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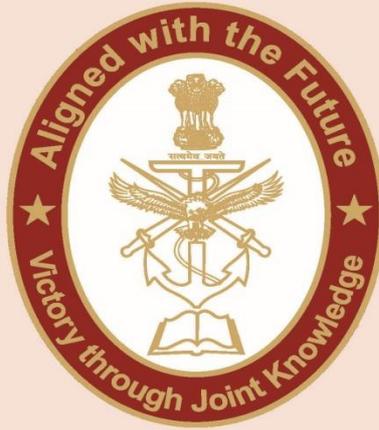
# EMPLOYMENT OF FIRST PERSON VIEW (FPV) DRONES: A NEW PARADIGM IN DRONES' WARFARE

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### **EMPLOYMENT OF FIRST PERSON VIEW (FPV) DRONES: A NEW PARADIGM IN DRONES' WARFARE**



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### **Abstract**

*The world has witnessed numerous drones' standoff attacks and wars in the 21<sup>st</sup> Century. However, it was a mad race for the maximum capabilities- longest range and endurance, largest payload, longest power backup, deadliest munition, highest altitude, heaviest size, most secured communication, etc. Despite the hysteria surrounding drones, one thing that has stood out is that boots on ground still matter the most. However, the prolonged periods of static attrition warfare in the Russo-Ukraine conflict ushered in the era of small simple drones where innovative tactics and fastest speed in kamikaze style target engagements led to the introduction of First Person View (FPV) drones in the tactical battlespace. These highly affordable FPV drones have severely disrupted the survivability of those boots on ground, thereby forcing changes in combat tactics. The innovative evolution of FPV drones by both Ukraine and Russia has thus introduced a new paradigm in drone warfare on all critical combat fronts triggering changes conceptually, doctrinally, in organisation structures, technological evolution including counter measures, and calls for adoption of a coherent whole of nation approach (WONA). This paper will analyse each of these issues to draw out implications in Indian military context.*

## Introduction

“The courage of Ukrainians+ Technology= the key to Ukraine’s future victor”

*-Ukraine’s Deputy Prime Minister Fedorov (April 2023)*

Every new war brings an era of new technology and lessons as we transform militarily from an era where ‘Tactics Determined Technology’ to an era where ‘Technology can also determine Tactics.’ The Russo-Ukraine and Iran-Israel conflicts are daily unearthing a new military lesson with rapid-pace battle-testing of new technologies. In a drones infested, GPS-denied, Electromagnetic (EM) contested and dense Air Defence (AD) environment, two major takeaways that stands out in the ongoing decade of 2020s is the mass commercialisation and the miniaturisation of the drones and that confrontation competition in the ‘drone – anti-drone’ category is just beginning.

The American Gulf wars against Iraq and Operation Enduring Freedom in Afghanistan introduced the era of drones’ warfare. While these wars witnessed one sided drones’ employment, it was the Armenia-Azerbaijan war which made it a near peer two-sided drones’ conflict. However, it was the Turkish TB-2 Bayraktar UAV which brought victory for Azerbaijan over Armenia. The Russo-Ukraine and Iran-Israel conflicts have innovatively progressed many steps ahead evolving the drones’ employment methodology with every new battle. The Russia-Ukraine conflict has shown that the density of AD and electronic warfare (EW) platforms on both sides in conjunction with their well-enmeshed Intelligence Surveillance Reconnaissance (ISR) networks severely restricted the range and depth of long-endurance large drones. The initial successes of Turkish TB-2, to blunt Russian advances on narrow Ukrainian streets, lost charm soon and gave way to proliferation of smaller Iranian Shahed drones being exploited by Russia.

The Russo-Ukraine conflict is the first 24x7 drones war where both sides innovatively employed robust drones-based reconnaissance-strike complexes (RSCs) at tactical and operational levels<sup>1</sup>. This war witnessed millions of small-drones being employed in high-intensity conflict zones including commercial pieces by both sides to achieve decisive victories in battles covering ISR, propaganda, and kamikaze strike missions<sup>2</sup>. The conflict introduced a new specialised sub-section of drones’ warfare – First Person View (FPV) drones.



**Figure 1 – Russia’s Ghouls FPV Drone**

(Source- David Hambling<sup>3</sup>)

FPV drones are simply home-made versions of loitering munitions. They are small drones with camouflaged launch capability which extend the pilot’s view to that of the drone by placing the drones’ view in the pilot’s goggles. Having been developed out of commercial off-the-shelf (COTS) racing drones without the requirement of stabilisation for hovering, they have excellent manoeuvrability but require specialist pilot skills. For anyone who has read Indian epic Mahabharata, it is a tactical Sanjay wherein the pilot gets to observe the target area exactly as the drones’ camera sees it and thereafter engage it in Japanese kamikaze style suicide attacks. They are being effectively employed as single-use one-way attack drones to create tactical ‘Dangerous No-Move’ zones up to 10-15 km along combat battlespace by dropping explosives to cause havoc on frontline infantry soldiers even inside the trenches and to limit the use of heavy armour on the frontline<sup>4</sup>.

Ukrainians have attributed FPV drones as a key battle winning factor in defeating many Russian mechanised assaults. These new variety of drones gave Ukrainian forces the initial tactical edge where they have been consistently outnumbered and outgunned. As per official Ukrainian statements in March 2023, they required 20,000 artillery shells daily for combat sustenance for effectively using the nearly 300 Western-made artillery systems. Ukraine was however consistently short of supplies managing 9,000 shells per day at its peak and generally remaining at one-tenth of its requirements at just 2,000 shells. FPVs played a major role in overcoming this shortfall by enabling precise and cost-effective strikes<sup>5</sup>. While the FPV drones could not and cannot achieve the matching destruction effect as that of artillery strikes, it could achieve better harassing, delaying and disruptive potential and could also simultaneously guide artillery more precisely. Integrated fire strikes with other shooters in various innovative forms accentuated their destruction potential. More importantly,

FPV drones have achieved dynamic targeting both on ground and air thereby becoming a multi-domain destruction platform.

FPV drones, in the affordable cost range of 400-500 US dollars, are thus reshaping the combat frontlines. When compared with anti-tank guided missiles and costlier loitering munitions, FPV drones became the most useful game-changer combat platform because of their low-costs, easy and innovative civil-military fused mass production and employment cycles, unprecedented manoeuvrability both against aerial and ground targets, easier evasion of radars, concealed launch capabilities, reusability even after missing targets, extending the kill-web to the tactical commanders right up to section commanders and even individual crews. The Russians adapted very well to this new trend and evolved their own tactical RSCs by employing FPV and small drones very effectively. Thus, the evolution of FPV drones has brought in a new paradigm in drones' warfare by triggering a revolution in military affairs conceptually, organisationally, doctrinally, and technically.

### **'Detection equals Destruction' Concept**

Drones, mainly FPVs, acquired 86-90% targets for Ukrainians as per various claims. The two opposing forces shortened the hunter-killer kill-chain cycles to 30-180 seconds aptly battle-proving the new combat concept "Detection Equals Destruction" with Artificial Intelligence (AI) enablement of the procedures from acquisition to tracking to engagement. FPV drones transformed Artillery's conventional munition into precision munition and facilitated distributed Artillery employment<sup>6</sup>. The versatility of FPVs eased dynamic targeting by swift engagement of fast-moving targets up to 12 km away. Russian forces altered their counterbattery-fire concept with increased reliance on loitering munitions, effectively employed cheaper Iranian Shahed-136 loitering munitions to deplete Ukrainian air-defences<sup>7</sup>, and intelligentised (AI-enabled) their EW procedures to counter Ukrainian drones<sup>8</sup>. Samuel Bendett aptly summarises this- "the rapid rise of commercial-grade drones such as the DJI Mavic, along with the unprecedented impact of thousands of FPV drones, has created a battlespace that is increasingly transparent, with numerous remote-controlled ISR assets guiding combat drones ready to pounce on any target"<sup>9</sup>.

