO	World Health Organisation