The new military buzzword is “Big isn’t Beautiful anymore.” Large costly radars and tanks have been decimated by small explosive laden FPV drones. Sergio (2023), based on data analysis, claimed that successful FPV and Mavic-style drones’ strikes accounted for 25% of all damaged and destroyed Russian equipment, comprising 42% of tanks and 47% of armoured vehicles. FPVs, the aerial kamikaze tank-destroyers, established a new record of effectively hitting 428 Russian combat platforms- 75 tanks, 88 APCs, and 153 artillery pieces from 09 September to 16 October 2023. Thus, the fundamental tactical concepts such as “front,” “rear,” and “forward line” have been altered by just two phrases: “target” and “non-target” for precise remote kamikaze FPV drone strikes. The kamikaze role of FPV drones was extended to from ground to aerial domain too as Ukrainian FPV drones shot two Russian helicopters mid-air during combat on two different days in August 2024<sup>10</sup>.

The other conceptual Idea re-proven in the ongoing drones’ conflicts world over is that quantity can overcome quality. In the case of Russia-Ukraine war, production of thousands of drones per day has become a norm. These small commercial low-tech, lightweight FPV drones have altered the modern combat battlespace by delivering tactical battle victories as against the much costlier million-dollar large-size drones whose success is contingent either on the absence or failure of enemy’s air-defences<sup>11</sup>. Estonian President Kaljulaid’s quote “there is no point in having one fancy weapon if the enemy has 10,000 non-fancy ones” aptly summarise this idea. It is evidently proven that despite establishment of technology-enabled powerful systems, quantity can overcome quality<sup>12</sup>.

## **Organisation**

The establishment of drone-enabled RSCs, civil-military drone units and strengthened robust drones’ military industrial complex were the key organisational innovations. Ukrainian Aerorozvidka drones’ units, comprising civilians and military persons, crowd-funded faster drones’ procurements. Data shows that approximately 60,000 drone operators were provided privatised training with basic proficiency in one week and expertise in 2-3 months with operational experience<sup>13</sup>. Ukraine spent 867 million US Dollars to procure 200,000 kamikaze drones in 2023 itself and built an ‘army of drones’ for frontline surveillance. The Russians allocated 60 billion roubles for a new national drone base with a very ambitious aim of achieving 41% of drones’ production capability worldwide having “Made in Russia” label by 2025<sup>14</sup>. The significant rise in Russian

drones manufacturing capacities is well recorded by Gabriel Collins in his LinkedIn post of 27 November 2024. In the graph prepared by him below, he highlights a significant rise in long range kamikaze drones since September 2022 to November 2024. A similar surge is appreciated in FPV drones' manufacturing capacities.

### **Figure 2: Russian Surge in Drones' Capacities**

(Source- Gabriel Collins, LinkedIn, 27 November 2024)



Ukrainian drone units can be found holding most parts for the frontline. A very fine case study is of the Ukrainian drone unit Yasni Ochi, deployed at Chasiv Yar under the 23<sup>rd</sup> Mechanized Brigade in the Avdiivka sector. It is claimed that within a six-month period, the 150-strong team, could upset combat force ratios by eliminating over 1,500 Russian soldiers with minimal own casualties<sup>15</sup>. Another major Ukrainian organisational expedient is the Brave 1 Defence Cluster which has been jointly established by Ukraine's Ministries of Digital Transformation, Defence, Strategic Industries and Economy, Ukrainian Military and the National Security and Defence Council. The Brave 1 Defence Cluster, enabled by new Prozorro procurement platform, has fast tracked the mass drones' procurement procedures incorporating latest innovative solutions at cheapest prices.<sup>16</sup>

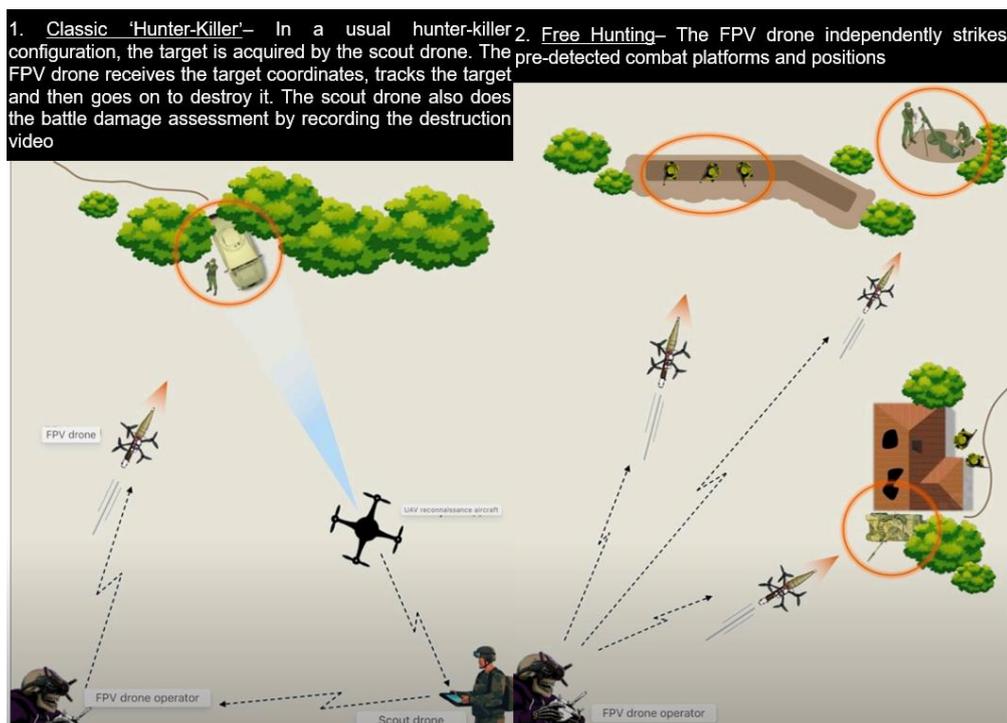
## Doctrine

FPV drones replaced forward soldiers wherever possible. Many experts claim that complete armed reconnaissance companies were replaced by FPV drones' units as these Manned-Unmanned-Teams (MUMTs) executed the 7Ds tasks on the battlefield- Dangerous, Destruction, Dull, Dirty, Decoys, Difficult and Disruptive. Every possible combat task and innovation was battle-tested on FPVs from mounting of machine guns and delivery of repurposed munitions against enemy equipment and personnel to logistics delivery in addition to the standard ISR, artillery fire adjust, communication relay, battle damage assessment (BDA).<sup>17</sup>

A manual on FPV drones' employment and countermeasures being circulated on Russian telegram channel, translated by a Ukrainian S Curtis on LinkedIn, provides an idea of variety of combat roles performed by FPV drones – Classic Hunter-Killer; Free Hunting; Group Strikes; Assault Support; Ambush; Combined Strike; Double Blow; Trap with multiple options; Miner; Sapper; Delivery mode; Dragon; Aerial kamikaze; Raid; Marsupial; On Wires; Buildings' Inspection; Broadcast; and Flipping. Each role has been explained below by the pictorials downloaded from a series of three posts of Curtis on LinkedIn<sup>18</sup>.

### **Figure 3: Roles for FPV Drones from FPV Employment Manual Circulating on Russian Telegram Channels with Translation Available on LinkedIn**

(Translated Diagrams by Curtis<sup>19</sup>)



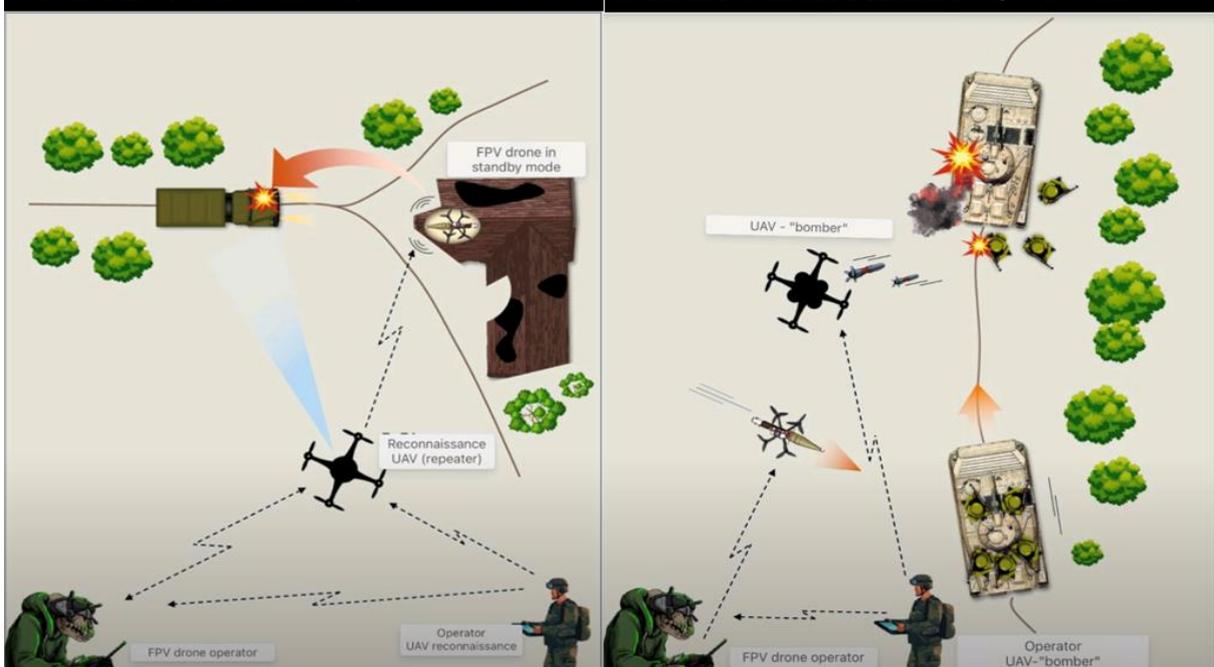
3. **FPV Group Strikes**– In a hunter-killer configuration, the target is acquired by the scout drone. A group of FPV drones, generally between 5 to 12, exploit the mass objective suitably integrated with simultaneous artillery and kamikaze effect to destroy multiple targets. To maximise the destruction impact, direction of artillery / mortar fire can be integrated simultaneously. The scout drone does the battle lifted for safety reasons.

4. **Assault Support**– A group of 3-5 FPV drones, guided by the reconnaissance drone, support the assault on an objective suitably integrated with simultaneous artillery and mortar fire. This method would be beneficial for last 250-350 metres of assault when artillery fire would have to be integrated simultaneously. The scout drone does the battle lifted for safety reasons.

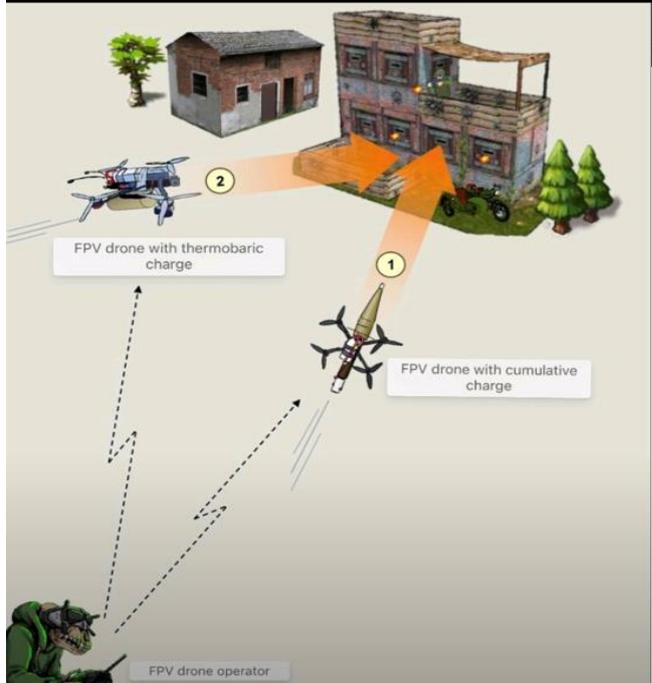


5. **FPV Drone Ambush**– A FPV drone occupies a pre-selected concealed ambush site by landing earlier and waiting for enemy movement along an anticipated route. A repeater UAV is employed to enhance the depth more than 5 km with a waiting time up to 6 hours. During night, the FPV operator attacks the headlights of the vehicle or uses Thermal Imager which is costlier and heavier.

6. **Combined Strike**– A FPV drone and a bomber drone, like Baba Yaga or Black Window, conduct a joint strike to inflict damage by a mixture of fire and bombs with either one employed first. During engagements of armoured vehicles, FPV drone strikes first followed by bomber drone targeting evacuating personnel. In case of unarmoured vehicles, fire bombs demobilise the vehicle followed by FPV strikes.

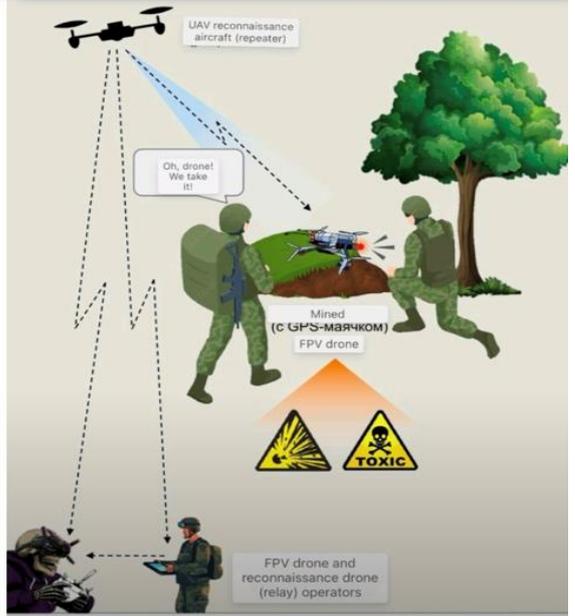


7. Double Blow— A tandem use of 2 or more FPV drones with mixed charges successively to initially punch a hole with a cumulative charge to provide passage for the following FPV drones to deliver thermobaric or shrapnel to inflict damage inside the building or vehicle.

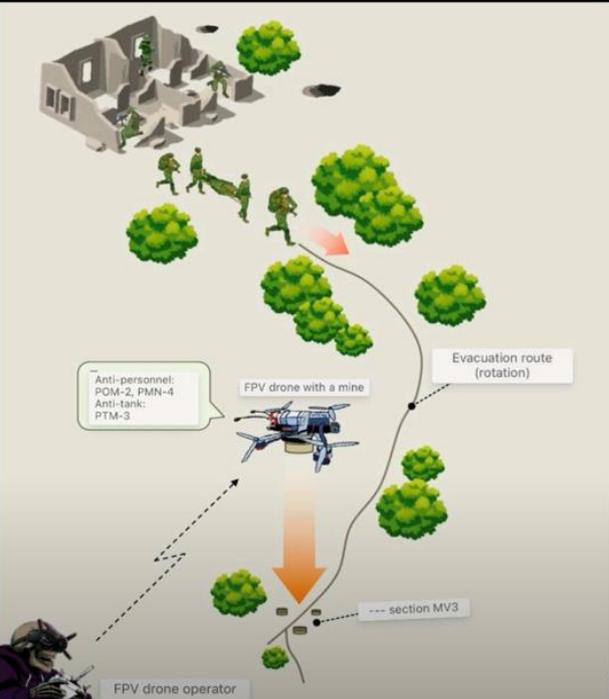


8. FPV Trap with Multiple Options—

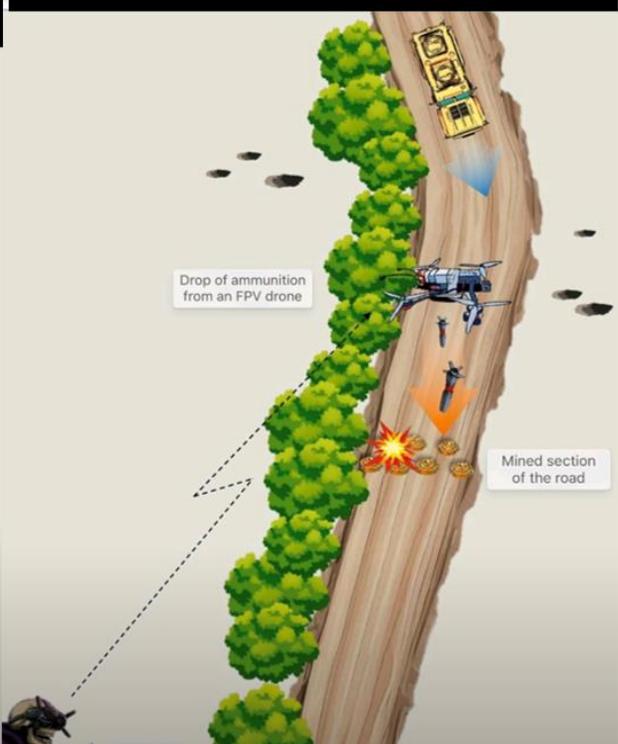
- Relay UAV operator explodes a pre-landed UAV when approached by enemy soldier to capture it
- Self-detonation option, on change of position, based on a magnetic target sensor installed on metal
- Placing 20 to 50 grams charge into the drone design which is activated whenever the drone is dismantled
- Pre-treatment of toxic substances on drone's body



9. FPV Miner— A FPV drone is employed for delivery and concealed laying of anti-personnel / anti-tank mine / IED along deployment or evacuation route or near enemy combat locations to maximise destruction of personnel and equipment.



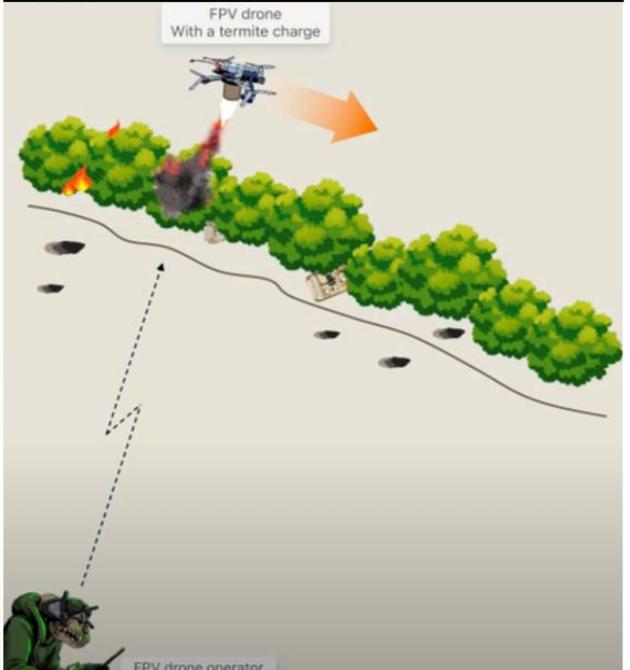
10. FPV Sapper—FPV drone is employed to demine a particular area / route by dropping ammunition or an overhead charge on open mines



11. **FPV Reset / Delivery Mode**—Reconnaissance UAV guides the FPV drone to drop ammunition on enemy personnel in open or less protected shelter. The delivery mode may also be employed for delivering useful goods to own troops.



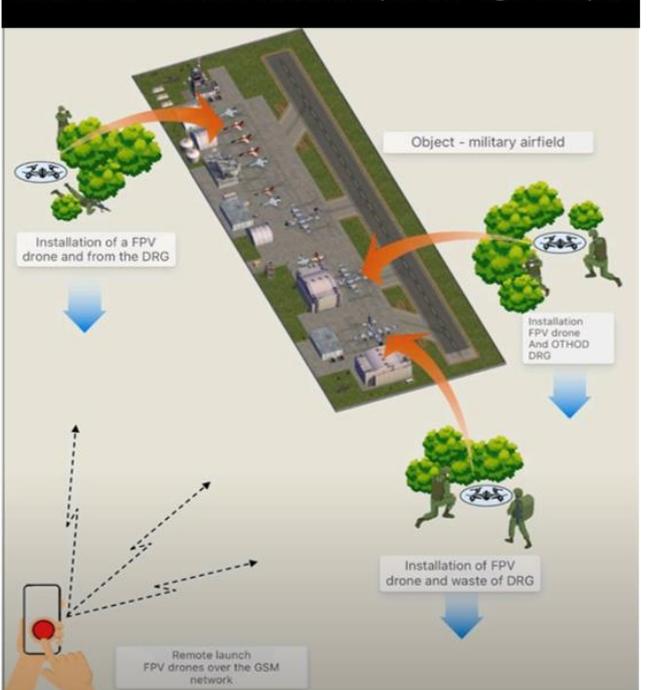
12. **FPV Dragon**—A FPV drone, equipped with thermite charge (20mm artillery incendiary ammunition) is employed for spraying incendiary mixture over the enemy's combat positions from a height of 20 to 50 metres to generate temperature over 2300 degrees thereby causing a burning time of up to two minutes



13. **UAV Destruction / Aerial Kamikaze Role**—In aerial kamikaze role, FPV drone is used to destroy enemy reconnaissance UAVs and hexacopters flying at altitude of up to 3 km and speed up to 110 kmph. Based on the detection and tracking by own radar operator, FPV drone is launched to detonate fragmentation charge in proximity while approaching or by ramming the enemy aircraft



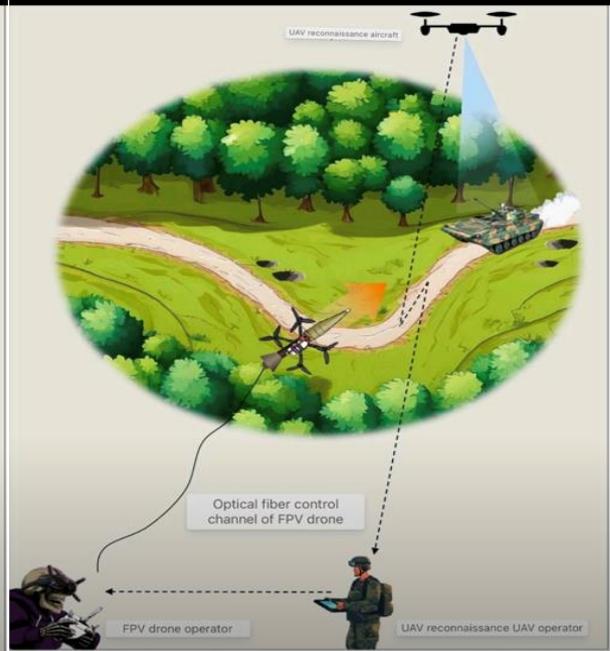
14. **FPV Saboteur / Raid**—A group of 4 to 6 FPV drones, are pre-placed at a distance of 2-3 km from the intended target with pre-loaded target coordinates and switched to 'waiting mode'. The GSM network signal is then used to remotely activate the FPV drones to strike the planned targets complex



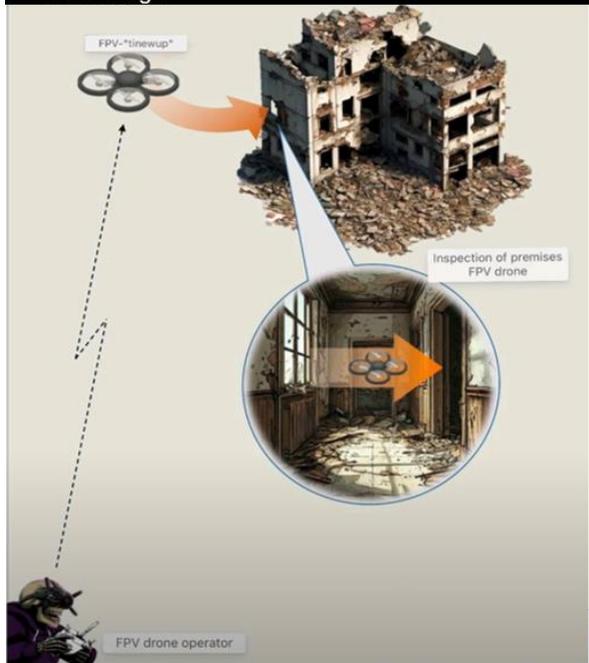
15. **FPV on the Uterus / Marsupial FPV**—A mother UAV carries 2-3 FPV drones and also acts as the relay UAV to extend the range to 60-70 km of FPV drones. In a multi-domain environment, unmanned boats could also be employed in the marsupial role by carrying FPV drones



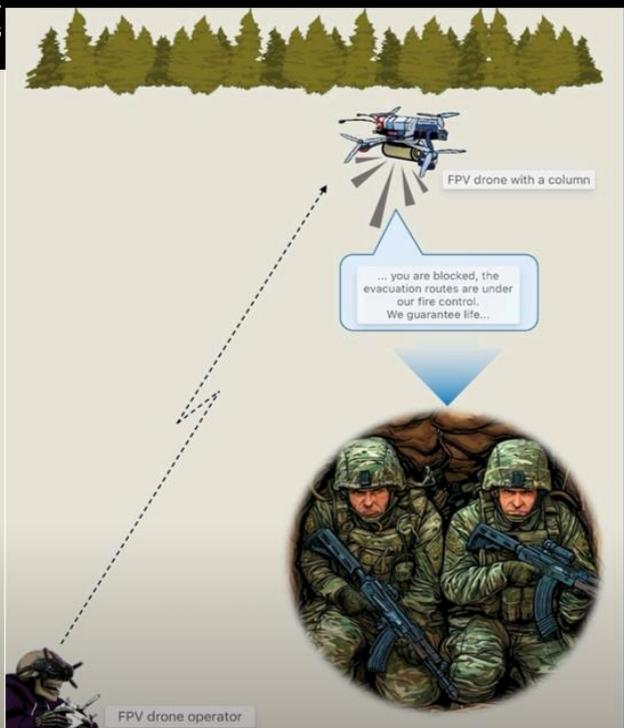
16. **FPV On Wires**—Fibre-optic cable is used to negate RF detection and improve video clarity thereby ensuring guaranteed target engagement up to 10 km (extendable up to 25 km). However, sharp manoeuvres and areas of fire are to be avoided.



17. **Inspection of Buildings**—Special short range FPV drones, micro copter with blade protection, are employed to investigate the interiors of buildings for detecting enemy in urban warfare. The special dimensions are 100mm in diameter, 50 grams weight, flight time up to 4 minutes and communication range up to 500 metres inside buildings.



18. **FPV Broadcast**—FPV drones with speakers, at a height up to 50 metres, are used for psychological warfare by broadcasting messages for disrupting morale of enemy troops and even coercing surrender.



19. Flipping FPVs—As psychological warfare tool, FPVs are used for dropping leaflets (nearly 200 of them weighing up to 2 kg) on to enemy positions.



Combat dispersion has become a survivability essential in the new drones-infested environment. The effectively employment of FPVs and corresponding doctrinal evolution forced both sides to change their combat tactics and adopt widely dispersed deployment forgetting the erstwhile concentrated infantry deployments and long tank convoys etc<sup>20</sup>. Randy Noorman highlights that Russian sensor-shooter combination of *artillery* superiority and drones-based sensors prohibited Ukrainians from infantry deployments larger than company size, since larger deployments were easily detected and effectively targeted from standoff distances. Ukrainian infantry companies thus undertook dispersed deployments up to three kilometres wide, occupying defended localities frontages that were traditionally occupied by their brigades<sup>21</sup>.

One more impact of FPV and small drones has been a shift by both sides to motorcycles replacing armoured vehicles as the transportation mode. With less dust and resultant reduced visibility to enemy drones, the evasive agility, covert manoeuvrability, and reduced battlefield profile for small crews outweighs the protection provided by traditional armoured vehicles. With tanks mobility on the frontline becoming more costly and destructive, Ukrainians have moved back their M1A1 Abrams tanks from the frontline to indirect fire role. In fact, Ukrainian FPV drone commander has gone to predict “a future where vehicles will not be able to move within a 12-mile grey zone” due to small drones’ dominance<sup>22</sup>.

As the Russians improved their dispersal and vegetation cover, Ukraine further modified their FPV drones to develop “Dragon drones” also known as “Dracarys” sometime around August 2024. These drones sprayed molten thermite on Russian positions at temperatures of nearly 2,000-2,200 degrees C to ignite enemy cover and fortifications and forcing the exposure and thereby causing Russians to desert their combat position<sup>23</sup>.

Curtis summarises important lessons in battlefield tactics to counter FPV drones. His recommended measures include earliest detection of FPV drones; enhanced hardening cum protection measures of own positions and equipment; optimal concealment; regular changing of profile of camouflage nets with blurred silhouette; complete blackout drills at night; passive detection of enemy’s FPV drones’ video transmissions; and controlling the sky from both rear and flanks during convoy movements.<sup>24</sup>

### **Technical**

Russo-Ukrainian war has marked a return of technological innovation on the battlefield as it became a battle test lab for laboratorial drone experimentation. Majority of the global drone suppliers’ including Chinese DJI have tested their disruptive drones’ technologies, faced problems, and fielded their subsequent adaptations. Most American drone companies are looking for the tag ‘battle-tested in Ukraine’ to sell their drone products to US Department of Defence<sup>25</sup>. The FPV drones by themselves have seen continuous technological advancements. Ukrainians claim of launching a new FPV drone grenade launcher as well as plan to add thermal imaging sights for night operations by FPV drones. The munitions variety tested ranges from high-explosive and cumulative to thermobaric and fragmentation rounds. Ukrainian Brave 1 defence cluster is now testing a naval FPV drone- Hard Cat Drone to destroy small motorised boat as also for clearance of anchor mines<sup>26</sup>.

The most significant technical development is the Intelligentisation of drones. When the war began, neither the Ukrainians nor the Russians had onboard AI/ Machine Learning (ML) capabilities. However, extensive combat operations and battle testing has enabled incorporation of AI/ML and image recognition techniques for automatic target identification through various visual and language learning models<sup>27</sup>. Ideal example is the latest AI enablement of FPV drones for the last 100 metres target engagement

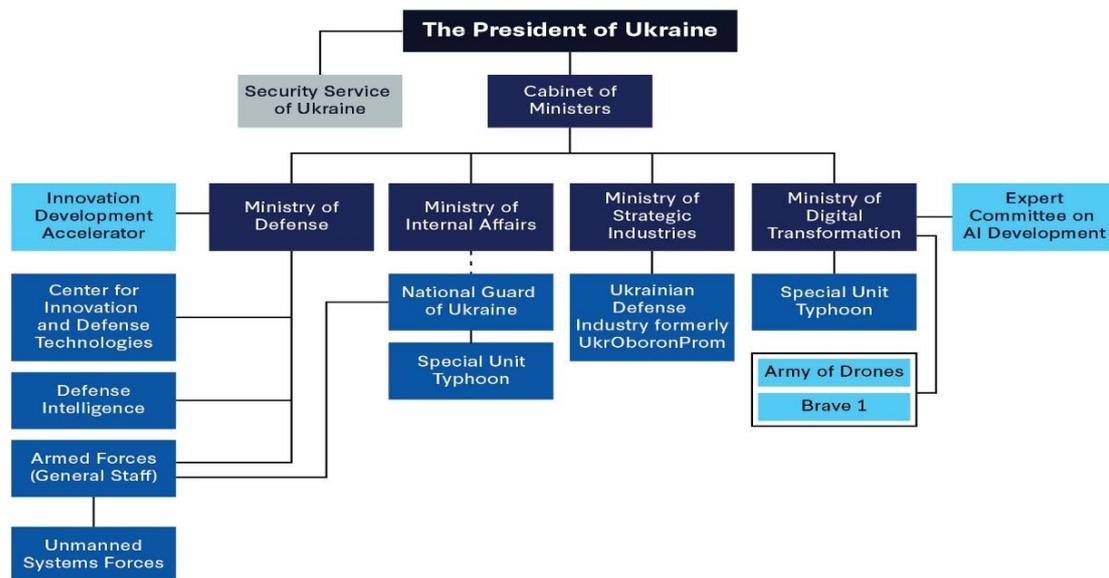
wherein professional pilot skills were required as the drone suffers communication loss due to altitude loss for final target engagement. The Ukrainians have just developed machine vision FPV drones. A CSIS report of November 2024 has aptly mapped the organisation structure of Ukrainian AI and drone management organisational structures.

### **Figure 4: Ukrainian AI, Innovation and Drone Stakeholders**

(Source- Bondar<sup>28</sup>, CSIS, November 2024)

#### **Map of Military AI Stakeholders in Ukraine**

■ Central bodies of the government   ■ Structural units of central government bodies, state-owned entities  
■ Initiatives with government participation   ■ Agency in direct subordination to the president



Source: CSIS analysis.

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The counter-drone technology development initially faced challenges against FPV drones but it eventually caught up predominantly the Radio Frequency Jammers. In the counter-drone domain, the ever-changing drones' threat assessment surpassed the camera and access control system towards a more complex 'drone detection and monitoring system' (Edwards, 2022). Ukrainian Brave 1 Defence Cluster held a Jammer Hackathon from 29 November to 01 December 2024 with a prize money of 100,000\$ to identify asymmetric counter measures to counter Russian drones. The two major solutions being sought were disablement of drones used by Russians like DJI Mavic 3 or Autel 4T by cyber intervention, manipulation, and component interference; and automating detection and tracking of FPV and anonymized commercial drones. The counter-drone firms have established a new specialisation field called Drone forensics to enable defenders to build better drone counter measures. Analysis of

adversary's fallen / captured drones is also being conducted to develop appropriate defensive tactics, concepts, and doctrine<sup>29</sup>.

As the counter-drone measures evolved, so did the hardening and resilience capabilities of the FPV drones themselves with latest evolution being the optical fibre based FPV drones. The optical fibre FPV drones, though limited in range due to cable weight and intervening obstacles, face minimal rain disruptions, are resistant to jamming and EW techniques, and thus have made most of the Counter-drone systems ineffective. Ukrainian Brave 1 FPV vs EW tests have adopted 'Solution Battles' testing methodology to test a FPV drone along a 6 km saturated stretch of active EW systems in November 2024. Few EW resistant FPV drones, out of 45 tested, managed to execute their intended missions on intended target in realistic conditions thus providing diverse solutions and iterative improvements in FPVs to overcome counter-drone platforms<sup>30</sup>.

### **Innovation**

The two major ongoing conflicts Iran-Israel and Russia-Ukraine have proven that innovation must meet necessity in the modern combat battlespace. Ukraine's employment of low-cost FPV drones has MacGyvered innovations to overcome precision-guided munition shortages. FPV drones have provided section commanders their own integral airborne real-time imagery reconnaissance and strike capability<sup>31</sup>. In this era of Battle-space attempting simultaneous 'Autonomisation', 'Robotisation' and 'Intelligentisation', two stages of 'Man-in-the-Loop' and 'Man-on-The-Loop' have been effectively demonstrated both in the FPV drones and counter-drone system development during war. Rapid innovations in face of combat have thus become a major battle winning factor. Ukrainians have proven their edge in the ability to innovate, accept new ideas, swiftly implement effective solutions which define success on the battlefield. The Russians have smartly copied the solutions and implemented them on a larger scale with their mass manufacturing capacities further helped by Chinese and Iranian R&D bases. Thus, the Russo-Ukraine conflict has become a crucible for technological innovation<sup>32</sup>.

Makysm Cherkis, a Ukrainian Defence Tech Innovator in his LinkedIn post of 28 November 2024, has aptly explained Ukraine's unique initiative 'Iron Field' for innovation, research, and development (R&D), and testing of cutting-edge defence

technologies. The initiative has been launched together by Ukrainian Ministries of Strategic Industries and Defence, Ukrainian Military and the Brave 1 FPV defence tech cluster. The ‘Iron Field’ project is an attempt to bridge the gap between innovative idea and successful battlefield solution by providing defence industries with free access to military testing facilities, military experts’ evaluation, and critical feedback during initial R&D. This project, since its test evaluation in August 2024, has received 70 defence manufacturers’ applications, completed full testing of 20 of them by 28 November 2024 and 6 are in que for early testing<sup>33</sup>. The combat employment of FPV and small-drones facilitated Russian and Ukrainian militaries to gain significant temporal advantages by winning battles by combat *innovations at tactical levels*. FPV drones’ innovators have proven that “there can be a solution for each battle-space problem encountered rather than a problem for each solution” as exemplified by the infographic below: -

**Figure 5: FPV Drones’ Innovation Cycle**

(Author’s research)

Technology / Example	Problem Encountered	Innovative Solution
Large Drones (TB-2 Variety)	Dense AD, EM contestation	AD saturation by large numbers of small drones
Small Drones / Loitering Munition (Shahed)	Slow speed; high cost; Stability for hovering	Low cost racing drones upgraded into FPV drones
FPV Drones	Vegetation cover	Dragon FPV drones dispensing Thermite; automatic target recognition
Upgraded FPV Drones	Radio Frequency Jammers, battery life	AI.ML enablement for last mile guidance, & Fibre Optic FPVs
Counter-Drones	EW resistant & Fibre Optic FPVs	Cyber Hacking; AI enabled automated detection

**Civil-Military Fusion (CMF)**

In the ongoing Russo-Ukraine war, drones’ demand is daily exceeding the supply capacities. With restricted access to Chinese drone industry that too through covert European links, an ecosystem of non-profits and volunteer groups and more than 200

Ukrainian firms have persistently tried to manage drone supply chains<sup>34</sup>. Massive crowd-funding campaigns like the Dzyga's Paw, have supported over 100 military units to build robust supply chains. Ukraine's innovative massive employment of non-military drones and mastering of expertise by its volunteer Aerorozvidka units has been facilitated by inspiring involvement of Ukrainian civil society including the low-cost commercialisation of high-level sensors, easy-to-use control, and seamless FPV drones. The Aerorozvidka units evolved cross-domain tactics fusing cyber-security with drones to enhance battlespace awareness and precise direction of conventional artillery fire and missile batteries to minimise wastage. Google Meet has been used to livestream drone footage, providing commanders real-time combat ISR<sup>35</sup>. Such privatisation of Ukrainian drones' doctrine development most likely gave Ukraine an edge over Russia's comparatively lower-quality technical specialist corps<sup>36</sup>. The fast pace civilian experts supported technology development, their deep understanding of military requirements, innovative mindsets challenging the status quo, coupled with military doctrinal transition demonstrated true CMF thereby enabling product refinement by producers' directly in contact with frontline troops in the face of war<sup>37 38</sup>.

On the Russian side, the small drones' production did not exist at the start of the conflict but only took off later. The Russians have also relied on volunteers to scale up production. However more affected by military bureaucracy, the quality and quantity of Russian military's FPV drones are not equally spread amongst all units. Wherever, the frontline units have taken initiative, they have got more drones. The biggest Russian producer of FPV drones is the volunteer group Sudoplatov Battalion which is most likely financed through 'charitable donations' from wealthy Russian backers. The group claims to produce more than 1,000 Vanguard VT -40 FPV drones daily with more than 90% components supposedly coming from within Russia. However, the build quality of Sudoplatov's VT-40s is projected as poor due to lack of assembly standardization wherein one-third cannot even take off. The numbers of FPV drones launched are also restricted by the limited number of pilots trained. On being launched, many are lost because of poor coordination with inadequately trained Russian drone pilots and their own EW platforms. And when they finally reach Ukrainian lines, the Ukrainian defenders are ready with jammers tuned to the right frequency to knock them out. An extremely grim situation painted claims that few Russian FPV operators have been launching 30-40 drones daily with zero hits. New Russian drone groups Ghoul, Joker, Piranha, Gortenzia

and others have also entered the production race and claim better quality than Sudoplato<sup>39</sup>.

**Figure 6: Russian drone makers Sudoplato’s poster with translated text “VT-40 FPV Drones, Munitions, Repeaters, Electronic Warfare”**

(Source – David Hambling<sup>40</sup>)



**Takeaways for Indian Military**

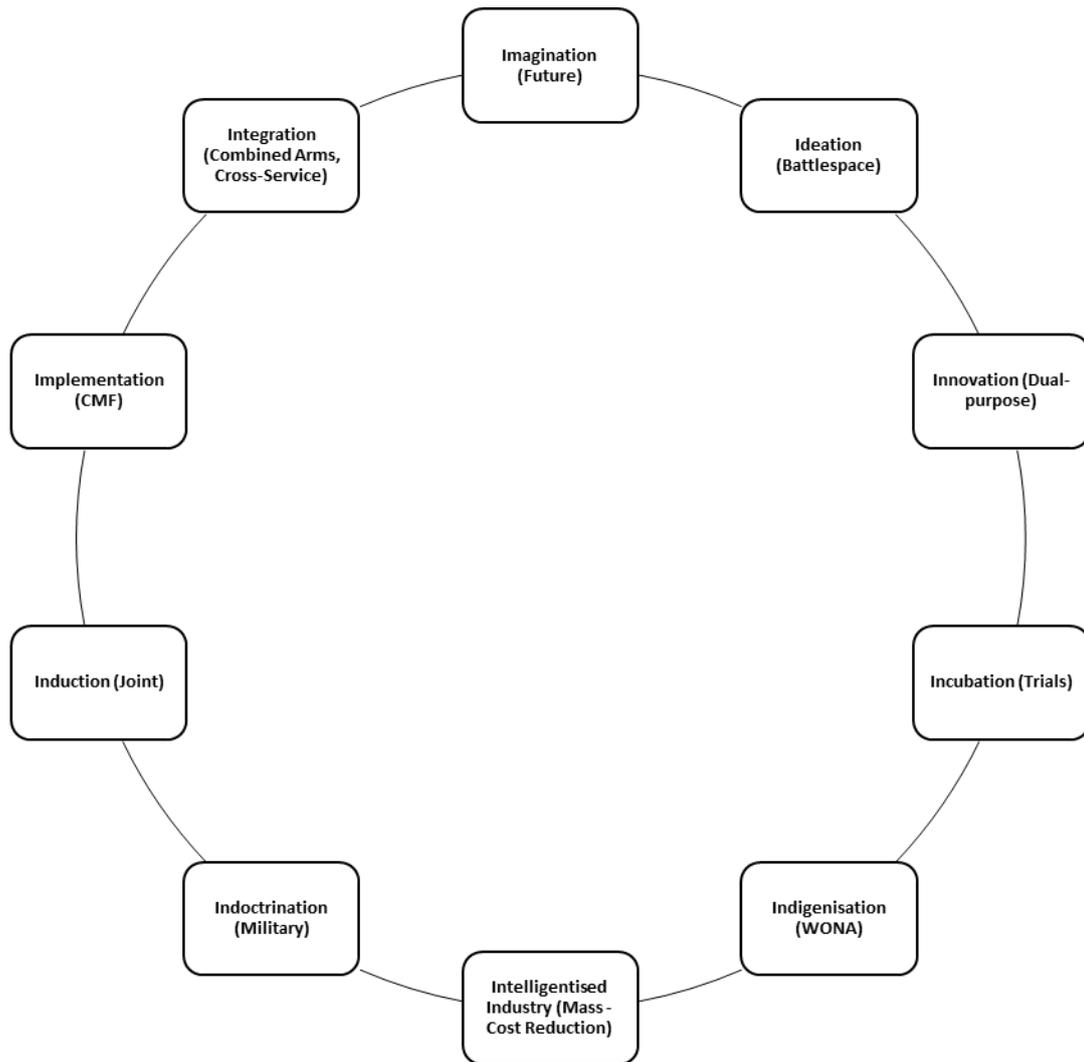
There are many takeaways from the evolution of FPV drones in the Indian military context. While the flat landscape of Ukrainian plains favoured extensive employment of FPV drones, the same maybe possible in limited fashion along Indian Western borders. However, the high-altitude terrain and narrow river valleys along Northern borders will necessitate innovative technological solutions particularly for power management. It is an accepted fact that boots on ground matter most. Hence, strengthening of the frontline soldier to protect himself from FPV drones as well as optimally exploit the same for combat tasks is vital.

The exploitation of COTS Chinese DJI MAVIC drones by both sides, Iranian and Turkish drones proves that Western domination of high-technological drones is over. Ukraine’s Digital Transformation Minister Mikhaylo Fedorov has claimed that 96% of the million drones to reach the frontlines in 2024 have been Ukrainian-made with the balance being

predominantly Chinese, and very limited Western drones have been on the ground<sup>41</sup>. With Chinese firms' monopoly in commercial small drones and components particularly batteries, its asymmetry is significant against India in combat drones. Thus, CMF particularly for daily mass-production of low-cost drones is necessary as technological evolution in the battlefield is necessary to keep pace with accelerated developments of disruptive technological.

Adoption of cross-domain combined arms innovations rapidly adapted on the battle front and smoothly integrated across the complete spectrum of Indian defence forces should become a norm. One single technological innovation can lead to many more and thus become disruptive. The mental mobility of experienced commanders and the inquisitiveness of the young combat soldiers need to be balanced optimally to derive successful battle space solutions to all combat problems. The 'status quo' approach, which breeds military bureaucracy must be curbed. Each battlefield problem must be innovatively solved indigenously. Indian military, civil and defence industry must together evolve a shortened dual-purpose 10 "Is" Innovative Technology cycle of "Imagination, Ideation, Innovation, Incubation, Indigenisation, *Intelligentisation of Industry*, Indoctrination, Induction, Implementation and most importantly Integration."

**Figure 7: Author's Proposed 10 'Is' Cycle for Dual-Purpose Technology Induction**



A lesson clearly driven home is that Technology Localisation and Indigenisation free of external supply constraints is a strategic necessity. The most efficient military technology testing is not best done in labs alone but it must happen in realistic field, under combat pressure, and particularly in collaboration with those who need it the most. Thus, every Indian military's major firing or training exercise with troops must result in a realistically validated technological solution ready for induction in field army. The Ukrainian 'Iron Field' project must be replicated to facilitate Indian MSMEs / start-ups/ tech firms to field test their new equipment during military exercises. In tune with government's 'Atmanirbhar Bharat', Indian military needs to identify one firm or its local facility, each for every military formation for integration for drones' production locally from assembly including 3D printing to repair and new technology trials expanding range, payload, resilience and altitude along Northern borders. Any kind of reliance on any foreign firm for smallest component must end whatsoever be the necessity.

With a true CMF approach, Indians have the capability to bring down the cost of standard FPV drones drastically from current 400-500 US dollars to less than 250 US dollars. When training, production and logistics backup is made dual purpose from coffee-delivery FPV drone for a lake-based boat to an aid delivery to a miner stuck deep inside to munition delivery in a counter-terrorist operation, the costs on all fronts will come down drastically. The cost cutting will automatically happen when mass production capacities of minimum 10,000 drones per month are planned for. To ensure indigenous quality at cheapest costs, the Indian GeM portal needs to rate all vendors as 'IQTC'- 'I' in terms of indigenisation component duly justified by Directorate of Indigenisation, 'Q' for quality tested in successful field evaluation trials, 'T' in terms of technology ratings and lastly 'C' being the cost.

The Indian Home Minister's announcement, at BSF function in December 2024, of creation a special counter-drone unit on Western front is a much-needed reform. There is a need to undertake organisational reforms on all fronts – section level structures to handle both MUMT, even Robotisation, and counter drone tasks; tactical military structures for small drones and counter-drone units; logistical backup; tactical and operational RSCs; civil industry liaison links; government R&D incubation centres etc. The siloed compartments within the military need to be integrated and fused so that the kill web response times of 30-180 seconds are made possible and realistically tested at all levels. The Indian government and military too need to set up Drones' Forensics Centres for both combat and non-combat scenarios.

The battlespace tactical doctrine particularly for assaults, defensive counter attacks, combat movement methodology from staging areas in the 10-30 km distance from frontline need a relook. The FPV drone manual discussed above in this paper above must be studied in detail to develop own innovative doctrine. The formation of counter-drone teams without additional manpower induction needs urgent formalised implementation. The training of counter-drone shot-gun soldier needs to be made as important as a LMG gunner. The counter-FPV protection measures adopted need a serious deliberation particularly with delayed and two stage explosive methods being used. Tactical machine simulations and wargames need to be followed up by live two-sided confrontation test exercises across all domains- air, land, cyber, EM etc to validate doctrine and tactics formulated.

The AD procedures need to be stepped up to well enmeshed Integrated Counter-Rockets-Air-Missiles-Drones (CRAMD) defence catering for AI enablement for 360 degrees protection including for FPV and small-drones. While AD detection and strike platforms will get saturated by swarms of small drones, decoys etc, optimal cost-effective solutions need to be indigenously sought for critical assets. Multi-domain resilience including dispersion and tunnelled survivability options need to be pursued ruthlessly from tactical to strategic levels optimally exploiting dual-purpose assets.

The skillset developments of our drone pilots and counter-drone gunners both in quality and quantity needs accelerated measures to be undertaken both by government and the military. Drone Territorial Army units would be ideal for agricultural / policing / surveying / delivery civil-oriented duties in peace while being capable of aggressive offensive duties both during war and annual practice exercises. Combat training both in urban and rural, plains and high-altitude scenarios must be ensured in GPS-denied, EM-contested, Drones-infested, and dense AD environments for both drone pilots and counter-drone crews.

Indian defence forces need to upgrade their talent harnessing policy wherein talent identification caters for domain specialisation in drones and super specialisation in FPV drones. The talent acquisition must facilitate direct JCO / NCO induction route particularly for drones' pilots and cyber hackers. The skillset calibration cards need to be prepared to maintain records of flying hours, target engagement and counter-drone proficiency, assembly, and repair proficiency etc.

Technological asymmetry is extremely important in today's battlefield. Every advanced military is looking at futuristic technologically advanced combat platforms. While the FPV drones came as the game changer combat technology in 2022, Robotic Dogs could be the next. China presented numerous Robodog solutions at Zhuhai International Aero show in November 2024 as a new strategic opportunity. While Chinese have made distinct advancements in swarm drones, Ukrainians have also tested centralised, distributed and hybrid variety swarms in October 2024. The Robodog based MUMTs and swarms could become essential for infantry just like the FPV drones in air. The Indian military thus needs to crystal gaze further ahead and come with up true asymmetric technological solutions for the futuristic multi-domain wars.

Last but not the least, intelligentised robotisation and automation is the future of warfare wherein mass swarms of multi-domain unmanned vehicles will fight battles as a system either with man in the loop, or on the loop and later even out of the loop. In such an AI enabled conflict scenario, data, algorithms, and computing power will play the most critical role to achieve 'Algorithmic Superiority' which will be quint essential for decisive victory. India has the capability to exploit all three pillars of AI – Data, Algorithms, and computing power. Indian military needs to integrate its vision for 'Drone Shakti 2030' on all fronts- policies, procedures, doctrine, training, infrastructure, and grey zone employment through relentless execution of planned measures.

### **Conclusion**

To conclude, FPV drones have filled the tactical gap between traditional conventional weapons and individual combat systems. While Ukrainians optimally used technology and innovation to mass-utilise FPV drones through a distinct and determined whole of nation approach, Russians covered up to neutralise many of its disadvantages of initial infrastructure shortages, poor training, and hierarchical bureaucracy by scaling up copied solutions, optimally exploiting easy Chinese and Iranian access to cheap Chinese and Iranian drones, massive Russian EW and AD capabilities and finally building up their own drone infrastructure. The Western firms have lost the technological edge in the small drones' segment at least. Although not battle-tested, the Chinese equipment display at recent Zhuhai International Aero show in November 2024 aptly propagated Chinese prowess both in drones and counter-drones spectrum.

**Figure 8: Comparison of Russian and Ukrainian FPV Drones' Employment**



Having monitored Ukraine conflict closely with world's top most drone firm DJI actively involved, Chinese military is actively focussing on incorporation of FPV drones with regular PLA units, Border Defence Regiments and even People's Armed Police as seen in their propaganda videos. They have also modified their combat vehicles like T-15 tanks in counter-FPV role. Hence, both from the perspectives of threat-based and desired capability-based advancements, Indian military needs to review its multi-domain FPV drones' policies comprehensively. 100% indigenisation of small drones through WONA is the only plausible solution ahead. The equipment production and induction must be timely matched with comprehensive doctrinal evolution, revised human resource policies, cross-services and combined arms integration, CMF, and organisational restructuring.

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